

Processes Optimization in Logistics Operational Centers

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*"Don't let the fear of the time it will
take to accomplish something
stand in the way of your doing it.
The time will pass anyway"*

Earl Nightingale

Abstract

The Logistics sector is a well-established market where there is a constant pressure to meet customer demands, add significant value to their products and maintain low prices. In this environment marked by volatility and disruptive challenges, companies that can find the right balance between the adoption of cost reduction policies and innovation, are the ones that most easily succeed. It is therefore essential to consistently refine and improve processes through waste reduction, in a way that aligns with current needs, standardized operations and increased value for the company and all its employees.

This dissertation explores the application of continuous improvement in a logistics center in order to implement improvements and optimize operations to achieve increasing efficiency. The primary focus was dedicated exclusively to incorporating daily *Kaizen* meetings across all warehouse teams, supported by physical informative boards and a PDCA cycle to track ongoing developments. To complete this process, several performance indicators were reformulated or designed from scratch and all employees trained to take advantage of continuous improvement in their daily tasks, which increased the warehouse's productivity over 10% in five months.

In addition to this implementation, this project provides analysis and results of the most complex improvements that were carried out in the warehouse. From optimizing equipment charging to streamlining a new picking line, there are many opportunities to develop processes in a logistics operational center that encompass diverse knowledge on different areas. These were particularly interesting initiatives to highlight the transformative potential of the *Kaizen* culture in environments new to continuous improvement practices.

Resumo

O setor Logístico constitui um mercado consolidado onde existe uma pressão constante para atender às necessidades dos clientes, acrescentar valor aos seus produtos e manter os preços baixos. Neste ambiente marcado pela volatilidade e por desafios disruptivos, as empresas que conseguem encontrar o equilíbrio perfeito entre a adoção de políticas de redução de custos e a inovação, são aquelas que mais facilmente conseguem ser bem sucedidas. É, portanto, essencial refinar e melhorar continuamente os processos através da redução de desperdícios, de forma alinhada com necessidades atuais, operações normalizadas e valor acrescido à empresa e a todos os seus colaboradores.

Esta dissertação explora a aplicação de melhoria contínua num centro logístico, a fim de implementar melhorias e otimizar as operações de forma a aumentar a sua eficiência. O foco principal foi dedicado exclusivamente à incorporação de reuniões *Kaizen* diárias em todas as equipas do armazém, apoiadas por quadros informativos físicos e um ciclo PDCA para acompanhar os desenvolvimentos em progresso. Para completar este processo, foram reformulados ou desenhados de raiz vários indicadores de performance e foram formados todos os colaboradores para que pudessem tirar partido da melhoria contínua nas suas tarefas diárias, o que levou a um aumento da produtividade do armazém além dos 10%.

Além desta implementação, este projeto fornece análises e resultados das melhorias mais complexas que foram realizadas no armazém. Da otimização de cargas ao desenvolvimento de uma nova linha de picking, existem muitas oportunidades para desenvolver processos num centro de operações logísticas, que englobam conhecimentos diversos em diferentes áreas. Estas iniciativas foram particularmente interessantes para destacar o potencial transformador que a cultura *Kaizen* tem em ambientes alheios a práticas de melhoria contínua.

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Acronyms

CLAV - Logistics Center of Aveiro (*Centro Logístico de Aveiro*)

CLG2 - Logistics Center of Gaia 2 (*Centro Logístico de Gaia 2*)

CMR - “*Convention relative au contrat de transport international de marchandises par route*”

DLR - Receiving Deadline (*Data Limite de Recebimento*)

DLS - Service Deadline (*Data Limite de Serviço*)

DST - Daylight Saving Time

EDC - European Distribution Center

EN - European Norm

ETA - Expected Time of Arrival

FTE - Full-Time Equivalent

JIT - Just-in-time

KPI - Key Performance Indicator

MTP - Minutes To Produce

PCB - Pieces per Case/Box

PPT - Pedestrian Pallet Truck

PV - Photovoltaic

SAV - After-Sales Service (*Service Après Vente*)

SKU - Stock Keeping Unit

TPS - Toyota Production System

UAT - User Acceptance Testing

VSM - Value Stream Mapping

WMS - Warehouse Management System

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1 Introduction

The first step to take before introducing this project is to present the company where it took place, considering not only the business area it belongs to, but also all the historical context that follows. Hereafter, it is possible to dive deeper into the project, namely, its subjects and its relevance in the circumstantial factors where the company is included. To conclude the introduction, it will be presented the way this dissertation is organized so it can be easier to understand its sequence and chain of covered topics.

1.1 Motivation and Project Framework

Nowadays, as the market becomes more demanding, there is a need to increase the competitive capabilities of companies as there is a high market pressure to maintain low prices and focus on adding more and more value to the final product. This way, every activity that does not add value to the operations should be eliminated or, at least, reduced.

In Portugal, this situation is emphasized in the Logistics Sector, as this has greater relevance when it comes to economic terms. Regarding business volume, the Logistics Sector reached around 14,7 billion euros, in 2018, showing an average annual growth of 3.7% since 2014. For this volume of business and growth, the most relevant sub sectors were “Storage and auxiliary transport activities” and “Road transport of goods”. These represented more than 90% of the total in 2018 and are also those that showed more robust growth in the period of analysis. Apart from that, in that same year, logistics costs represented, on average, around 11.6% of the overall cost structure (APLOG, 2020).

The logistics industry is a well-established and mature market, driving the need for continuous improvement to maintain competitiveness and avoid obsolescence. Simultaneously, it is a highly volatile environment with disruptive challenges that beckons flexibility, new challenges and innovative processes, instead of its stability, which lubricates specialization and continuous improvement (Interlake, 2021). For instance, the bullwhip effect, that was named by Stanford Business School Investigator, Hau Lee, describes how minor fluctuations in demand can cause significant disruptions and amplified effects throughout the supply chain. This phenomenon was particularly evident in the years following the Covid-19 pandemic, providing a perfect example of the type of strains applied to the logistic market.

This essay was accomplished at Garland Logistics, Lda, in the CLG2, the logistics operational center that is located in Vila Nova de Gaia, Valadares, which was inaugurated in August 2022. This project arose from the constant need to meet customer demands, which allied to the increasing market competitiveness and need for cost efficiency, resulted in a more complex business process, making continuous improvement mandatory to enhance all the operations of the company.



Figure 1 – Facilities of the Logistics Operational Center of Garland Logistics, Lda, located in Vila Nova de Gaia, Valadares

1.2 Garland Logistics, Lda

Garland was created by Thomas Garland as an international trading company in 1776. As a company with almost 250 years, it went through several mutations across its existence. With remarkable accomplishments throughout the 19th and 20th centuries, it was not until 1994 that the company extended its portfolio to Logistics. In 2006, Garland announced a new international brand to align its values and, finally, in 2014, it began its international expansion for Spain and Morocco. Nowadays, with over 160 thousand square meters of warehousing area in Portugal, Garland offers several different logistic services that allow it to manage all its clients supply chains through outsourcing. Last data from 2022 showed that the company performed over 8 million warehouse pickings and handled almost 3 million tons of sea cargo. Garland is currently divided into four major services:

- **Logistics:** Outsourcing and In-House warehouse management and national distribution services.
- **Transport:** International transport services by land, sea and air. It is the only service also reflected in Spain and Morocco.
- **Navigation:** Navigation services on regular lines, tramping and ship handling.
- **Corporate:** Group shared services, such as investments and management of affiliated companies.

Garland's culture is marked by three essential differentiating characteristics: globality, solidity and flexibility. These features are obtained by combining integrated solutions with worldwide reach, escorted by more than two centuries of experience, a solid financial status and an accumulated know-how to answer its clients' needs easily and promptly. One of the main keys behind Garland's success, as many other companies, is its people. With over 440 collaborators, the company considers that only the happiness of its employees will bring the satisfaction of its clients. This way, the organization's culture goes by promoting a perfect work environment where everyone is important and has responsibilities, as part of the big Garland family (Garland, 2016).

The Logistics Center of Gaia, in Valadares, is the biggest warehouse of the company. Equipped with some of the latest technology in energy efficiency, mechanical handling of goods, WMSs, Human Resources training and environmental footprint reduction, the CLG2 has 38 thousand square meters dedicated to warehousing with capacity for almost 100 thousand pallets. Most of the warehouse's operations are dedicated to support the bicycle production activity of a specific client, thus contributing to the consolidation of an important industrial export activity in the municipality of Gaia (O Gaiense, 2022). This way, the workforce is divided into four different teams: *Service Après Vente*, Components, Exportation and EDC Factory.

As several companies that work in Logistics, Garland is accustomed to face big obstacles and is very flexible when it comes to solving them quickly. When working with important clients, it is mandatory to focus on process efficiency to add the most value to the final product or service. However, as the workload increases, people are prone to center their attention more on the output, than on how it is done. This way, evaluating processes becomes a secondary task that is many times forgotten until it accumulates into a major worry. Garland's culture lacks this communication skill to, as a team, talk about its previous workday, its main obstacles and how they can overcome them with a proper solution. A simple approach that, if done daily, helps in reducing the number of times a company faces a major difficulty every now and then. Thus, this project's main goal is to implement an Operational Communication Plan, at the level of each team's workstation, that includes daily meetings with previously defined KPIs to monitor the team's operations. The execution of these meetings is crucial for the identification of small improvement opportunities that will contribute directly to increase the productivity of logistic operations. Garland's main goal for the CLG2 is to get productivity to grow around 10% until the end of 2024. This way, it is necessary to account and measure all the small gains that each of the solutions implemented reaches.

In the follow-up of this continuous improvement philosophy, Garland's CLG2 has significant enhancements that can be done to become more efficient and sustainable, since it is a recent warehouse with many aspects that need to be optimized. Thus, this dissertation was attentive to two other projects: Restructuring of the Picking Model of the Components activity and Equipment Charging Management. When it comes to the former, it was necessary to reformulate the way the picking is made for the shared SKUs, in other words, components that are necessary for the operations of two different suppliers that provide for the same client. The main goals are to increase effectiveness in the overall supply chain and to make it easier for clients to order their components, at the expense of a more complex, yet efficient picking process. For the latter, as the CLG2 has its own solar panels, it becomes imperative to join equipment charges with the energy production cycles of the logistics center to make them compatible and optimized for economic and environmental value gains.

Within a culture of daily improvement, these projects are just three of the many enhancements that can be made in the CLG2 to develop daily operations that match the company's values of globality, solidity and flexibility towards a sustainable future.

1.3 Methodology

In order to achieve the proposed goals, it was necessary to structure the different projects and define the milestones of the project. At Garland Logistics, Lda there is a large volume of information and available systems that make it critical to understand which is the relevant data for the study. This way the project was divided into five main phases, according to the plan that was made together with the company's supervisor and that can be seen on the Gantt Chart of Figures 37 and 38, Annex B.

The first phase, “Integration and Dissertation Planning”, as the name implies, was focused on getting to know the several teams and the different operations that take place in the CLG2. This way, it was necessary to know more about all administrative and operational procedures that take place in the center and the WMS that is used in these corresponding tasks. After that, a work plan was designed and proposed to support the overall project development.

The next phase, “Reformulation of Continuous Improvement and Daily *Kaizen* Program”, was dedicated exclusively to implementing everyday meetings whose main purpose was to identify existent improvement opportunities. The process to incorporate daily meetings in Garland’s operations was designed right after performing a Current State Analysis on the company. To successfully execute this plan, *Kaizen* documentation was created to help teams develop their meetings. Besides, *Kaizen* boards, meant to be kept in the workstation, were designed to help teams track all the developments implemented, in a process that demands some know-how of how each team operates. Thereafter, employees received training on how to use the documentation for their benefit and on how to monitor the solutions yet to be concluded. In a culture of continuous improvement, this phase is never fully completed as there is always something that can be optimized and adjustments that need to be made and studied.

Subsequently, in “Equipment Charging Management”, an analysis was made to identify the actual charging method so that it could be studied. Only then, it was possible to identify comparable solutions and which corresponding corrective actions needed to be implemented. After selecting the solution that better optimized the charging of equipment, all employees were trained and instructed to act in accordance with the new procedure. Throughout this project, data analysis was consistent as it was needed to survey any changes that needed to be made. The main purpose of this project was to increase the amount of energy equipment consumed from self-production by around 10%.

When it comes to the “Study and Implementation of a New Picking Line” it was first necessary to understand what the process behind the previous picking line was, before beginning the actual study. To better understand the operation, a visit was scheduled to the facilities of the CLAV, in Aveiro, to learn about a similar picking line that was recently established for a different client. After that, the most suitable SKUs for the new process were identified, along with the impact this would have on the current truck loading procedure. Following the presentation of a similar solution to be validated by the final client, a plan was created to implement the new picking line. The next step would be to monitor the solution through proper analysis, however, as the new picking line is yet to be implemented, it was not possible to measure the results and make the necessary adjustments.

The last days were dedicated to presenting the project conclusions to the management team that accompanied me throughout this dissertation. It should be noted that, due to the confidentiality existing with Garland Logistics, Lda, it was necessary, throughout the report, to safeguard internal information, in terms of prices, costs, suppliers, partners and other sensitive data. This way, many values were used in percentage in order to represent the work carried out with the best possible details, without compromising any agreement established with the Portuguese company.

1.4 Document Structure

The present document is divided into five different chapters. After this first introductory part, the theoretical contextualization in the second chapter provides the frame of reference for the work here developed, mainly regarding Continuous Improvement,

Sustainability and Statistics. In other words, the works and studies that were previously done in these areas.

The third chapter describes in detail the CLG2 and its operations. It is important to provide an accurate portrait of the warehouse's processes and its human resources to better understand the project.

Afterwards, the fourth chapter presents all the work developed during this dissertation. This includes all the documentation, calculations and methodology needed to further study the context of the project and of how the processes can be properly optimized.

In chapter five are presented the conclusions gathered from the improvements implemented and how they impacted the CLG2. Moreover, a small demonstration of the work there is to be done to further develop this project, along with some guidelines for future possibilities.

2 Theoretical Framework

In a steadily more demanding market where competition is increasing and access to information is becoming more and more important, companies are forced to be more effective and efficient in all their processes. Therefore, they must focus on eliminating waste and actions that do not add value to the product or service provided to the customer. From this need arises the concept of Logistics, aimed not only at the importance, but also at the complexity of optimizing all company's operations.

2.1 Warehousing

Ganeshan and Harrison (1995) define a supply chain as “a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers.” Warehousing is one of the stages inside a supply chain that involves significant financial and operational challenges, including storage costs, inventory management and the coordination of inbound and outbound logistics. As this is a critical point between production and the final customer, it is imperative to have a high service level, which usually implies more attention to reducing costs as much as possible.

Warehousing can be defined by three key operations: receiving, picking and shipping. Over the past few years, the demands and challenges in these areas have significantly increased. According to Frazelle (2002), today's warehouse managers are under a lot of pressure due to global competition and supply chain integration initiatives to decrease order picking times, increase throughput rates and lower costs and lead times of their operations. The increasing demands in this area forced companies to adapt and evolve in order to meet the needs of both suppliers and customers.

2.1.1 Warehousing Main Operations

There are many different operations that take place in a warehouse, but not all of them have the same level of significance when it comes to adding value to the final client. Let's look at the main activities that take place in a warehouse.

RECEIVING

As the name itself implies, this activity consists of receiving all the products that enter a warehouse to be stored. Besides this action, this operation also includes an inventory check, where the quality and quantity of all the goods received are analyzed according to specifications (Frazelle, 2002).

STORING

The process of handling the goods, checking their storage location and assigning them to that same location are all part of the storing process. This is highly dependent on the warehouse layout, on human labor (mainly in conventional warehouses) and on the inventory turnover itself. This way, storing may be one of the processes which presents more opportunities for optimization. After the goods become assigned to their location they will stay there until they are included in an order preparation. The permanence of the material stored is dependent not only on the product itself, but also on the shelving conditions and the available machines that exist in the warehouse (Frazelle, 2002).

PICKING

Picking is the main phase of order preparation, where the corresponding products are selected and retrieved from the shelves (Frazelle, 2002). This is, for sure, one of the most time and resource-consuming processes inside a warehouse, being often considered a crucial aspect when designing its layout (D'Angelo, 2010).

Discrete order picking is the most common fulfillment method and it is also the most time-consuming. In discrete order picking a single worker walks to pick all the items necessary to fulfill a single customer order. Workers search the warehouse for each item one-by-one to complete the order, meaning they often travel the same route repeatedly throughout their shift. Discrete order picking is common not only because of its simplicity and reliability, but also because of its ability to pick orders quickly upon receipt, and thus is commonly used by e-commerce operations. The greatest disadvantage is the predisposition for the pickers to travel long distances, since it is the main reason for them to take longer when preparing a single order. However, optimized layouts and data analysis for better product display, using technology, can be used to get around this obstacle, allowing picking shelves to be organized according to inventory turnover (Eisenstein, 2008).

One method of storing goods in a warehouse is on wooden platforms called pallets. A pallet may carry a single big item or several little items, depending on its size. Thus, pallet picking is used when a full pallet of goods gets picked and transported to the packing area (Inbound Logistics, 2023).

Another method that is very commonly used in warehouses is case picking. Case picking involves picking a product in full case or carton quantities from different storage locations. These cases are then typically placed by the pickers onto pallets, carts, or conveyors. This type of picking is often used by distribution centers that serve retail or e-commerce stores and it is common to have a whole section of a warehouse devoted to picking cases (Lucas Systems, 2023).

After retrieving the products there are still two actions to be made: packing and labeling. This last step allows the product to be tracked as soon as it leaves the warehouse for transportation.

SEPARATION

Products should be separated according to their final client. This includes not only the orders that went through picking, but also those that are composed by entire pallets of products from the warehouse. As previously seen, this action has many variables associated with it, such as the warehouse layout or the operational staff *modus operandis* (Pinto, 2014).

SHIPPING

To conclude the main operations of a warehouse, all the orders are shipped. From an administrative point of view, this is one of the most demanding operations, as it implies the verification of all orders, in both quantitative and qualitative ways, the sign of a contract with the conveyor who will transport the products and, finally, the loading of the truck (Pinto, 2014).

CROSS DOCKING

Cross-docking is a relatively recent activity where materials are delivered directly from a manufacturer or a mode of transportation to a customer or another mode of transportation. Cross-docking often aims to minimize overheads related to storing goods between shipments or while awaiting a customer's order.

In a warehouse, cross docking joins three different activities: receiving, separation and shipping. In this process, goods should stay only a few hours in the warehouse, which leads to decreasing lead times and increasing cost efficiency (Álvarez-Pérez *et al*, 2009).

2.2 Lean Thinking

Lean Thinking is a philosophy or a management system whose main purpose is to develop processes and procedures by focusing on waste reduction throughout the value chain of a product or service. In an organization, value is something that generates simultaneous happiness across all intervening parts: stakeholders, shareholders, clients and society. Value is everything that justifies the attention, the time and the effort we dedicate to something (Pinto, 2008).

After World War 2, chief-engineer of Toyota Motor Corporation, Taiichi Ohno, visited the Ford company in the United States of America with the main purpose to watch the concepts behind the production line suggested by Henry Ford, in 1923. However, inventory surplus across the value chain and the standard work default of workers, led Toyota's executives to conclude that the implementation of this system was far from being successful.

Just-in-time was born as one of the pillars of the TPS, whose main purpose is to instigate waste reduction in all the processes that exist for a product to be made. It is a system which allows continuous improvement and maximizes resource utilization (Shingo, 1996). The implementation of JIT enables production in small quantities, which are delivered to the client with shorter deadlines. This way, there is a faster answer to demand, which is only produced in the right quantity at the right time (Liker, 2003).

Even though it looks easy, Lean Thinking may get difficult to control, mostly if it is not assisted with tools and methods that help in its implementation. The absence of these techniques will, most likely, lead to a short life for Lean. Thus, it becomes essential to keep these measures in order to maintain a culture of continuous improvement and its continuity.

2.2.1 The 7 Wastes - MUDAs

In general, every activity that does not add value to an organization is considered a waste. This accounts for the resources consumed and the time spent of which we can't get economical or differentiating advantages from.

Identifying wastes can be a difficult task. Pure waste represents those activities that can be easily defined as fully dispensable. On the other hand, there is another type of waste, called necessary waste, which amounts to those activities that clearly don't add value to the process, but are required for it to take place. For instance, when it comes to logistics, an inventory check is needed to verify received goods, although it adds no worth to the value chain itself.

When developing the TPS, Ohno and Shingo identified seven categories of wastes, which were known as the 7 *MUDAs*. *MUDA* is a Japanese word meaning "futility", "uselessness" or "wastefulness" (Kenkyusha, 2003). These are the following wastes identified:

- **Overproduction** - when you produce more than what is necessary, when is not needed and with inadequate quantities;
- **Over-processing** - when a process is inefficient or when too many resources are used to complete a task that could have been made with less;

- **Waiting** - time spent by employees or equipment waiting for something that is preventing the normal execution of the activity. It is usually associated with the concept of bottleneck, which is a process, in a chain of processes, with limited capacity, that creates stalls in production, increase in supply stock and higher idle times (Wallace, 2015);
- **Transport** - when products or goods are transported from one place to the other the activity takes more time to be accomplished and with increased costs;
- **Motion** - similar to transport, any movement of people or equipment that does not add value to the final product is considered a waste that increases costs and task conclusion times;
- **Inventory** - keep or store goods that aren't absolutely necessary constitute a significant waste;
- **Defects** - all defects in products require reworks, imply complaints and force the need for more quality control throughout the process, which are undesirable as they imply extra costs and time spent.

2.2.2 5S

The 5S tool was developed by Kaoru Ishikawa in 1950, in Japan. It presented itself to be so efficient in optimizing the workstations that, so far, it became the main quality and productivity instrument used in the country (Moulding, 2010).

The name of this methodology emerged due to 5 different Japanese words starting with an S: *Seiri* (Sort), *Seiton* (Set in Order), *Seiso* (Shine), *Seiketsu* (Standardize) and *Shitsuke* (Sustain).

Seiri represents the removal of secondary items, keeping only what is necessary. This way, it becomes easier for employees to organize their workstations according to the *Seiton* philosophy: "a place for everything and everything in its place". *Seiso* implies that everyone should be responsible for their workstation and keep it clean. This way it's easier to identify anomalies and solve problems. The next 2 phases of this methodology focus on maintaining and controlling the first 3 S's. First, it is necessary to define what aspects to control to achieve the desired outcome in order to standardize the working area. After that, continuous work must persist in order to maintain the 5S's and to achieve more and better results. Thus, *Shitsuke* guarantees that standards are fulfilled, through honest communication, training and autodiscipline of employees so that it can become a daily routine inside the company (Imai, 1997).

2.2.3 Standard Work, PDCA Cycle and Value Stream Mapping

One of the factors that leads to a company's success involves the creation of work instructions that require employees to perform tasks according to previously defined standards. A crucial characteristic of Lean Thinking is Standardization, since it allows workers to have enhanced capabilities (Liker, 2003).

"We get brilliant results from average people managing brilliant processes."

Fujio Cho

Operations must be executed in the same way they are defined, with no margin for errors (Arezes *et al*, 2010). To ensure processes are normalized it is necessary to document all work methods so that everyone can follow the same procedure. Idealized by Rother *et al.* in 2008, VSM is a tool that allows the visualization of the course of a product or service provided. With this method, it is easier to identify the different steps, tasks and flux that such

product or service takes during its lifetime. When a process is well detailed it is useful to identify existent wastes in a more straightforward way. This way, improvement plans can be made to update or eliminate phases of the process that add no value to the final output. Despite having been projected to reduce task times, nowadays VSM has a wider appliance for different situations, with several forms of presentation and complexity degrees.

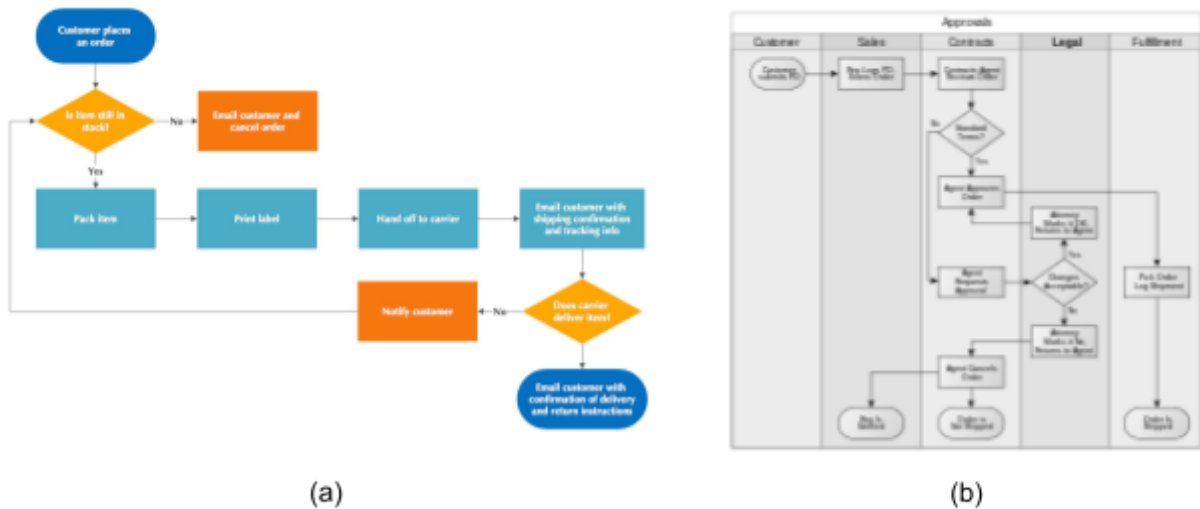


Figure 2 – Examples of (a) Flowchart (b) Swimlane

Standard work and normalization are characteristics of a company that can be supported by the PDCA Cycle. This Lean Management tool is a simple, yet efficient method used to develop continuous improvement. However, there is a relatively small number of organizations that can fully implement it in its daily routine. As a decision-making and management mechanism, it is composed by the following steps:

- **Plan** - define the problem, brainstorm root causes for why it happened and specify an action plan with determined goals;
- **Do** - execute the tasks of the action plan that was established in the planning phase;
- **Check** - evaluate the process, measure deviations and validate results;
- **Act** - share the results and lessons learned in order to train employees and implement the new process, in case it went well, or, if not, return to the beginning of the cycle and implement a new, more informed action plan.

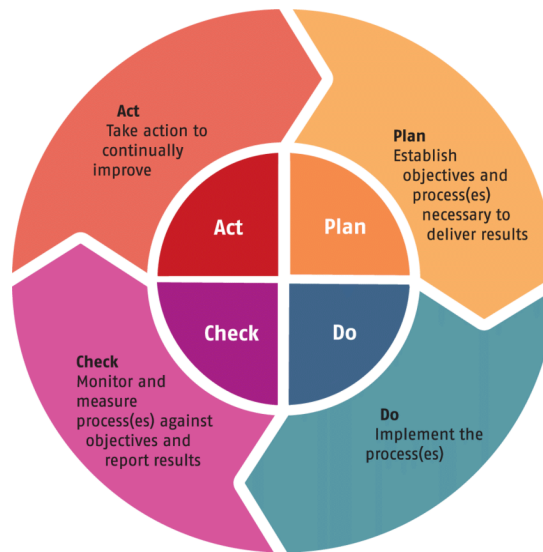


Figure 3 – PDCA Cycle

When well implemented, it is easy to understand that each time the cycle happens it can lead to increasing productivity and quality levels, since an improvement can become the target to accomplish new, better improvements.

2.2.4 Daily Meetings

In order to keep track of continuous improvement, it is necessary to follow live what happens in the workstations. Only a united, aware, well-informed team, with values and goals clearly defined is able to comply in a culture of daily improvement.

A common tool used to enhance this collaboration are workstation daily meetings, where all team members should be present, from the manager to the worker. The purpose of these meetings is to update everyone on the current situation, establish common or individual goals and raise relevant questions that are essential to the continuous improvement of daily processes and operations.

These meetings should have an agenda, so they can be efficient and straightforward, and they must take place near the workstation. To further help the meetings' development there should be something where it can be written everything that was said, like a whiteboard or a flipchart. In them, there should be pertinent information for the operation, such as the workstation's plan, the company's organigram or several operational KPIs (Braga, 2015).

2.2.5 Visual Management

In order to make simpler processes many companies employ visual management. Visual management is a tool widely used at an industrial level as it is easy to implement and brings great benefits for a company if well used. The main purpose of this methodology is to make obvious the presence of wastes, variabilities and errors through the use of proper visual signs, thus, making it easier to take immediate corrective actions (Pinto, 2008).

The way this tool is used must allow anyone to interpret its message clearly in the same way. Every information ought to be in visible locations, to help workers quickly understand if there is any situation that needs to be amended (Hall, 1987). Using an image or

a color code, it is easier to normalize and discipline workers in an efficient way with small investments, making this tool very tempting for most organizations (Pinto, 2014). One of the greatest advantages of this tool dwells in the fact that it aids process management of production, as a way to prevent errors and wastes (Pinto, 2008). In cases where there are job exchanges between workers, recording how each task is carried out proves to facilitate how it is learnt (Liker, 2003).

2.2.6 Spaghetti Diagram

Spaghetti Diagrams refer to a mapping tool that visualizes the flow of products in a process to identify any potential area of improvement. It also helps organizations see how their products move physically through the company (MIRO, 2023). The main purpose of this tool is to optimize the layout of the working area, as a way to reduce motion in the space in question (George *et al*, 2005).

Some of the benefits of a spaghetti diagram are:

- Identification of inefficiencies, as this tool shows the problem areas and pain points within the work layout and creates plans to eliminate them;
- Creation of an effective flow, by reducing the time wasted and delays caused by workers moving through multiple locations to complete their work;
- Clear directions, by setting a work path that reduces confusion amongst workers (MIRO, 2023).

2.3 Sustainability

The idea of sustainability began to make its way into the academic lexicon sometime in the mid-1980s, and since that time it has gone through substantial evolution. Mazmanian and Kraft (2008) suggest that the world has begun to enter a “third epoch” or period of environmental concern. The first epoch was focused on federal regulation to mediate and prevent environmental damage, whilst the second was committed to achieve greater economic efficiency in environmental protection. This third one is focused more broadly on sustainability.

An understanding on this matter starts with the definition provided by the World Commission on Environment and Development in 1987, when it stated that sustainability is the economic-development activity that “meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). It is clear that, at its core, sustainability is a concept that focuses on the condition of Earth’s biophysical environment, particularly with respect to the use and depletion of natural resources. It is not the same as environmental protection or preservation of natural resources, though some argue that it is where the roots of sustainability can be found. It is more about finding some sort of steady state so that Earth or some piece of it can support the human population and economic growth without ultimately threatening the health of humans, animals, and plants. The basic premise of sustainability is that Earth’s resources cannot be used, depleted, and damaged indefinitely, as their exploitation undermines the ability of life to persist and thrive (Portney, 2015).

In 1987, the report of the Brundtland Commission described sustainability as having three co-equal parts or elements, all of which start with the letter “e”: environment, economy and equity. These elements have formed the basis for disaggregating and elaborating sustainability, as it can only be achieved by simultaneously protecting the environment, preserving economic growth and promoting equity. Essentially, it is about achieving results on

all these three concepts, as one of them cannot and should not be accomplished by sacrificing one of the others (Portney, 2015).

2.4 Statistical Analysis

Statistics is a branch of mathematics that deals with the collection, compilation, analysis and interpretation of data. Statistics can be applied to several areas of knowledge.

Statistical methods can be divided in three main classes: predictive, descriptive and inference methods. Predictive statistical analysis is based on historical data to predict and prevent future occurrences. Descriptive statistics intends to analyze information regarding past occurrences and represent it in a more comprehensive way, usually by using graphics and tables. Statistical inference is more ambitious than descriptive statistics, as it intends to classify a population by analyzing a sample. Statistic inference uses more complex methods and techniques (Guimarães and Cabral, 2011).

In ordinary language, an average is a single number or value that best represents a set of data. The type of average taken as most typically representative of a list of numbers is the arithmetic mean, the sum of the numbers divided by how many numbers are on the list. The median of a set of numbers is the value separating the higher half from the lower half of a data sample, a population, or a probability distribution. For a data set, it may be thought of as the "middle" value.

The basic feature of the median in describing data compared to the average, is that it is not skewed by a small proportion of extremely large or small values, and therefore provides a better representation of the center. Depending on the context, the most representative statistic to be taken as the average might be another measure of central tendency, such as the mid-range, median, mode or geometric mean. Median income, for example, may be a better way to describe the center of the income distribution as increases in the largest incomes alone have no effect on the median. For this reason, the median is of central importance in robust statistics. Moreover, it is recommended to avoid using the word "average" when discussing measures of central tendency and specify which type of measure of average is being used.

In statistics, an outlier is a data point that differs significantly from other observations (Grubbs, 1969). An outlier may be due to a variability in the measurement, an indication of novel data, or it may be the result of experimental error. The latter are sometimes excluded from the data set. An outlier can be an indication of exciting possibility but can also cause serious problems in statistical analyses (Pimentel, 2014). Estimators capable of coping with outliers are said to be robust: the median is a robust statistic of central tendency, while the mean is not (Ripley, 2005).

3 Description of Existing Procedures at the CLG2

As it has been mentioned before, increasing competitiveness in Logistics have forced companies to become more efficient in their processes, eliminating actions that do not add value to the final product or service. For this to happen, it is mandatory to present the initial scenario of the CLG2 to analyze and better understand the key daily operations and how they can be developed.

3.1 The CLG2 Warehouse

The CLG2 is located at the intersection between two of the busiest highways from the region of Porto, A29 and A44. With 38 thousand square meters of warehousing, it is currently divided into four different sections, as can be seen in the warehouse plant of Figure 4. This image also outlines the main operations that take place in each of the sections.

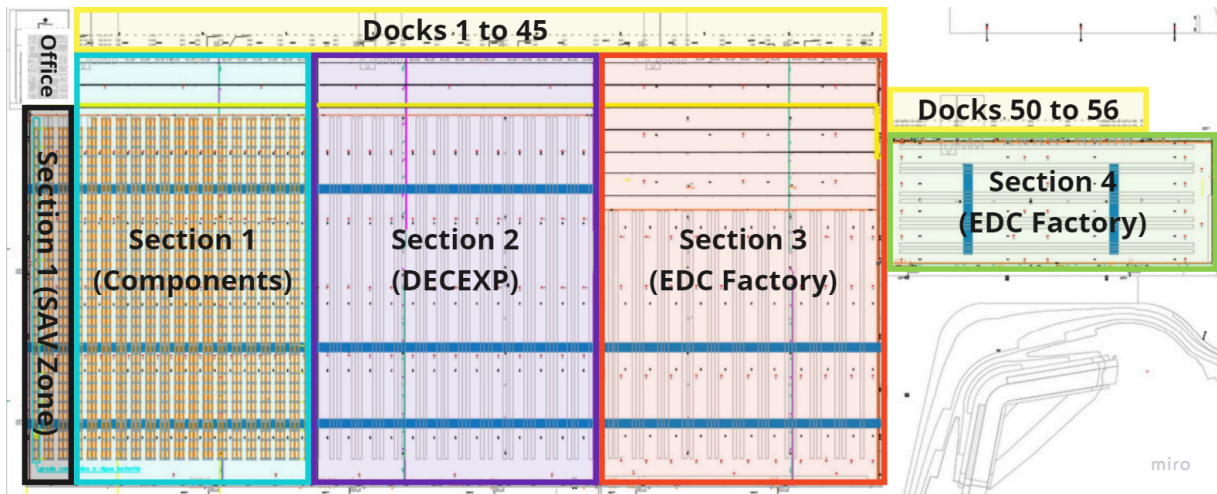


Figure 4 – Warehouse Plant of the CLG2

3.1.1 Human Resources

The CLG2 usually works around 18 hours per day, from Monday to Friday. This schedule is covered by three different shifts organized as follows:

Table 1 – Human Resources Operational Schedule

Shift	Operational Coordinators	Team Managers	Operators	Total
07h - 16h	1	0	4	5
08h - 17h	1	2	34	37
17h - 01h	0	1	6	7
Total	2	3	44	49

Every shift is composed of two 15-minute breaks and another hour for lunch or dinner. Despite the shifts' disposition, they can be flexible and adapted according to the warehouse's daily needs. This means that, if necessary, operators may be rearranged to enter at a different team considering the existing activity demand. Moreover, due to the fluctuations on the operational flows throughout the year, the number of employees may differ from the ones presented on Table 1 and on the histogram of Figure 5.

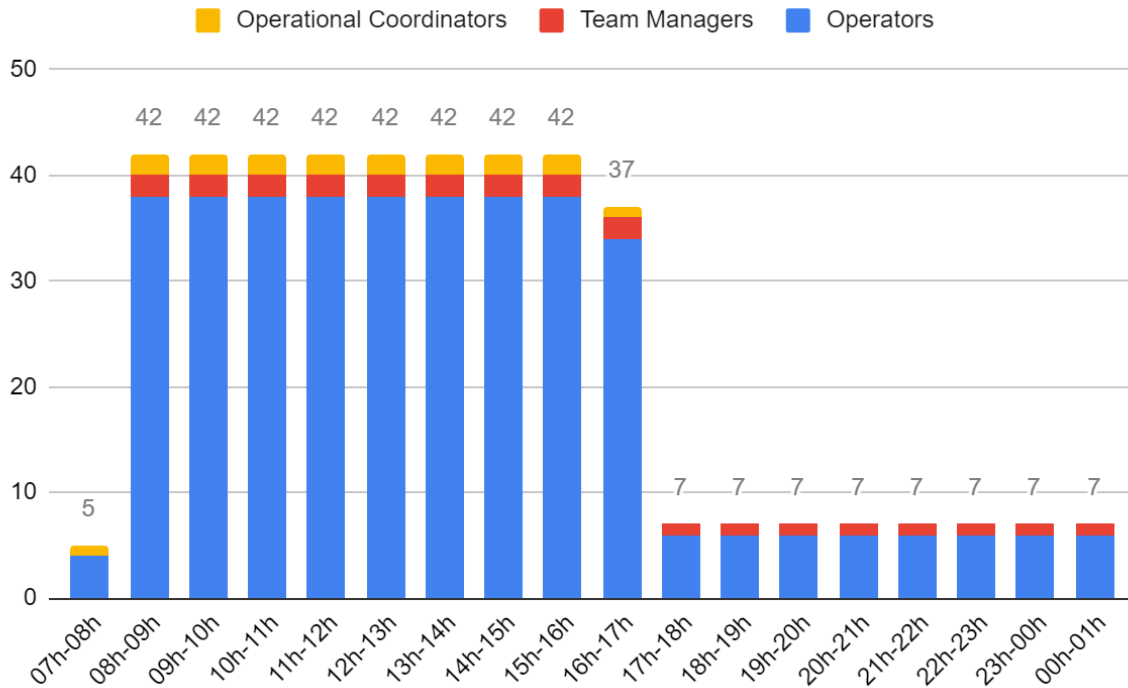


Figure 5 - Histogram of existing human resources during warehouse working hours

3.1.2 Warehouse Equipments

A warehouse of a magnitude like the CLG2 must have a considerable number of devices for pallet transportation. Table 2 shows the available equipment in the warehouse. After that, will be explained the main characteristics and purposes of each specific machine.

Table 2 - Existing equipment in the CLG2

Equipment	Quantity
Pedestrian Pallet Truck	15
Stacker	2
Reach Truck	2
Turret Truck	5
Total	24

Pedestrian Pallet Truck - an electrical equipment used for simple pallet movement. It is operated by one person only. Used to transport merchandise inside the warehouse and to load and unload the trucks stationed at the docks. It is the most common equipment used in the CLG2. The difference between a single and a double pallet truck is the number of pallets it can carry at once, in this case, one or two, respectively.

Stacker - an electrical equipment, used to move pallets up to two levels. It is operated by one person only. Used for transporting pallets within the warehouse and for loading trucks, it is able to lift the pallet to a higher level, which allows them to be stacked inside trucks.

Reach Truck - an electrical equipment, used for lifting pallets. It is operated by one person only. Mainly used for lifting pallets to the highest levels of the racking but can also be used to transport them within the warehouse. In the CLG2, it is particularly used in the EDC Factory operation.

Turret Truck - an electrical equipment, used for lifting pallets. It is operated by one person only. It is used for lifting pallets to the highest level of the racking and it makes it easier to check the pallet that is being stored or retrieved, as the operator is elevated with the equipment. Besides, since it can carry pallets sideways, it is perfect for warehouses that need more room for storing, as they can be operated in consecutive aisles with less space between. This way, they are used mostly in the Components operation.

3.1.3 Lean Procedures

Despite being a company that still hasn't fully integrated Lean thinking and continuous improvement in its culture, Garland Logistics, Lda, already has some procedures that show its investment on this subject.

One of the main aspects of Lean that is currently implemented in the CLG2 is Visual Management. This one refers not only to the identification of each place or area inside the warehouse, but also to the indication of other details that make it easier for employees to perform their tasks. When there is a well-defined color code, it becomes more intuitive for operators to move in their workstation and perform their tasks. In the CLG2, however, there is not a specific code used to identify different areas. Instead, these areas are identified using only yellow tape, as can be seen on Figures 39, 40 and 41, Annex C. Their purposes are either to indicate where a pallet should or should not be placed or to designate the places for waste segregation and other materials, which are usually not clearly identified. Besides that, blue tape is used to identify the pallets destined to the E-commerce in the EDC Factory operation, as shown on Figure 42, Annex C. This is necessary due to the fact that the E-commerce flow has priority when it comes to the expedition phase and needs to be shipped as soon as possible. One of the last features related to Visual Management that is being now implemented in the SAV operation of the CLG2 is a system to identify when new boxes should be ordered before they run out of stock. Despite not being fully developed, this system was created based on the arrival lead times of each specific box, allowing the respective Team Manager to be aware of this situation and to request new consumables every time they are close to ending. This signal is marked with the use of a yellow tape in the corresponding position after which the material should be solicited, as can be seen on Figure 6.



Figure 6 - Visual System used to request new boxes for the SAV operation (a) Visual System of Boxes Crankset (b) Identification of Boxes Crankset (c) Visual System for other types of Boxes

Another important Lean characteristic that is present in the CLG2 is the 5S tool. Despite not being fully implemented, the 5S can be seen in some areas of the warehouse, particularly when it comes to the identification of consumables and to the association between equipment and their respective chargers, as can be seen on the examples of Figure 7.

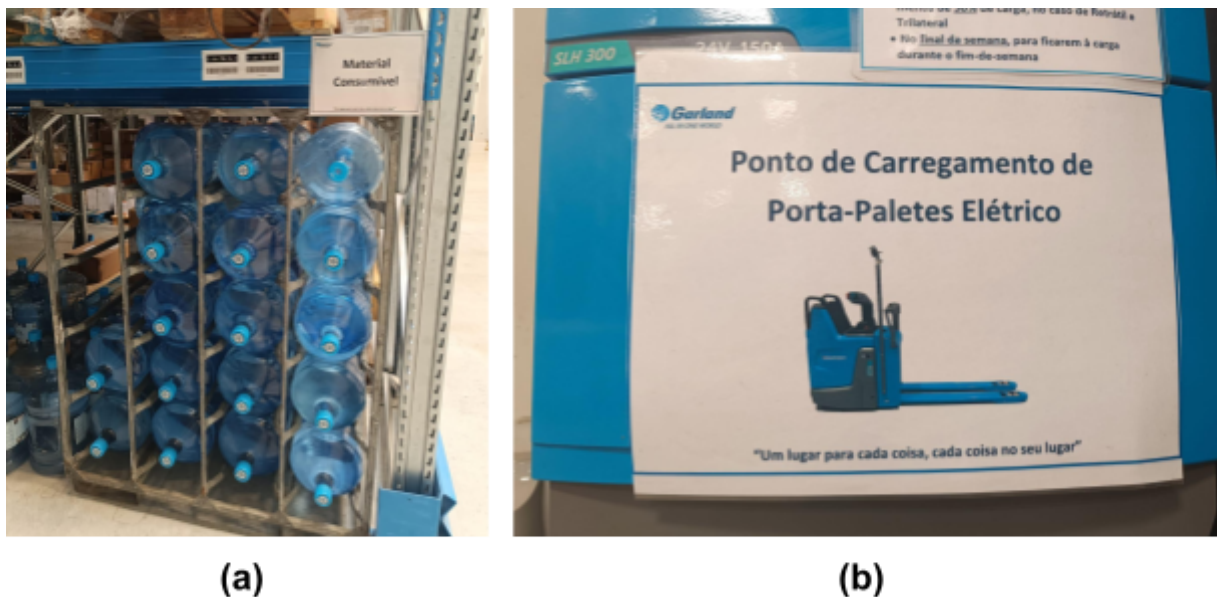


Figure 7 - Examples of 5S implementation on the CLG2 on (a) Consumables and (b) Equipment Chargers

However, in regard to the rest, this philosophy is often forgotten, and employees are likely to be looking for material during their work shift. This simple event significantly increases the time it takes for workers to perform their tasks. It is worth highlighting that, even when it comes to the aspects where the 5S tool is already implemented, the 2 last steps, *Seiketsu* (Standardize) and *Shitsuke* (Sustain), are not yet well embedded in Garland's culture and still need to be improved with the operators.

As it was mentioned before, in the CLG2 teams lack the communication skill to talk about their previous workday, its main difficulties and how they can overcome them with a proper solution. However, each of the teams has a meeting at the beginning of its shift.

Despite not having a follow-up agenda standardized, they are mandatory for all members and are led by the respective Team Manager. The key goals of these meetings are the following:

- Inform the team about the work there is to be done during their shift;
- Distribute tasks among operators;
- Report any unusual activity or action from the previous day that should be corrected;
- Introduce a new procedure to be implemented in the operation.

The three first aspects are essential for the operation to run as smoothly as possible without any complications, while the last one is occasional and only essential when there is a major change in the operation that must be put into practice. Despite the existence of these meetings, it is clear that they lack some information that could help the meetings run with an objective goal in mind. Process mapping, organizational charts, operational indicators relative to productivity and other specific KPIs could be used to monitor the established objectives and to identify possible improvements to be made.

3.2 Equipment Charging in the CLG2

In the quest for sustainable solutions, the integration of photovoltaic panels has emerged as one of the key strategies to meet the growing demand for clean and renewable electricity. Among several sectors, the industrial business stands as a significant area for innovation and implementation in this period of energy transition. In logistics, warehouses present a great opportunity for the adoption of solar energy, as they have big infrastructures suitable to install photovoltaic panels.

3.2.1 FusionSolar

Equipped with some of the newest technology in solar energy efficiency, the CLG2 possesses 930 square meters of solar panels on its rooftop that are aimed mostly for self-sufficiency. As for the beginning of this dissertation, the solar production and overall consumption of the warehouse were monitored through an energy software, named FusionSolar that was only available to the Maintenance department. Despite having information dating back to the beginning of April 2023, the values regarding energy production and consumption only began to be correctly calculated after an intervention carried out at the end of February 2024. Due to this fact, it was difficult to plan actions whose aim was to optimize solar consumption in the warehouse. This way, it was decided that it would be better to wait until the end of April to gather enough data that could be used for an AS-IS analysis for the “Equipment Charging Management” project.

FusionSolar is a software that represents three different measurements at 5-minute time intervals: “PV Output”, “Total Consumption” and “Consumed from PV”. While the former describes the amount of solar energy produced, the second one reflects the overall electrical consumption of the warehouse. The last one is simply calculated as the minimum value of the first two, in other words, the consumption that was satisfied by solar electricity.

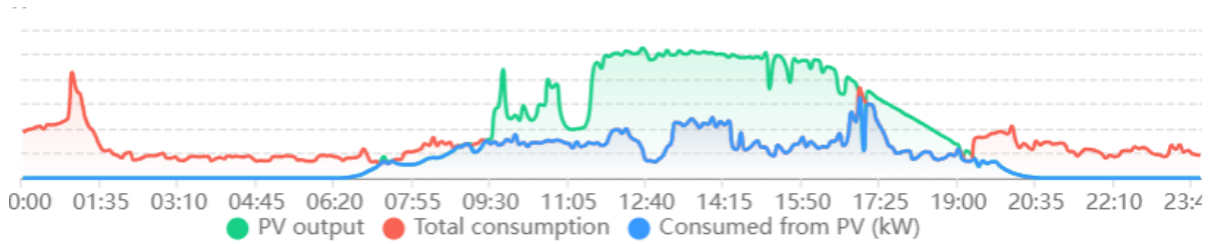


Figure 8 – Interface of the FusionSolar software showing the measurements for the 9th of May of 2024

3.2.2 Initial Analysis

As mentioned before, an initial analysis was made to identify the actual charging equipment method. This way, data from the FusionSolar software was gathered to better understand this process and to brainstorm solutions to optimize it.

As the information contained in the software could not be correctly exported, the first step of this approach was focused on evaluating the quality of the data and collecting it into an editable document. The information gathered for every 30-minute interval was the following: date, hour, “PV Output” and “Total Consumption”, as “Consumed from PV” could be easily obtained using a formula. In order to simplify, from 2:30 am to 6:00 am a value was used to represent the overall consumption of the warehouse outside working hours, in other words, its idle consumption. Moreover, to better understand consumption patterns for the warehouse, it was only considered the data corresponding to working days, leaving aside weekends and holidays, which were only considered to calculate idle consumption.

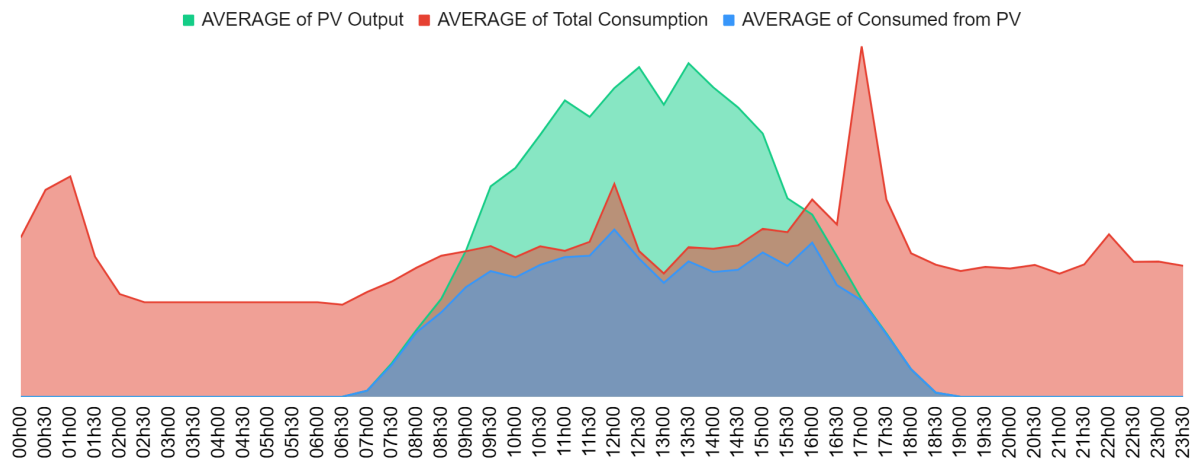


Figure 9 – Average measurements of "PV Output", "Total Consumption" and "Consumed from PV" for March 2024 at 30-minute intervals

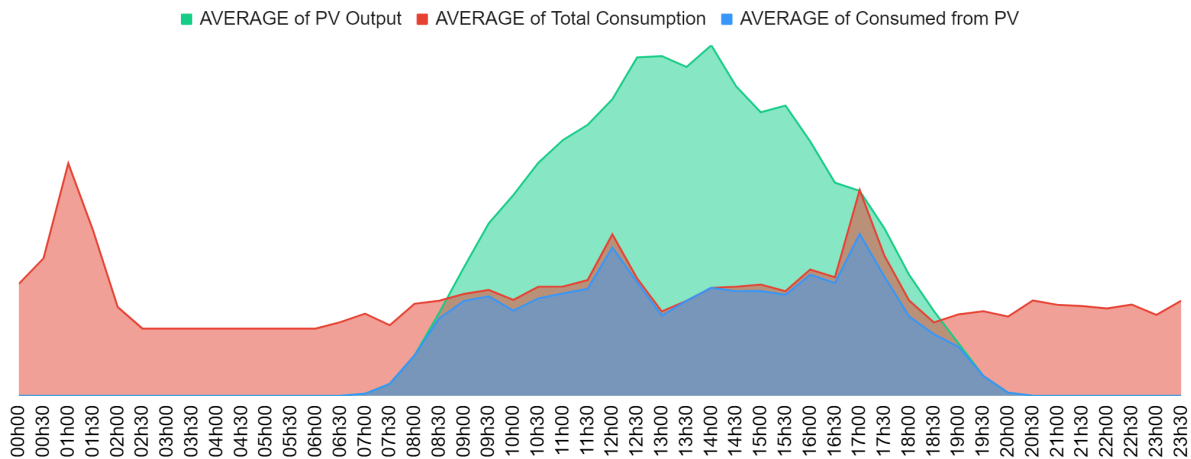


Figure 10 – Average measurements of "PV Output", "Total Consumption" and "Consumed from PV" for April 2024 at 30-minute intervals

Figures 9 and 10 illustrate the average measurements for the three energy values corresponding to March and April 2024, respectively. It is worth noting that the 31st of March was the transition day to Daylight Saving Time, which means that clocks were set forward by one hour, gaining an extra hour of daylight in the evening. This change explains the shift difference of the "PV Output" from March to April. The first conclusions that can be visually drawn from the data provided by FusionSolar are the following:

- Peaks in consumption at the end of both day and night shifts;
- Substantial increase in consumption during lunch break;
- Most of the consumption during daylight is derivative from the warehouse's self-production;
- There is a slight decrease of consumption during the night shift, which tends to be more stable during its course.

In fact, operationally, workers tend to put their equipment charging in either one of the following situations: when they notice it won't have enough battery for the rest of their work or at the end of their shift. Sometimes, they take advantage of the lunch break to charge the machines when their batteries start depleting, so that they can work in the afternoon without complications.

When it comes to the general consumption during the day shifts (from 7:00 am to 5:00 pm), around 71% to 85% was derived from photovoltaic panels. However, when looking at the whole day, solar energy only represented 37,1% of the total consumption during the month of March, which increased to 48,2% in the following month, mostly due to the transition to the DST and to the intensification of the sun during this period. In reality, the "PV Output" grew 59% in April relative to its previous month. Considering these facts, it was expected that the amount of electricity from self-consumption of the CLG2 would be higher, despite its significant increase. On one hand, the DST's transition made it possible to include the 5:00 pm consumption peak in the period of more intense sunlight. On the other hand, from March to April, there was a rise in consumption at the end of the night shift of around 25%, which is undesirable since none of this demand is solar-based. This way, it became clear that a decrease in the night shift consumption peak should be prioritized when implementing a corrective solution, as it would bring more evident results.

One of the main obstacles that arises when dealing with charging equipment is the fact that any change in the regular procedure is prone to interfere with the normal course of

operations. This way, it became also necessary to know all machines' specifications to better understand the relationship needs that exist between the equipment and the operators. Table 3 presents the main features of each of the CLG2's main machines, according to the supplier's specifications.

Table 3 – Supplier specifications of the equipment that exists in the CLG2

Equipment	Battery Voltage	Battery Capacity	Opportunity Charging Time	Charger Power	EN Cycle Consumption
Pedestrian Pallet Truck	24V	130 Ah 3,3 kW	50% in 30 minutes	3,6 kW	1,29 kWh/h
Stacker	48V	390 Ah 20 kW	50% in 58 minutes	9,6 kW	5,5 kWh/h
Reach Truck	48V	520 Ah 26,6 kW	50% in 40 minutes	14,4 kW	4,64 kWh/h
Turret Truck	80V	500 Ah 43,2 kW	50% in 35 minutes	20,8 kW	11,2 kWh/h

Opportunity charging is a battery charging technique that can extend the run times and service of battery powered equipment. The term opportunity charging refers to the charging of the batteries wherever and whenever power is available. Simply put, rather than waiting for the battery to be completely discharged, or for the duty cycle or work shift to be over, opportunity charging is the “power as you go” possibility to extend the capabilities of equipment during shift breaks, meal breaks and other equipment downtime periods (Discover, 2022). In order to maximize its benefits, it is advisable that lithium-based batteries stay between 30% and 80%, avoiding for it to get below 20% or to be supercharged at 100%. One of the main disadvantages of opportunity charging is that the responsibility to make the most of this strategy falls upon operators. It's up to them to be proactive and consistent with charging their batteries during breaks and other downtimes. (Foxtron, 2022). The EN cycle consumption indicates the energy usage of an appliance during standard operating conditions.

Considering the number of different equipment that exists in the CLG2 and the power that each charger provides, it becomes clear that Turret Trucks are the ones that require more electricity from the warehouse, as can be seen in Figure 11. This illustration presents the accumulated power of all equipment if they were charging at the same time.

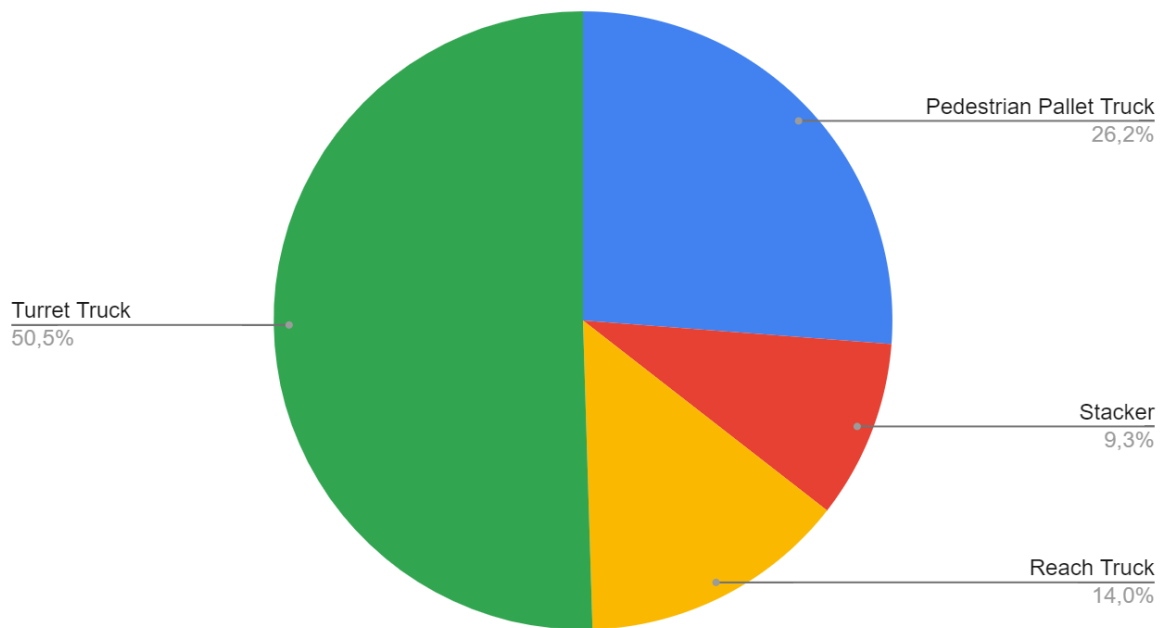


Figure 11 – Percentage of all power needed to charge every type of different equipment

This means that Turret Trucks' monitoring represents the type of equipment where charging management has the greatest impact on the results. However, the new procedure should obviously encompass all equipment, to increase the solution's efficiency and standardize corrective actions in all operations.

3.3 EDC Factory

Due to the complexity of the processes that take place in the logistics center, the detail will only be focused on one of the main warehouse operations, the EDC Factory.

The EDC Factory is one of the most demanding operations of the CLG2, which is an exclusive activity of the warehouse's main client. This entity purchases and receives items that are sold worldwide through its retail network, as well as components intended for the final production of its items. In order to increase the supply of bulky products and reduce logistic costs, the client decided to establish a new operation, located close to the factory of one of its suppliers. Its strategic role consists of dispatching all flows of manufactured products to the client's network spread across Europe. As it is a complex operation, the company turned to Garland Logistics, Lda knowledge and experience to establish itself in Vila Nova de Gaia, next to its main providers.

As a first-instance Lean tool for understanding how this operation works follows the flowcharts from Figures 12 and 13, as well as a brief description of each process. The flowcharts represent the receiving and expedition procedures of the EDC Factory operation, respectively. To understand these illustrations, it is necessary to explain the difference between an operator and an administrative worker. The former spends most of the time in the warehouse and is the one that works with the equipment and material to load and unload the trucks. On the other hand, the administrative employee is responsible for updating and working with the WMS and making sure that data flows correctly throughout the whole process, while also having to communicate with the client. Despite several employees being

flexible to work both jobs, every time a process goes from the operator to the administrative or vice versa, it is more prone to increase waiting times and wastes that make the operation less efficient.

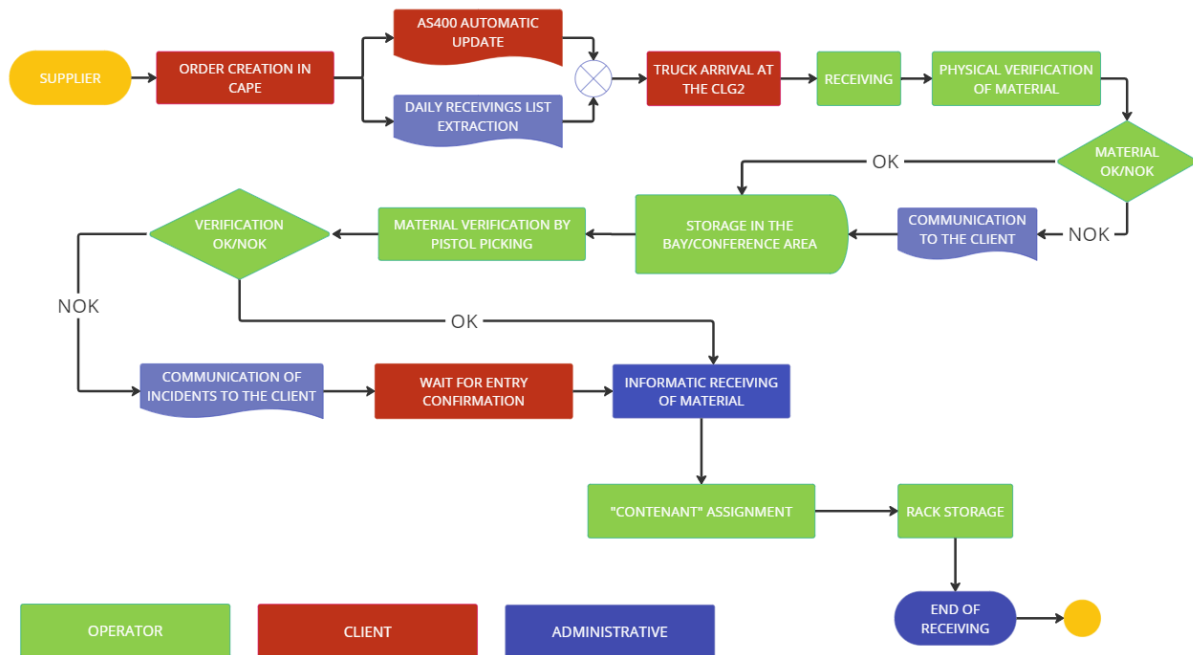


Figure 12 - Flowchart of the Receiving process of the EDC Factory Operation

In this process, purchase orders are created by the suppliers and automatically updated in the WMS of Garland. The trucks arrive at the warehouse according to the schedule for the specific day and are received by the operators. They verify the physical condition of the material for damages and other visually identifiable concerns. If not, the administrative contacts the client to report the incongruences found, otherwise, the material is stored in the conference area. Here, the goods received are compared with the list that exists in the WMS for a final confirmation that the material received is in conformity. If products or their quantities don't match, the incident is reported to the client, who must authorize the receiving and storing of the material, which is stalled until the entry confirmation is acquired. After that, all pallets are assigned a specific container number, where it is stored the information of all the products that compose the pallet. Only then it becomes possible to store the pallet in the rack. The position where it is located is assigned by the operator itself, closing the receiving operation.

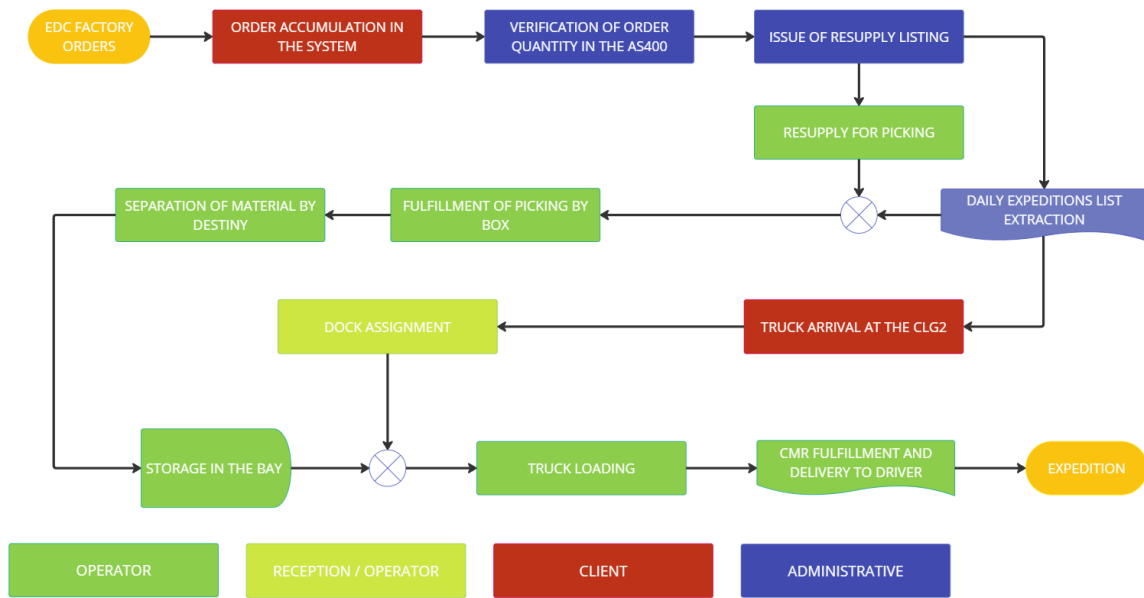


Figure 13 - Flowchart of the Expedition process of the EDC Factory Operation

When it comes to expeditions, two key activities are combined and integrated: picking and shipping. First, orders accumulate every day in the WMS as they are added by the client. At the beginning of each day, the administrative employee verifies the number of orders in the system and extracts the listing that is going to be used to resupply picking positions. This replenishment needs to take place before the beginning of the picking as the operators can't work efficiently if they don't have all the resources needed to fulfill their job. As each worker assembles a pallet and packs it, it is allocated in the bay, separated by destiny, where it will be put on hold until the truck to be loaded arrives at the CLG2 and is assigned a dock. After loading, the CMR is properly fulfilled and delivered to the truck driver, which leaves the warehouse, concluding the shipping process and the overall expedition operation.

As the complexity of activities increases it becomes difficult to track the flows of operations that go down in the warehouse. Thus, it became necessary to map the flux of products and people in a way that could be simpler to visualize. The Spaghetti Diagrams of Figures 14, 15 and 16, illustrate the different flows of each specific process that takes part in the EDC Factory operation: receiving, picking by box and expedition, respectively. To simplify the visualization of this procedure, the focus was put on the busiest area of this operation, section 3, which is shown in detail on Figure 28, Annex A. This simplification is made due to the fact that section 4 and the last two aisles from section 2 are used only to store pallets and don't involve other relevant activities. The movements recorded here are a collection of different employees, on distinct working days, in order to have only a general idea of the operational flows.

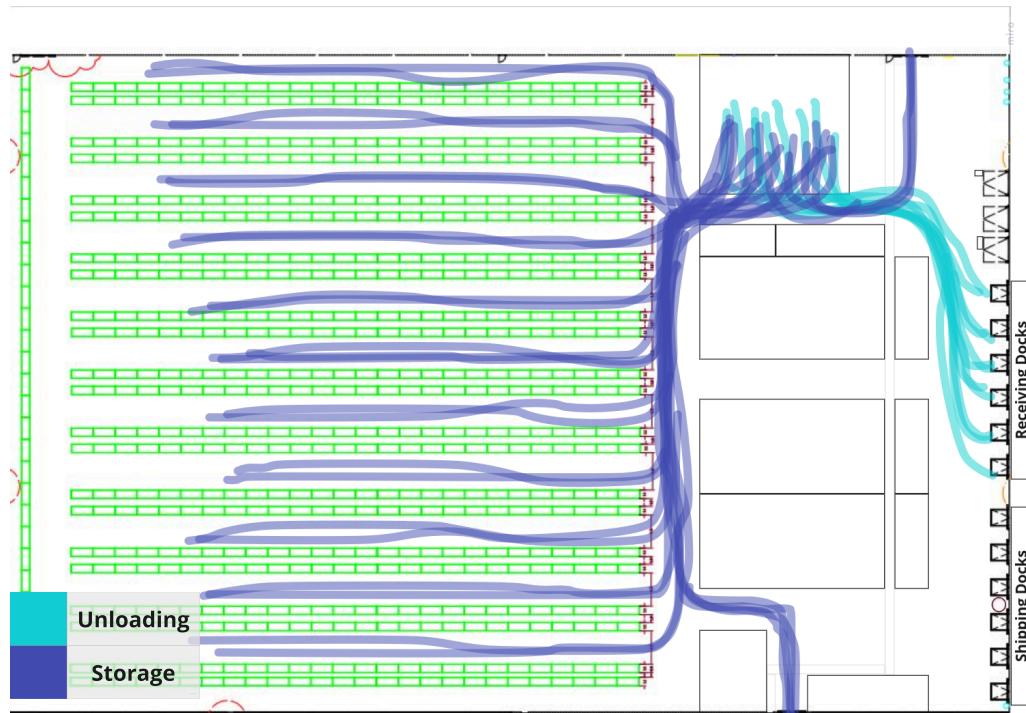


Figure 14 - Spaghetti Diagram of the Receiving process of the EDC Factory Operation

In the Spaghetti Diagram of Figure 14 it is clear the concentration of flow near the receiving verification zone, at the beginning of the picking aisles. It is important to highlight that these movements are not optimized, when it comes to the storage of the pallets. As the operation goes, it is not always considered by the operators the location where the pallets are going to be stored, as they choose the area themselves. This lack of normalization and automation may result in greater movements that increase the time required to perform this task and will certainly bring repercussions in the following steps.

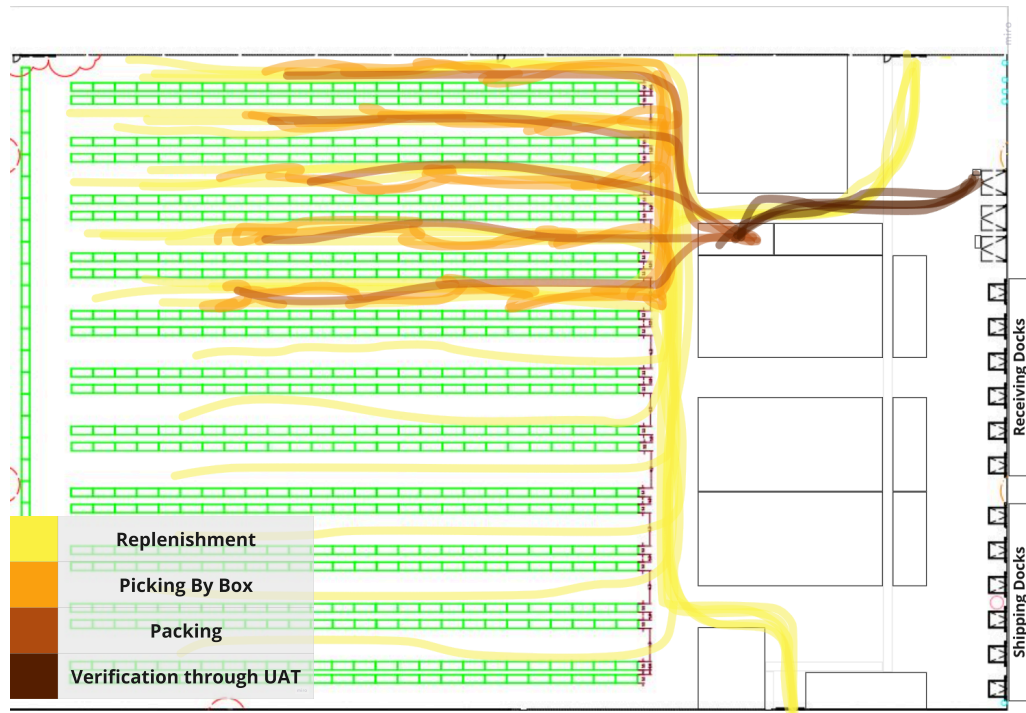


Figure 15 - Spaghetti Diagram of the Picking process of the EDC Factory Operation

The illustration of Figure 15 presents the most complex process of this operation, the picking by box. In here, it is noticeable the high flux near the packing area, which is also close to the beginning of the picking aisles and to the receiving verification area. When the pallets are packed, the operators still have to take them to the UAT machine, so the quantity and quality of the SKUs can be verified. As this equipment doesn't have a wireless connection to the internet, it must be located near the office, which requires that pickers travel a longer distance to conclude this production phase.



Figure 16 - Spaghetti Diagram of the Expedition process of the EDC Factory Operation

Although they are not concurrent processes, the decision was made to combine them in the same graph. This way, in the Spaghetti Diagram of Figure 16 it can be seen the concentration of flux close to the shipping docks, as likely from an expedition procedure. After verifying the pallet in the UAT machine, these are taken to the dock area where they are separated according to their shipping destinations. After the arrival of the truck, it is loaded with the corresponding merchandise.

Now that we have thoroughly examined the warehouse, its processes, equipment, human resources, solar production, and all relevant details, let's explore the solutions that were implemented to address the existing possibilities of improvement in the CLG2.

3.4 Components Picking Line

Regarding the picking line that needed to be updated, the main challenge was straightforward. In fact, there are several SKUs that are requested by both key suppliers of the CLG2's main client, denominated "shared skus". Through pallet picking, independently of the number of units ordered, a whole pallet needs to be sent to the respective factory, which may bring different challenges:

- increased storage in the factory;
- a chance for only one factory to receive their order on time, if the sum of ordered units is less than a whole pallet;
- consequent clients' unhappiness.

As one of the main goals of any company is its customer focus, pallet picking is an unwanted operation, despite being more cost-effective and demanding less warehouse labor. To align with the company's values, piece picking is the right choice to bring solidity and flexibility to the operation.

4 Daily *Kaizen* Implementation and Processes Optimization

As it has been presented before, the first project was exclusive to the development of continuous improvement in the CLG2 with the implementation of solutions to ease the tasks each employee has to perform. In a warehouse with this dimension and with this complexity of operations, there were many other projects that could be executed to optimize processes in this logistics center. In this chapter will one be presented some of them in more detail, in chronological order of when they were implemented during the dissertation.

4.1 *Kaizen* Documentation

As it has been presented before, the first project was exclusive to the development of daily meetings whose main goal was to identify existent improvement opportunities and implement solutions that could make the most of them on an everyday basis. In order to help operators fulfill this task, it was first necessary to formulate specific *Kaizen* documentation to help each team develop their meetings.

4.1.1 Value Stream Mapping

As for the beginning of this dissertation, it was necessary to know about all the different operations that take place in the CLG2. One of the best ways to do that is through the formulation of VSMS that illustrate each of the processes that exist in the warehouse and its main participants, thus, all operational flowcharts were updated. A color code was used to address one of the challenges behind flowcharts, the coordination between different roles or departments, making it visually simple to understand. Besides, a color-coding system further helps identifying process improvement opportunities, such as bottlenecks, redundancies, inefficiencies or any other type of waste within. Figures 29 to 33, Annex A, illustrate the main processes of each operation that take place in the CLG2.

4.1.2 Templates

As seen previously, *Kaizen* documents were created to help the development of every team's daily meetings. In this chapter will be presented the templates that were designed for that purpose. It is worth noting that the tools were chosen for their simplicity and straightforwardness to assist operators and to avoid overwhelming their daily activities.

Created by Kaoru Ishikawa during the 1960s, the Ishikawa Diagram shows the root causes of an event and is often used in manufacturing and product development to outline the different steps in a process, demonstrate where quality control issues might arise, and determine which resources are required at specific times (Hayes, 2023). It is usually divided into several different main causes, known as the 6 M's: Measure, Method, Material, Mother Nature (Environment), Man and Machine. Through the Ishikawa Diagram, it becomes easier for operators to brainstorm the reasons why specific challenges happen and how they can overcome it with a solution. Figure 17 represents the template created for the Ishikawa Diagram tool.

Brainstorm de causas no atraso na expedição de encomendas

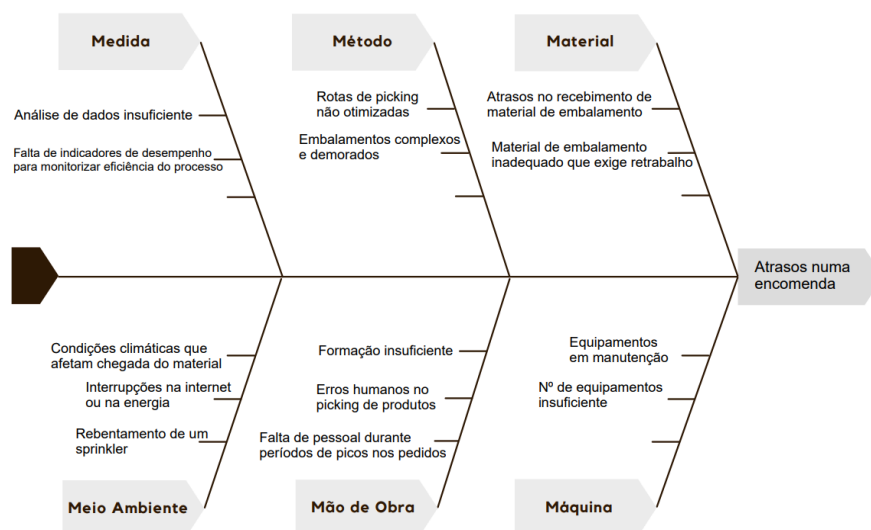


Figure 17 – Ishikawa Diagram Template Example

Another instrument used to help brainstorming solutions for a specific situation was the 7 MUDAs. As stated earlier, the 7 MUDAs is a tool whose main purpose is to identify process wastes that should be eliminated or, at least, reduced. When applied to a warehouse like the CLG2, this tool can be used in a more macro perspective to identify improvement opportunities in a whole operation instead of a specific process. This way, Figure 18 illustrates the template that was created for the teams to use, along with an example.

Desperdícios Gerais no Armazém

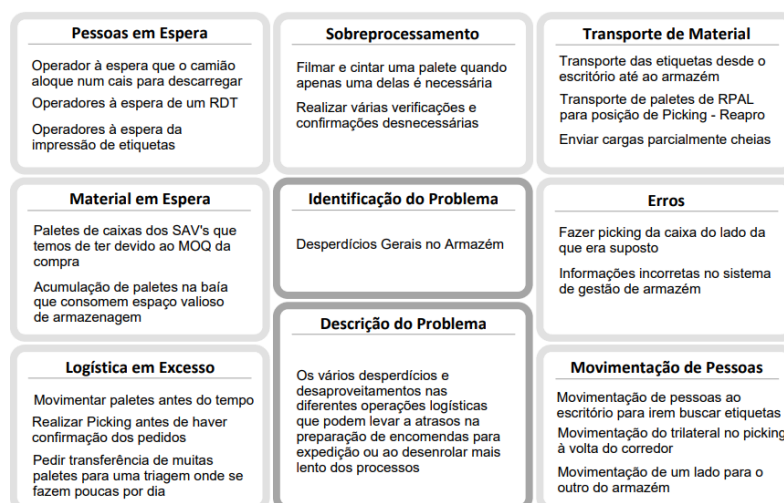


Figure 18 – 7 MUDAs Template Example

Of Japanese origin, the 5W2H tool is used to understand a problem or opportunity for improvement from different perspectives. Through its 7 explanatory factors, as can be seen on the template created in Figure 19, the problem can be visualized in a clear and objective way, favoring the operator's chances of taking an effective decision (Cancian, 2017). Furthermore,

it can also be used as a planning tool that combines all there is to know about an improvement that is scheduled to be made.

Implementação de um segundo batente de paletes de bikes



O que será feito?	What?	Vamos implementar um segundo batente de paletes de bikes
Por que será feito?	Why?	Para que as paletes sejam arrumadas centradas
Onde será feito?	Where?	Na parede entre a nave 3 e a 4, do lado da nave 3
Quando será feito?	When?	Até à semana 12
Por quem será feito?	Who?	Pela Gestora Operacional do CLG2
Como será feito?	How?	Pedindo pelo menos 2 orçamentos a duas empresas previamente contactadas, garantindo que o que é apresentado cumpre com os requisitos operacionais Adjudicando dentro das regras da empresa e acompanhando a montagem
Quanto custará fazer?	How much?	X euros de materiais Y euros de mão de obra para montagem

Figure 19 – 5W2H Template Example

The last technique that was applied to help teams develop their daily meetings was the 5 Whys. Having the same purpose as the Ishikawa Diagram, this tool is mainly used to reveal a problem's root causes. This simple, yet powerful resource was designed by Sakichi Toyoda, one of the founders of Toyota Industries, in the 1930s. The idea behind the 5 Whys method is to drill down to the root cause of an existing challenge, by asking why it happened, five times. (Pojasek, 2000). In many cases, asking “Why” 5 times proves to be enough to uncover the main cause of a problem, besides striking a balance between being thorough and maintaining simplicity.

Exemplos Gerais de identificação da Causa Raiz de um Problema



Problema	Passei um vermelho a conduzir	Ocorreu um atraso na expedição de uma encomenda	Não consigo realizar uma encomenda
Porquê?	Estava atrasado para o trabalho	As paletes não estavam preparadas a tempo do envio	Não tenho caixas-cassetes em armazém
Porquê?	Acordei tarde	O picking está a demorar muito tempo	Porque a última encomenda ainda não chegou
Porquê?	O despertador não tocou	Os produtos mais vendidos estão armazenados na zona mais longe do armazém	Fiz a encomenda tarde
Porquê?	O telemóvel estava sem bateria	Não há um critério específico para armazenar os produtos nos corredores	Não sei os lead times certos do tempo que as encomendas demoram a chegar
Porquê?	Esqueci-me de o meter a carregar	Não há um processo regular de avaliação das várias características do produto para criar esse critério	O estudo relativo ao lead time das encomendas ainda não foi realizado

Figure 20 – 5 Whys Template Example

4.2 Kaizen Boards

Every meeting in the CLG2 is meant to happen at a specific place inside the warehouse. Usually, they take place near the office area that exists in each one of the sections of the warehouse, as it is here that are concentrated all the materials and equipment needed to start the work. In order to standardize this process and monitor the operations with easily accessible information, the *Kaizen* boards that have been designed were placed in the exact location of each team's meeting.

As the main goals of these information boards are, on one hand, to help team in their operations and, on the other, to implement a culture of continuous improvement, they were divided into three different sections:

- General information - a place destined for overall data about the CLG2, the respective team and the company;
- Operational KPIs - this area would be used for monitoring the operations through the displaying of the team's monthly or annual goal and of relevant operational indicators;
- Continuous Improvement - a section dedicated to brainstorm new areas for improvement and to keep track of all solutions and corrective actions that were being implemented through the PDCA cycle.

Since the implementation of these boards serves as a pilot project at Garland Logistics, Lda, efforts were made to ensure their visual consistency throughout the entire organization, even though they were designed for individual teams. Next, we will outline the development of each board, focusing on the key aspects and characteristics that define the operations managed by each team.

4.2.1 General Information

Regarding General Information, the initial and most difficult challenge was deciding on the abundance of available data and whether it should, or not, be included here. In a first approach, it was determined that this section should include four different aspects:

- Team Information - names and roles of all team members, through the use of an Organizational Chart;
- Contacts Information - details for easily reaching team managers, operational coordinators and the operational manager;
- Employees Vacations Calendar - a calendar whose main purpose would be to help the team manager adapt and prepare its team for upcoming work projections;
- Attendance List - this list would be used to help team managers account for how many members they have for the day and how they should fill in their daily activities log.

On a second approach, it became clear that the attendance list would only add ambiguous and irrelevant information to the board, as some of this data would already be in the Team Information section. Instead, a list containing all employee's company id was added, since it was more suitable to monitor daily activities. The process to introduce these details in the board was straightforward, since this part of the data does not change frequently and doesn't need updates for a long period of time. This way, it was decided that the Team Information should include:

- a picture of each member with his correspondent name to make it easier for new people to address other coworkers;
- an organizational team chart composed by those same photos and the roles of each member;
- an updated vacation calendar with information for the following months;
- a sheet containing, on one side, each employee's company id and, on the other, contact information of all team managers, operational coordinators and operational manager.

In order to keep information confidential, Figure 21 represents a scheme that was used as the basis for designing this section.

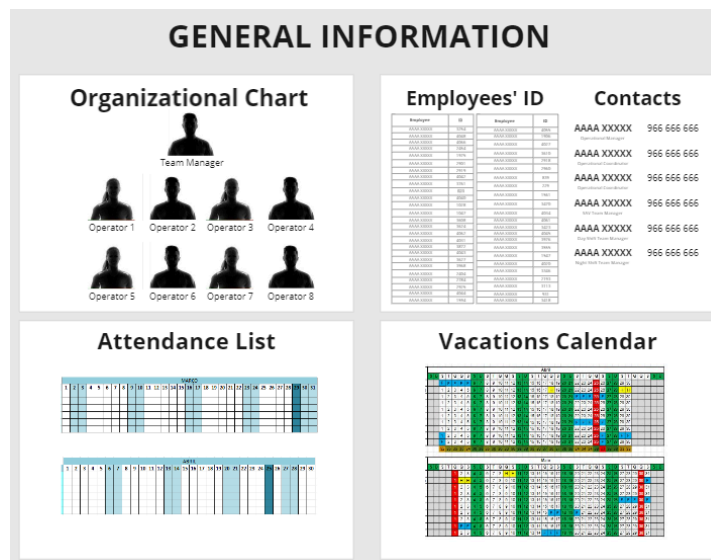


Figure 21 – General Information Scheme for all *Kaizen* Boards

4.2.2 Operational KPIs

This area of the *Kaizen* board was designed differently for each team, as each one of them had their own specific operations. However, the purpose across all was the same: provide information that could help team managers monitor their team and provide insights on improvement opportunities that could arise.

Before getting into specific details about each operation, there was an identical indicator across all teams, as a measure of productivity, called the “Human Resources Control”. This KPI is presented as a table with each operation’s expected total operating hours needed and the real corresponding values divided into three different categories: warehouse operations, general cleaning and administrative work. This data was gathered considering each employee’s daily activities log. This way, at the end of the month, the operational coordinators and manager can have a look at the discrepancies and make corrective actions between teams.

SAV

Before the beginning of this project there already existed a dashboard for the SAV team that was being used to monitor the operation. This dashboard includes a Production Plan that specifies the number of ordered items that need to be shipped each week. Furthermore, this control panel comprises a calculation of the percentage of orders and items that are either pending completion or have not yet been started by any of the operators. This plan helps the team manager adapt his team according to the work projections for each day and for upcoming weeks. Lastly, this dashboard contains another feature that illustrates the number of orders that are on delay and still not incorporated in the Production Plan, in other words, the number of items that should have been shipped in previous weeks. However, this piece of information lacks the capability to provide specific causes for why the orders are delayed. This way, in collaboration with the Team Manager and the administrative worker of the SAV team, an indicator was designed to reveal the reasons behind each delay. Three main causes were found for an order to be on hold:

- There is no stock on the warehouse for any of the items that comprise the order;
- This order is yet to be validated by the client;
- The team had no capacity to fulfill the order on time.

It becomes clear that the last motive is the one that brings more concern to the Team Manager, since the first two are the client’s responsibility. As a result, an automatic formula was developed to analyze all order data and identify those that were delayed according to each specific reason. This information was added to the existing SAV dashboard. Additionally, a chart was created to visually display the number of delays for each reason, with delays due to capacity highlighted in red for immediate insight, as can be seen in Figure 22. As this is the simplest operation of the SAV, all this information was included in a single sheet that could be easily accessed through each employee’s organizational mail and printed for display in the *Kaizen* board.

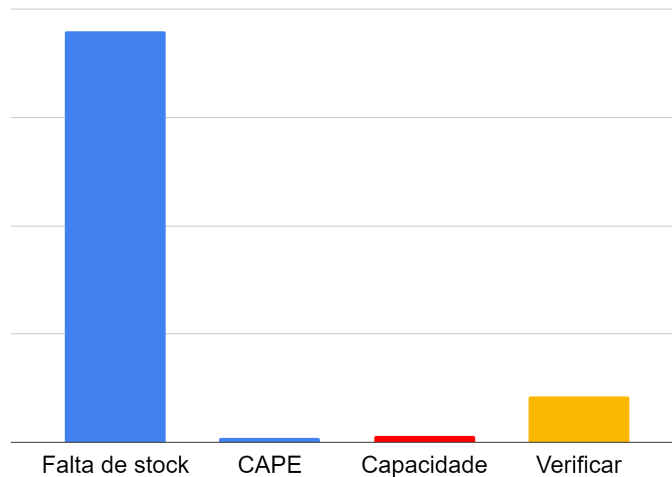


Figure 22 – Histogram of delays categorized by reason

Components

For the Components operation there were already several KPIs that were being updated each week to monitor the main processes. The first graph concerns the delays in order preparation and it contains four different indicators:

- Suppliers' deliveries to the warehouse;
- Warehouse orders preparation;
- Warehouse orders delivery;
- Customer returns.

For each of the mentioned indicators, the number of delays between the scheduled time and the actual arrival is calculated weekly, along with their average delay time. The second one represents the weekly loading and unloading plan, with the expected number of trucks, its average volume and its ETA. Additionally, it includes a description of each container type, its dimensions, and the expected contents, as their handling demands different amounts of workload. Besides these KPIs, two more were added to display in the *Kaizen* board: the Daily Loading Plan for each main supplier, with its corresponding status, and the Warehouse Consolidation Plan for each truck planned for that day. The first indicators can be seen in Figures 34 and 35 from Annex A.

Exportation

When it comes to this operation, there was an available shipments dashboard that was not being used, with information about the weekly number of containers per delivery third in comparison with data from the previous year. Beyond this indicator, it was added for display in the *Kaizen* board the Daily Loading and Unloading Plan.

Regarding other KPIs, a significant concern emerged about the delays of trucks arriving at the CLG2. This issue was particularly pronounced in the Exportation operation. Conversations with the operation's employees revealed that it was estimated that more than half of the trucks were delayed by over thirty minutes. Therefore, it was decided to start gathering approximate data on the arrival times of each truck, so that it could be studied and presented to the Distribution Department of Garland Logistics, Lda. This simple data analysis required operators to be as clear and honest as possible when recording these times, in order

to avoid further complications. To address this, a method was developed to combine the daily arrivals log maintained by the security lobby with the expected truck schedule, providing more accurate data on this issue. A simplified prototype of the expected report on monthly delays can be seen in Figure 23. Further developments started to be made to expand this report to every other operation of the CLG2.

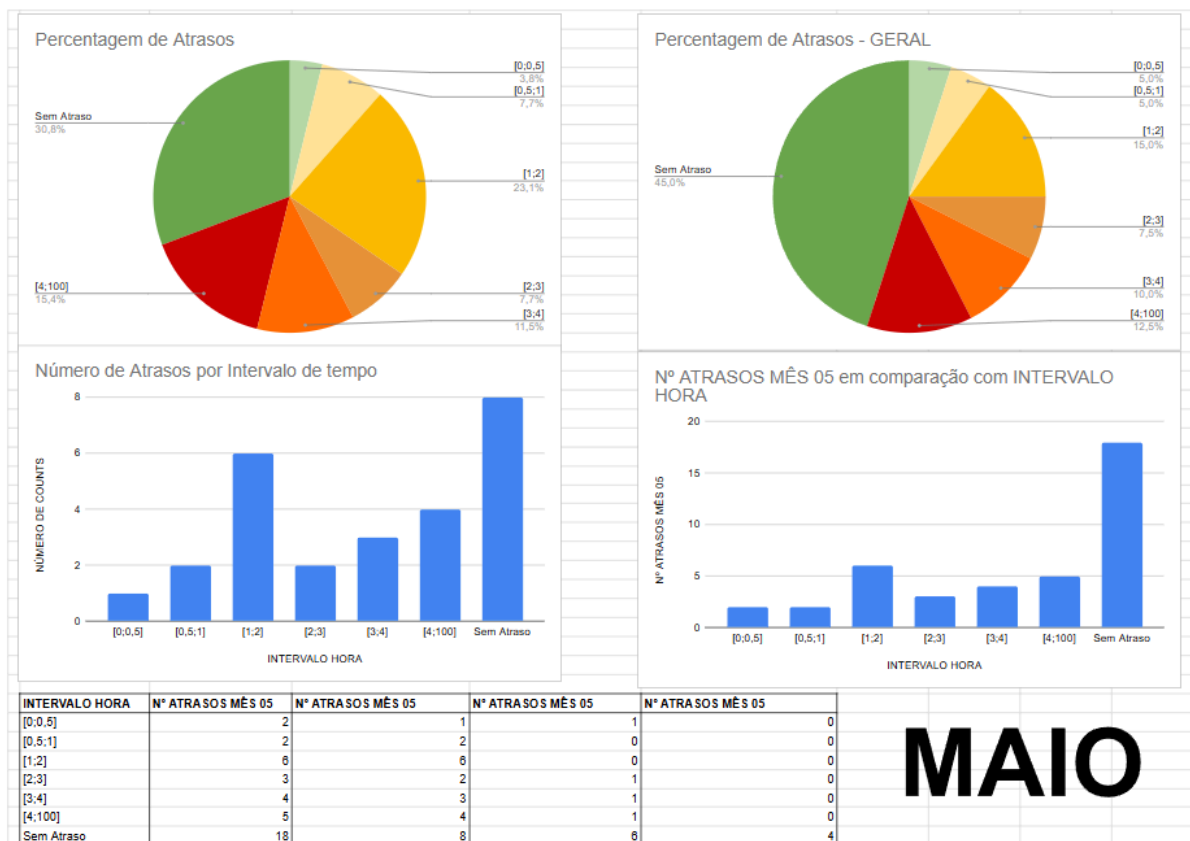


Figure 23 - Model of the delay report pertaining to May 2024

EDC Factory

Regarding the EDC Factory, the CLG2 itself did not have any indicators to monitor the operation. However, in conversations with the respective client, their weekly report was made available for the warehouse's team's analysis. This report contains a lot of useful information that could not be fully displayed on the board. Thus, the chosen indicators were the following:

- Annual evolution and weekly log of received and shipped quantities, per supplier or destination, respectively, and correspondent forecast for subsequent weeks (Figure 24a);
- Weekly warehouse delivery time and warehouse stuffing rate, with correspondent forecast for the whole year (Figure 24b);
- Weekly evolution of warehouse delivery time, with details about reception, picking and shipment lead times.

Since these KPIs are straightforward and address many of the characteristics of the EDC Factory operation, no further developments were needed.

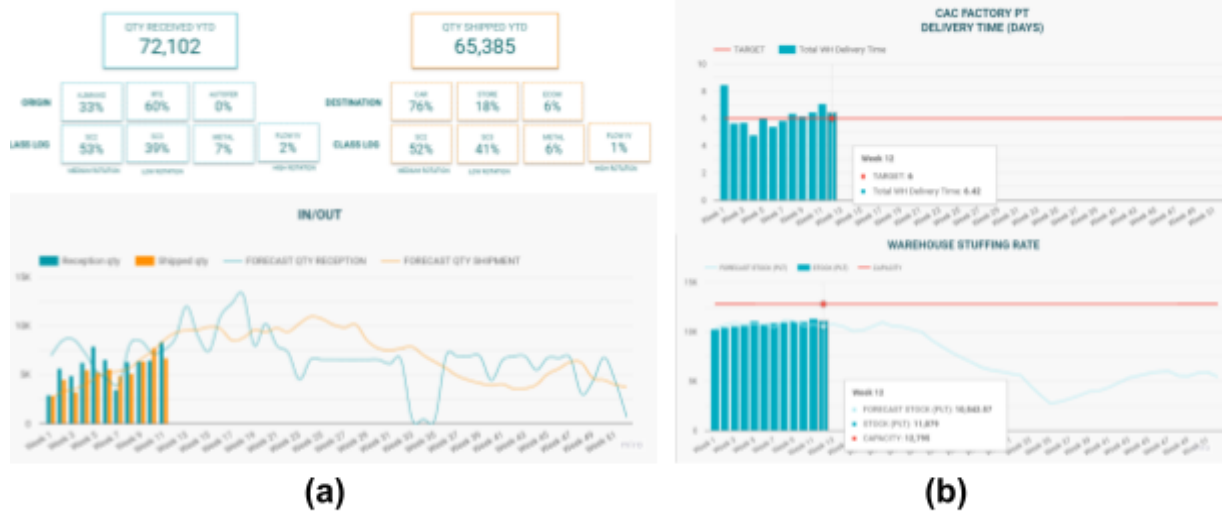


Figure 24 - Main KPIs regarding the EDC Factory Operation - (a) Annual evolution of received and shipped quantities (b) Weekly warehouse delivery time and warehouse stuffing rate

4.2.3 Continuous Improvement and PDCA Cycle

The last section of the *Kaizen* boards was completely focused on implementing a culture of continuous improvement on the teams of the CLG2. Due to its importance, it was decided that this should cover the biggest piece of the board.

When it comes to the PDCA Cycle, it is important to consider three different aspects:

- What are the different opportunities for improvement that were added by the team for evaluation;
- Who is the person or department responsible for ensuring that the improvement is being carried out;
- What is the current PDCA status of each of the improvements approved.

With respect to this, the section of the board was divided into three areas pertaining to “Improvements”, “Assigned to” and the PDCA Cycle, as can be seen in Figure 25. A color code was used to visually distinguish each PDCA phase, making it easier for everyone to track the changes in progress. An actual representation of each operation’s *Kaizen* board can be seen in Annex C.

Continuous Improvement and PDCA Cycle					
Improvements	Assigned to	PLAN PLANEAR	DO EXECUTAR	CHECK VERIFICAR	ACT ATUAR

Figure 25 - Mock-up of Continuous Improvement and PDCA Cycle of the *Kaizen* boards

4.3 CLG2's Teams Training

When talking about continuous improvement, it is mandatory to provide operators with all the conditions to implement new solutions on a daily basis. With the lack of *Kaizen* culture of the CLG2 teams, it was essential to train each employee in the basic principles of continuous improvement, as none had previously explored this subject in depth. Without adequate training, it would only be a matter of time before every improvement effort failed, as discipline (*Shitsuke*) is of great importance in *Kaizen* culture.

The topics chosen to address in this training were the following, due to their simplicity and ease of application:

- the *Kaizen* culture: what is it and basic principles;
- the PDCA Cycle: what is it and how to implement it;
- developed *Kaizen* tools to help them implement continuous improvement: 7 MUDAs, Ishikawa Diagram and the 5 Whys.

During the design of the training presentation, we ensured it was concise to meet its primary goal: raising awareness and alerting operators to the importance and necessity of continuous improvement, as well as emphasizing the significance of their behaviors in making this possible. Taking this into consideration, operators were divided into 4 different sessions, with around 8 to 10 people in each. The training sessions were led by Eng. João Barbosa, the Regional Operations Director, who played a key role in structuring the sessions and demonstrating the project's importance where everyone should participate, highlighting that it is overseen by one of the company's top executives. It is important to note that the training sessions were structured and designed to reflect the actual conditions of the warehouse. Real internal cases were used to make it easier for operators to understand the *Kaizen* concepts. The presentation slides can be found in Annex D.

4.4 Daily *Kaizen* Meetings

In order to apply the knowledge gained from the training sessions, operators needed to effectively incorporate daily *Kaizen* practices into their routine operations. Therefore, during the first weeks, meetings were scheduled at different times to ensure the presence of either the operational coordinator or the operational manager. Besides serving as a method to monitor

the project's implementation, it also highlighted its importance across all teams. Moreover, an agenda with guidelines was created to help team managers guide each one of the meetings. These guidelines were the following:

- **Introduction** - check attendances and underline the meeting's purpose;
- **Last day feedback** - talk about previous working day, challenges, positive aspects, actions to improve or highlight a specific event;
- **KPIs** - go through all indicators and check for relevant deviations from expected;
- **Continuous improvement and PDCA** - check in which step of the PDCA cycle each improvement is and point out main challenges in their development;
- **New improvement suggestions** - evaluate the need for new improvements;
- **Wrap-up** - summary of the meeting, highlighting key points.

These instructions are just guidelines, and each team manager has freedom to direct the meeting considering the team's best interest.

4.5 Equipment Charging Management

When it comes to the project of "Equipment Charging Management", the first step was to brainstorm homologous ideas that could be used as a solution to increase the amount of availed PV Output for equipment. This way, it made sense to account for three different aspects:

- the need to decrease the amount of energy consumed at the end of the night shift;
- the volume of equipment necessary to handle an exceptionally high demand shift;
- the benefits of opportunity charging.

In order to consider all these constraints, it was necessary to know the minimum amount of charge needed for an equipment to operate between the optimum battery percentage range for opportunity charging. This calculation should amount for a maximum work period of 2h, which is the longest period an operator should work before getting a break.

Considering the EN Cycle Consumption of each machine's type and its battery capacity, data corresponding to Table 3, it was calculated that, on an exceptionally high-demand day, all equipment would lose no more than 31,2% of battery charge, except the PPT, whose value amounts to 43%. This value was obtained as the percentage of energy spent by the equipment considering its battery life, the PPT, through the use of equations (1) and (2).

$$BL = C \times V / (P \times 1000) \quad (1)$$

$$BP = P \times MWT / (C \times V) \quad (2)$$

Where:

BL, represents Battery Life, in hours,

C, represents Battery Capacity, in Ah,

V, represents Battery Voltage, in V,

P, represents the EN Cycle Consumption, in W,

BP, represents the Battery Percentage, in %, and

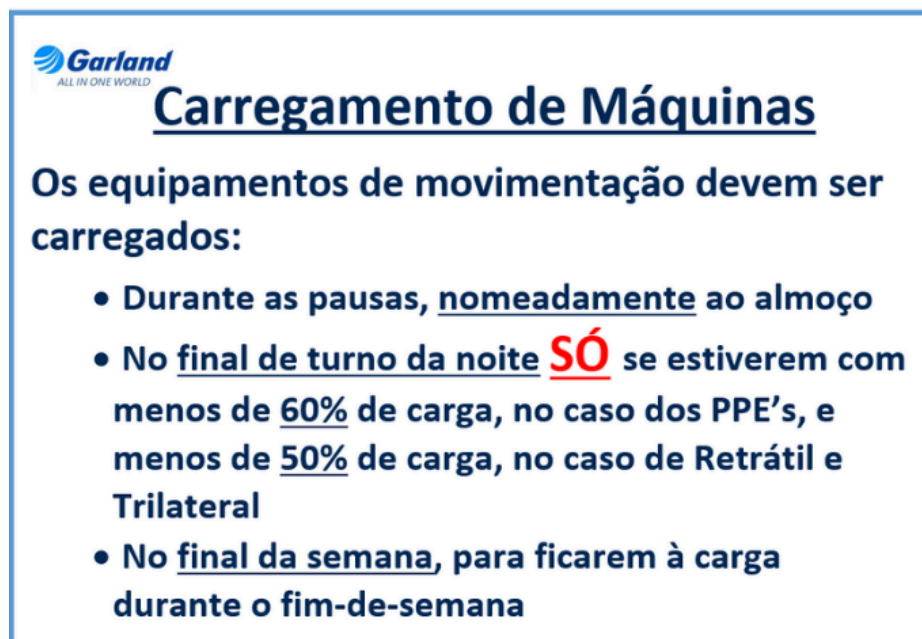
MWT, represents the Maximum Working Time, in hours

As the optimum battery percentage operating range for a lithium-based battery is between 30% and 80% and it shouldn't get below 20%, the first approach was to consider that, in any of the shifts, all equipment should have at least 70% battery charge for a PPT, and 60% otherwise. However, after conversations with the operations, it was acknowledged that these percentages, in practice, were too high a value to consider. Thus, on the second approach they were updated for 60% regarding the PPT, and 50% otherwise. If an equipment had a battery percentage below these numbers after the end of a working period or the end of a shift, it should be charged accordingly. This procedure would guarantee that operators had all conditions to work without worries and that they would take advantage of the benefits of opportunity charging.

One of the concerns that arose regarding this procedure was if it would allow the batteries to be supercharged more often. However, this possibility was left aside due to the fact that the charges have a feature that allows them to power off every time a battery is fully charged. Another concern was relative to the weekend, as the permanence of equipment without charging for long periods of time can shorten their batteries lifetime. On the other hand, it was found that each charger possesses another feature that would allow it to maintain all battery elements in balance for an extended duration, thus, demonstrating that equipment could and should be left charging during weekends and holidays.

4.5.1 CLG2's Operators Training

The second step was to apply this new procedure across all sections of the warehouse. In order to train the operators, it was necessary to explain to them the commitment of the company to increase sustainable practices in the CLG2 and to take advantage of the energy self-production it had. The message was transmitted during the *Kaizen* meetings of each team, inserted in the continuous improvement project. To standardize this corrective action, the document of Figure 26 was created and placed on every single battery charger, to remind employees of the corrective action to take.



 **Garland**
ALL IN ONE WORLD

Carregamento de Máquinas

Os equipamentos de movimentação devem ser carregados:

- Durante as pausas, nomeadamente ao almoço
- No final de turno da noite **SÓ** se estiverem com menos de 60% de carga, no caso dos PPE's, e menos de 50% de carga, no caso de Retrátil e Trilateral
- No final da semana, para ficarem à carga durante o fim-de-semana

Figure 26 - Document created to standardize the new equipment charging process

This document states the following:

“Equipment Charging

Moving equipment should be charged:

- during breaks, specially at lunch;
- at the end of the night shift, only if they have less than 60% battery, regarding PPTs, and less than 50% battery, regarding other equipment;
- at the end of the week, so they can be left charging during the weekend.”

The underline was used to highlight the most relevant information regarding this procedure.

4.6 Implementation of a New Picking Line

As seen in chapter 3.4, piece picking was the solution that should be implemented to counter the unwanted disadvantages of pallet picking, especially on shared SKUs. However, thinking more globally and since the CLG2’s section 1 has more than enough space to implement picking by box on the ground, the study was made considering all components and not only the shared SKUs.

The implementation of the new picking line must be first validated by the client. This way, the analysis behind the new picking line composed three different steps. The first was regarding data collection from the WMS used in the CLG2. It was necessary to know, among all SKUs and POs, each product’s pack config, in other words, the specific packaging and presentation details of the goods to be handled. This information includes box dimensions, volume and PCB and was required to calculate the number of units per pallet, for each SKU. Besides, in order to compare both picking lines, it was necessary to gather information about the orders made for these SKUs, which was made considering all data since the beginning of the year 2024. The first challenge was which SKUs to consider in this analysis, as not all of them should be represented in this study and may constitute outliers that shouldn’t be analyzed. Therefore, all SKU data was combined to calculate four different values: the average and the mode of each box’s volume and the average and the mode of each box’s PCB. After that, a test was made to compare the values obtained and to select which SKUs should be kept for the actual analysis.

The second step was to calculate the number of units per pallet, considering the budgeted volume of 0,93 m² per pallet, and the mode of either the PCB or the box volume, according to equation (5) as an integer.

$$QtyP = INT(PCB \times 0,98/V) \quad (5)$$

Where:

QtyP, represents the Quantity per Pallet,

INT(), represents the integer value,

PCB, represents the number of Pieces by Case/Box, and

V, represents the Box’s Volume.

Finally, with the number of units per pallet it becomes easier to go through the list of all orders since the beginning of 2024 and calculate the number of pallets and boxes needed for the new picking line.

$$N_total = Qty_requested / QtyP \quad (6)$$

$$N_pallet = INT(N_total) \quad (7)$$

$$P_box = (N_total - N_pallet) / N_total \quad (8)$$

$$N_box = Qty_requested \times P_box / PCB \quad (9)$$

Where:

N_total , represents the total number of pallets needed for picking,

$Qty_requested$, represents the number of units ordered,

N_pallet , represents the actual number of pallets needed for picking,

P_box , represents the percentage of picking done by box, and

N_box , represents the actual number of boxes needed for picking

The number of pallets requested for the old picking line corresponds to the N_total variable rounded up, in order to always meet the quantity demanded by the client.

5 Results of the Solutions Implemented

The main purpose behind continuous improvement is the implementation of solutions that can bring positive results and make it easier for employees to perform their tasks on a daily basis. Only the main implementations will be presented, but all of them will be accounted for in the final outcome. As for the suggestions for improvement, their conclusions will be divided in two different aspects: qualitative and quantitative results.

5.1 Implemented Suggestions for Improvements

The implementation of daily Kaizen meetings was crucial in identifying new improvements. Shortly after the beginning of these meetings, significant opportunities were recognized by the teams in order to develop processes within their operations. The simple fact of joining everyone for 5 minutes per day to talk about the main challenges of their work was more than enough to deliver positive early results.

On one hand, as the improvements were being developed, employees started feeling increasingly involved in the Kaizen project. Although it may seem like a small aspect, this fact is significant to boost every team's morale and motivation in the preservation of the project and its continuance. On the other hand, going everyday through all the improvements being executed, especially when not at the beginning of the shift, was starting to prove wearing for the teams. This situation becomes particularly evident at the beginning of the week, as in the case of the CLG2, this period was often the most demanding and the one with the most workload. When continuous improvement is not set as a priority to be accomplished by each team, it is usually left aside. For this reason, it became very difficult to give teams the responsibility of holding the meetings themselves, as there were always more important tasks to be done.

When it comes to the quantitative results, first will be presented the several improvements made throughout the course of this dissertation, organized by each operation. After that, the sum of their results. This way, the suggestions that were concluded in the last months were the following:

- **SAV** - improvement of the internal KPI for estimating production time, in order to better forecast the time it will take to complete the production plan for each week; changes in the number of personnel needed to carry out the weekly interior picking in the SAV's area, decreasing a total of 1 FTE, which is more than necessary to efficiently complete the operation; layout redesign of the SAV's area to increase the available space for workstations, storage and circulation flow.
- **Components** - realization of a site survey with the Innovation and Systems Department to identify network disruptions that promote regular outages during picking processes. This study concluded that additional routers were needed in sections 1 and 2 of the CLG2 to resolve these issues, thus, a quote was requested to purchase more equipment.
- **EDC Factory** - establishment of an internal communication channel to quickly notify operators about same-day extra expedition updates; realization of a study to install a wireless UAT machine in section 3 to enhance the picking process flow, pending client approval.

- **General Improvements** - layout redesign of computer terminals, picking devices, mobile printers and chargers in order to improve circulation flow and decrease motion wastes that add no value to the process; initiation of a project to enable direct entry of received goods into Garland's WMS, significantly boosting the efficiency of the receiving process of operations; setting up a flexible paired picking device and printer to minimize time spent searching for the right combination, allowing any picking device to work with any available printer; extension of the warehouse lights timer from 1 to 5 minutes during inventory week to address motion sensor limitations and improve working conditions for the night shift; implementation of a continuous training plan for operators to enhance their skills and keep them updated on system changes.

Despite being difficult to measure, most of the results of each improvement represent either time saved, or efficiency increase on tasks to be performed. Due to confidentiality reasons, specific results cannot be shared. However, between March and May, the internal performance KPI that measures human resources efficiency, recorded an improvement of over 10% compared to the months prior to the Kaizen implementation. This progress demonstrates the significant value of continuous improvement efforts, showing all stakeholders the importance of applying the *Kaizen* culture on a daily basis. Details of other improvements relative to the latest equipment charging procedure and the new picking line will be discussed in the following chapters.

5.2 Equipment Charging Management

As seen previously, data collection was one of the main challenges associated with the FusionSolar software and the PV hardware that made it difficult to develop this project earlier. This way, the introduction of a new process to charge equipment in the CLG2 could only be analyzed for the month of May 2024, as can be seen in Figure 36, Annex A, which represents the daily average of the three values considered: “PV Output”, “Total Consumption” and “Consumed from PV”. In order to properly analyze the new procedure, it had to be considered similar data between the month of May and either of the months of April or March. Figure 27 represents the daily average PV Output for each month, where it can be seen the resemblance between months April and May.

PV Output

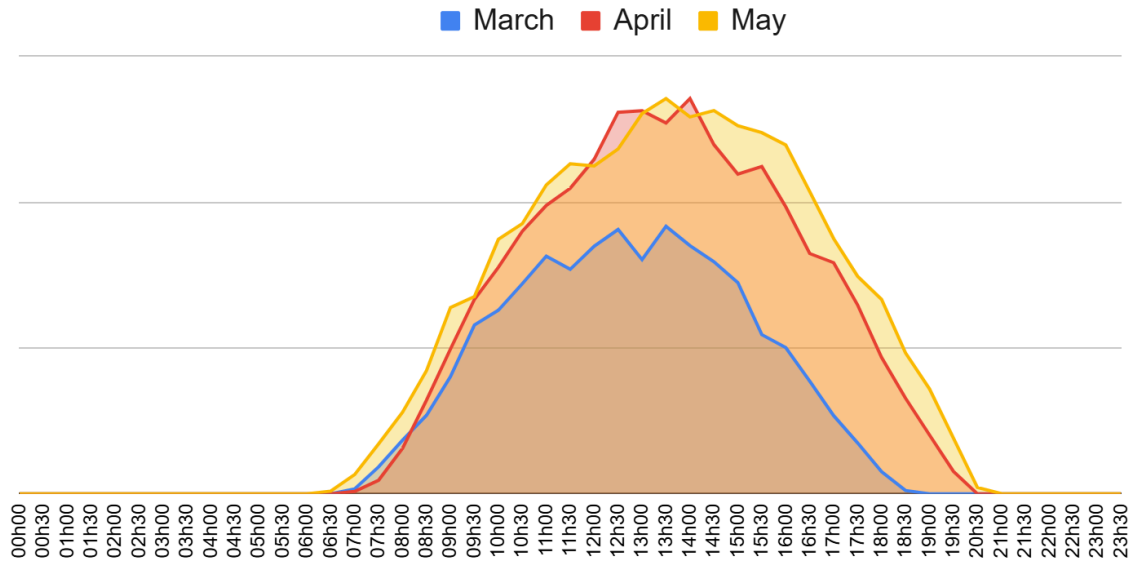


Figure 27 - Daily average of “PV Output” for March, April and May

This way, using April as the reference month to compare results, Table 4 presents the variations across all different indicators calculated, for the period of May, while Table 5 represents the percentage of PV that was consumed, “Yield”, and the percentage of consumption that was PV, “% of Consumption PV”.

Table 4 - KPIs variations from April to May

Month	PV Output	Total Consumption	Consumed from PV	Night Peak Consumption
May	+12,1%	-2,3%	+10,1%	-51,6%

Table 5 - “Yield” and “Percentage of Consumption PV” regarding the months of March, April and May

Month	Yield	% of Consumption PV
March	55,8%	37,1%
April	45,5%	48,2%
May	44,7%	53,4%

From these results, it can be assumed the following:

- On one hand, in part, the increase in PV consumption in May is explained by the similar increase in PV output. However, while the overall consumption had relatively significant reduction, around 2,3%, and the energy peak at night, which doesn't consider the idle consumption of the warehouse, dropped

significantly, by 51,6%, it can be assumed that much of this energy was spent during the day, thus, also adding to the increase of “Consumed from PV” during May;

- On the other hand, as can be seen in Table 5, the small decrease in Yield during May, of -0,8%, should not be evaluated alone, as the percentage of PV consumption grew remarkably in the same month, from 48,2% to 53,4%.

As it represents a decrease of 51,6% during night peak consumption, this amounts up to 18,5% of all energy spent in the CLG2 that was saved for PV consumption. In fact, these positive results are even higher than the main goal of saving 10% energy with self-production. As more developments are needed, other solutions were considered to further help achieve this objective. These refinements were the following:

- adjust the operating hours for the exterior warehouse lights from 8:00 pm - 7:00 am to 9:00 pm - 6:00 am, decreasing consumption up to 2 hours;
- consider acquiring access to the equipment supplier software in order to monitor in real time the battery percentage of each machine, to better decide on when they should be left charging;
- consider using complementary machines in the night shift every time they get to the optimum battery range. In other words, every time a turret truck reached 60-70% of battery, it would be substituted by another one. This way, during the day shift they would all be left fully charging with no further consumption during the night.

The only adjustment that was actually implemented was the first one, due to its simplicity and straightforwardness. This improvement came to be a significant one, saving around 2,0% of the total consumption of the warehouse. Considering the application of both solutions, the reduction in imported energy usage amounted to a total energy savings of 20,5%, with no added impact on the operations of the CLG2. The other two adjustments mentioned would bring either more costs associated or more complex processes to handle, which are undesirable outcomes, as more data is needed to properly implement them.

5.3 New Picking Line Analysis

Regarding the implementation of the new picking line, picking cost was not the sole factor taken into account. Besides that, it was important to understand the number of pallets that were going to be transported in both options and, consequently, the number of trucks needed. Lastly, in order to consider the impact this new picking has on sustainability, it was also taken into account the amount of CO₂ produced by the trucks.

The main results of this comparison are presented on Table 6. In order to keep information confidential, the picking and distribution costs appear as the ratio relative to the total cost for each line. The last column represents the variation, in percentage, from the old to the new picking line.

The assumptions considered for these calculations were the following:

- The stipulated prices with the client regarding piece picking and pallet picking;
- Each truck can load up to 33 pallets;
- The average distance covered by a truck from suppliers to the warehouse is around 66,15 km;
- Every km covered by a truck releases 800 g of CO₂ into the atmosphere (Transport & Environment, 2021).

Table 6 - Comparison of key metrics between Old and New Picking Lines

	Old Picking	New Picking	Difference OLD vs NEW
Picking Costs	28,9%	38,2%	+26,9%
Distribution Costs	71,1%	61,8%	-16,6%
Total Cost	-	-	-4,0%

The increase in picking costs in the new picking line is explained by the fact that piece picking requires more complex handling processes compared to regular pallet picking. On the other hand, the decrease in distribution costs is evident from the reduction in the number of pallets handled, which dropped from 37,753 to 27,965. Consequently, this also led to a decrease in the number of trucks needed, from 1,145 to 955. As a result, CO2 emissions were cut by 10,1 tons, which represents over 16% of the total emissions of the old picking line.

As can be concluded from the results, this new system is more efficient and environmentally friendly, ultimately lowering the total operational costs. Despite the higher picking costs, piece picking presents itself as the ideal solution to implement in the components line of the CLG2. Nonetheless, these conclusions were presented to the client and were not yet given green light to be developed in the operations of the warehouse.

6 Conclusion and Future Work Prospects

6.1 Conclusion

While developing this dissertation, it was possible to understand how the application of daily *Kaizen* and continuous improvement is able to increase the efficiency of the operations that take place in a logistics operational center. During this time, the focus was on implementing actions that could increase the productivity and performance of operators, organization, reduction of tasks with no added-value and the effectiveness provided to the final client.

Considering the starting goals, an initial analysis was made to identify the activities present in the warehouse, their processes and their associated wastes, in other words, their opportunities for improvement. The application of Flowcharts and Spaghetti Diagrams was crucial not only to define the main problem, but to guide each team in the understanding of their operations. Moreover, the implementation of daily *Kaizen* allowed the identification of areas that needed developments and which of these were most significant in accumulated gains for the logistics operational center, in regards to efficiency. Despite not having delivered its full potential, all implemented suggestions were able to increase the warehouse's productivity over 10% with a major impact in promoting a culture of continuous improvement in the organization.

From the improvements executed, there is a highlight on the process behind equipment charging through self-production, as a simple procedure was able to reduce night peak consumption around 51,6%, with gains over 18% on the overall amount of non-sustainable energy consumed in the warehouse. On the other hand, related to the study of a new picking line in components, it is possible to see how the unfolding of new improvements in the Logistics Sector may be dependent on an external client to be implemented, increasing the time and effort necessary to apply them.

With the accomplishment of the initial goals, the implementation of daily *Kaizen* in logistics operational centers is a transformative approach that drives operational efficiency and continuous improvement when aiming for sustainable growth.

6.2 Future Work Prospects

When embracing a culture of continuous improvement, there will always be developments to be made and suggestions to be considered for optimizing processes in a logistics operational center. As the *Kaizen* culture represents an ongoing process, this chapter identifies the potential areas that need further research to create even greater advancements in the CLG2's operations.

In order to successfully implement the continuous improvement and the *Kaizen* cultures in the CLG2, it is imperative to apply the 5S tool across all operations of the warehouse through regular audits. This simple procedure will bring positive results and ease the workload of operators; however, it is particularly important to focus on employees' discipline to see this project reach a successful outcome.

Regarding *Kaizen* meetings, it is necessary to consider the feedback given by all teams to update them, whether in its frequency or in its content. This way, it will become easier to have motivated employees, likely to give more and better improvement suggestions and participate actively in their development.

One of the major improvements that can be done in the CLG2 is related to the EDC Factory operations. Through the analysis of its processes, it is evident the existence of increased flow between the picking corridors, the receiving verification zone and the packing area. In such a manner, a further study should be made to update the section's 3 layout in order to decrease flow concentrations and optimize the overall operation. Moreover, despite being difficult to forecast the orders that came through the EDC Factory operation, an analysis should be conducted to study the quantity of pallets produced and shipped for each destination. This survey would be used to minimize the total distance traveled by operators, by identifying the most popular destinations and moving them closer to the shipping docks.

Another improvement that should be developed consists of extending to all operations the identification of the arrival time of all trucks. This analysis is essential to evaluate the impact these delays have on the CLG2's operations and communicate them to Garland's Distribution Department in order to optimize processes and develop internal relationships. This data collection should be automated using internal documents available in the CLG2, in order to reduce the workload for operators.

To sum up, the implementation of continuous improvement at CLG2 is a dynamic and ongoing process that demands dedicated efforts through discipline and strategic implementations. These improvements are just some that can be applied to develop the warehouse's processes and operating network. Only by applying the *Kaizen* culture on a daily basis and focusing on employee involvement and feedback becomes possible to aim for the ultimate goal to create a more streamlined and responsive logistics center, capable of meeting future challenges and opportunities with flexibility, sustainability and efficiency.

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ANNEX A: Data

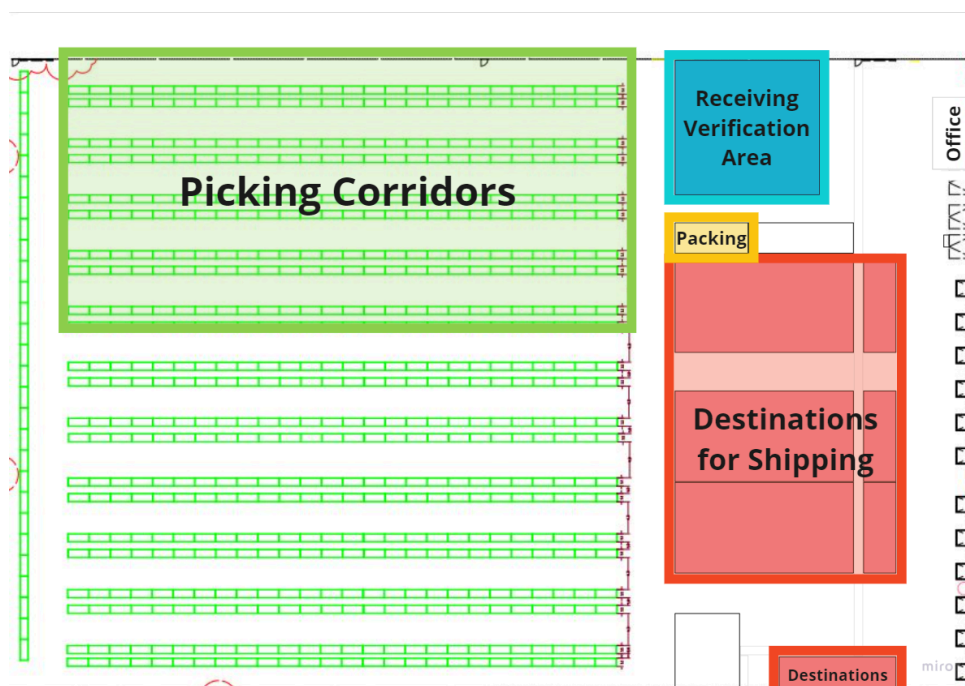


Figure 28 - Representation of the main areas of the CLG2's Section 3

Mapeamento do processo de Receção Componentes

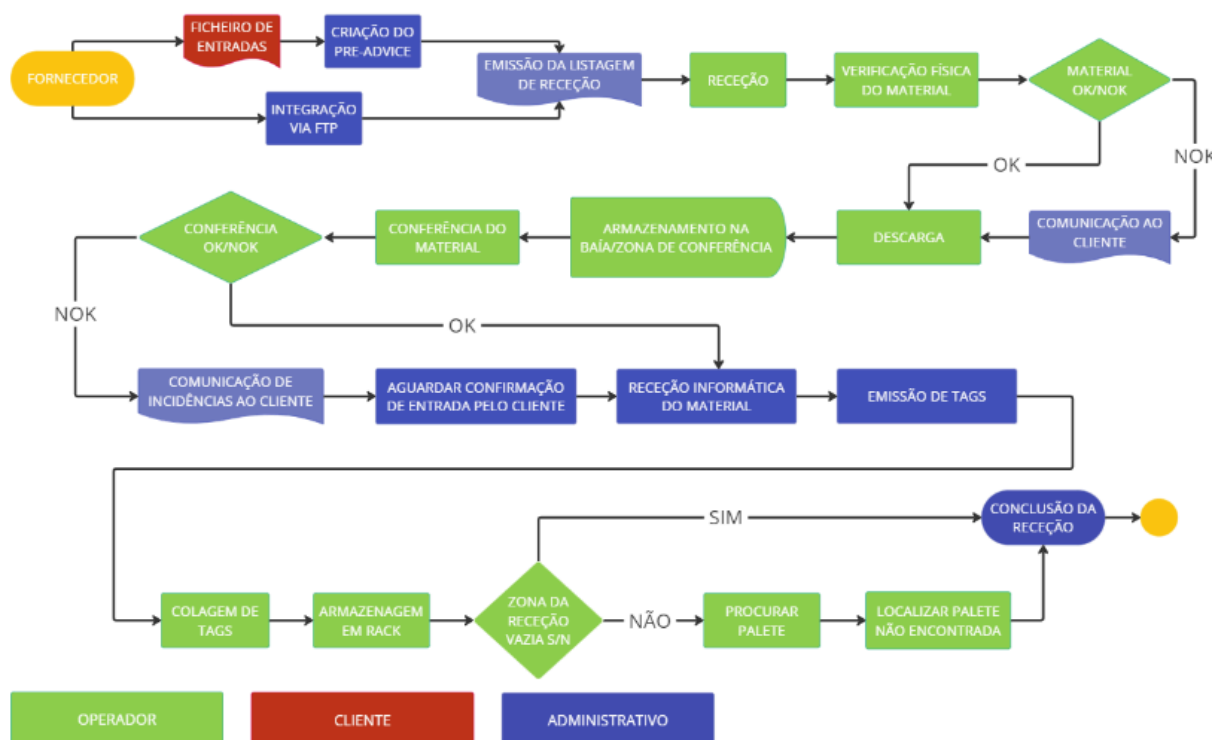


Figure 29 - Flowchart of the Receiving process of the Components Operation

Mapeamento do processo de Expedição de pedidos (fábricas)

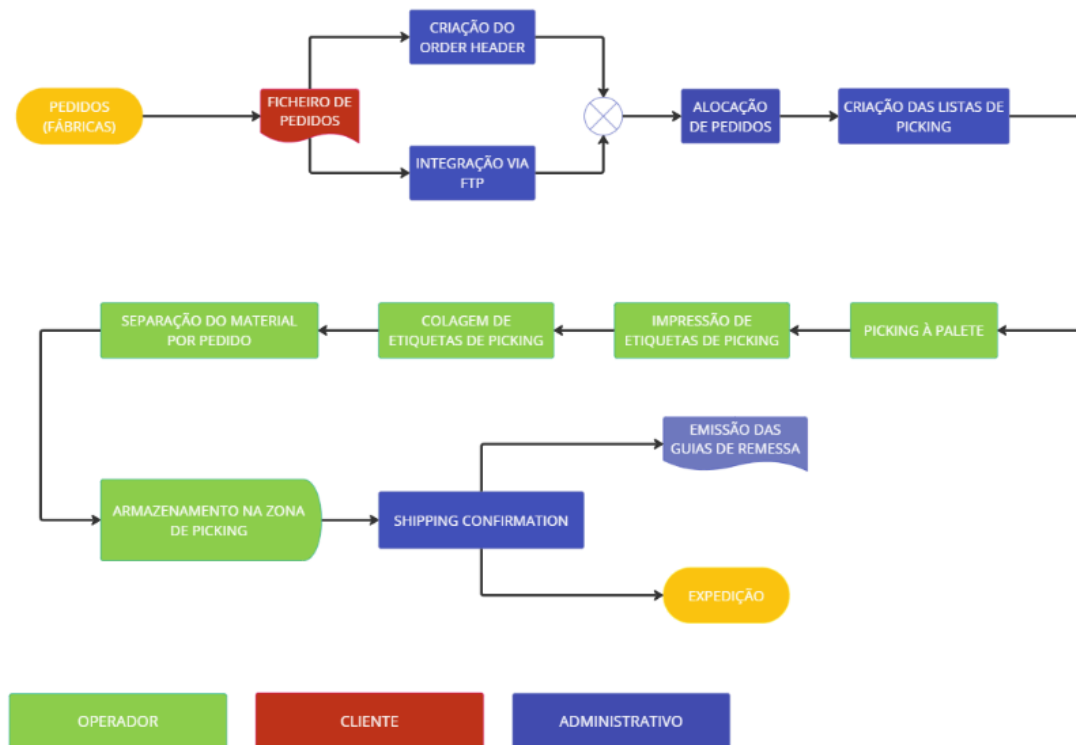


Figure 30 - Flowchart of the Expedition process of the Components Operation for factories

Mapeamento do processo de Expedição de pedidos (não fábricas)

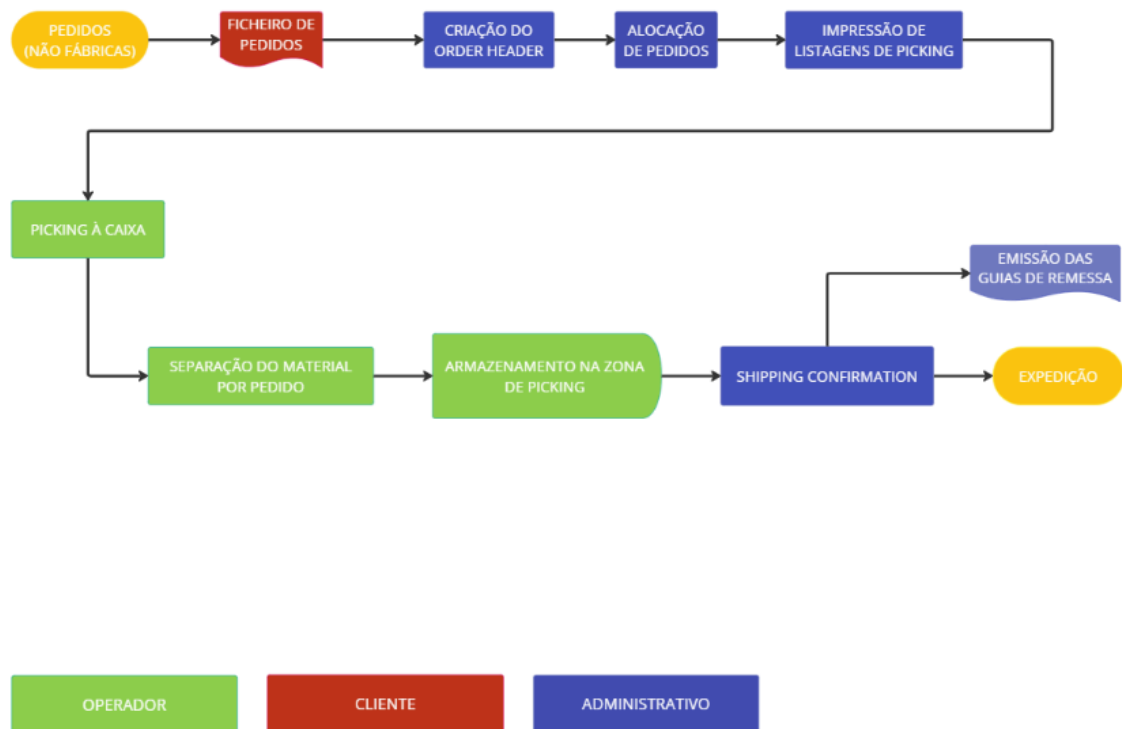


Figure 31 - Flowchart of the Expedition process of the Components Operation for non-factories

Mapeamento do processo de Pedidos SAV

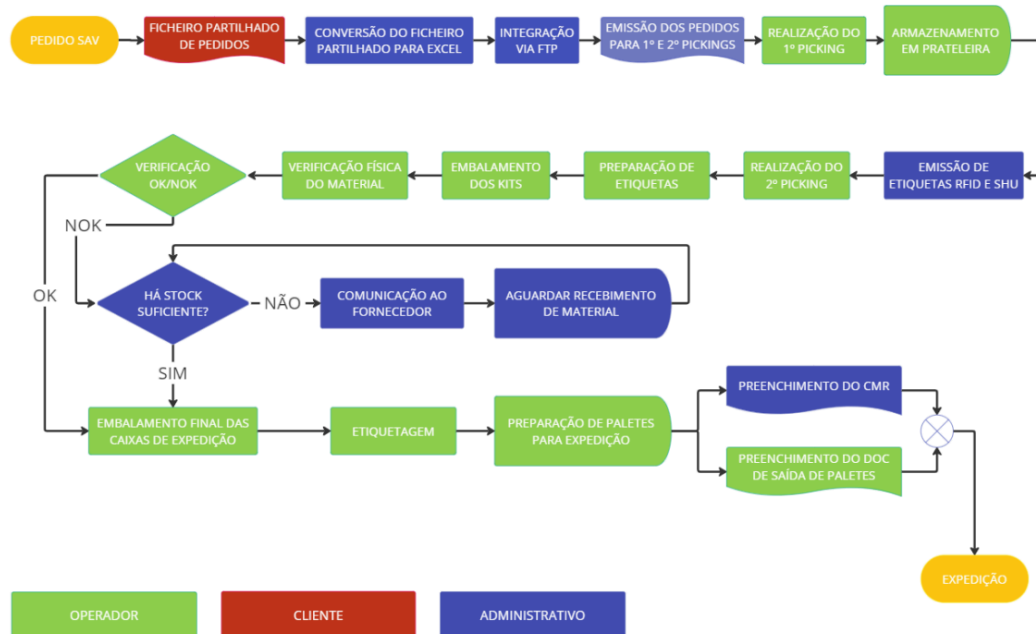


Figure 32 - Flowchart of the SAVs Requests' Process

Mapeamento do processo de Expedição de encomendas - Exportation

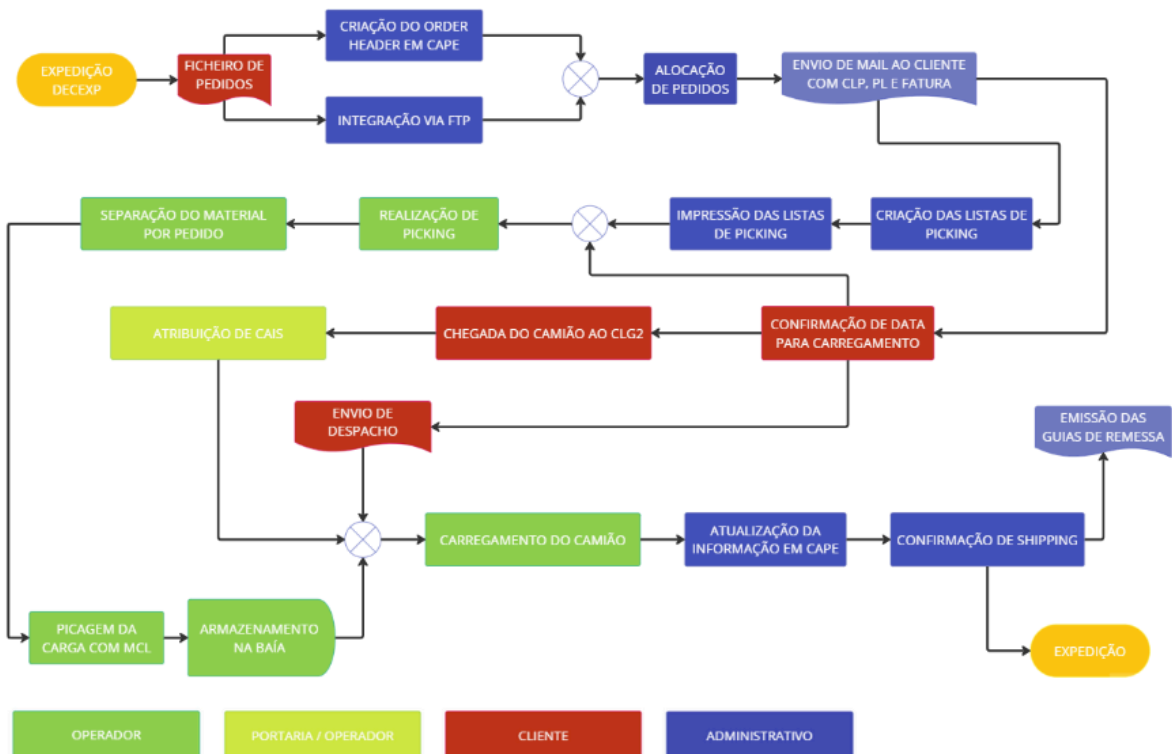


Figure 33 - Flowchart of the Expedition process of the Exportation Operation

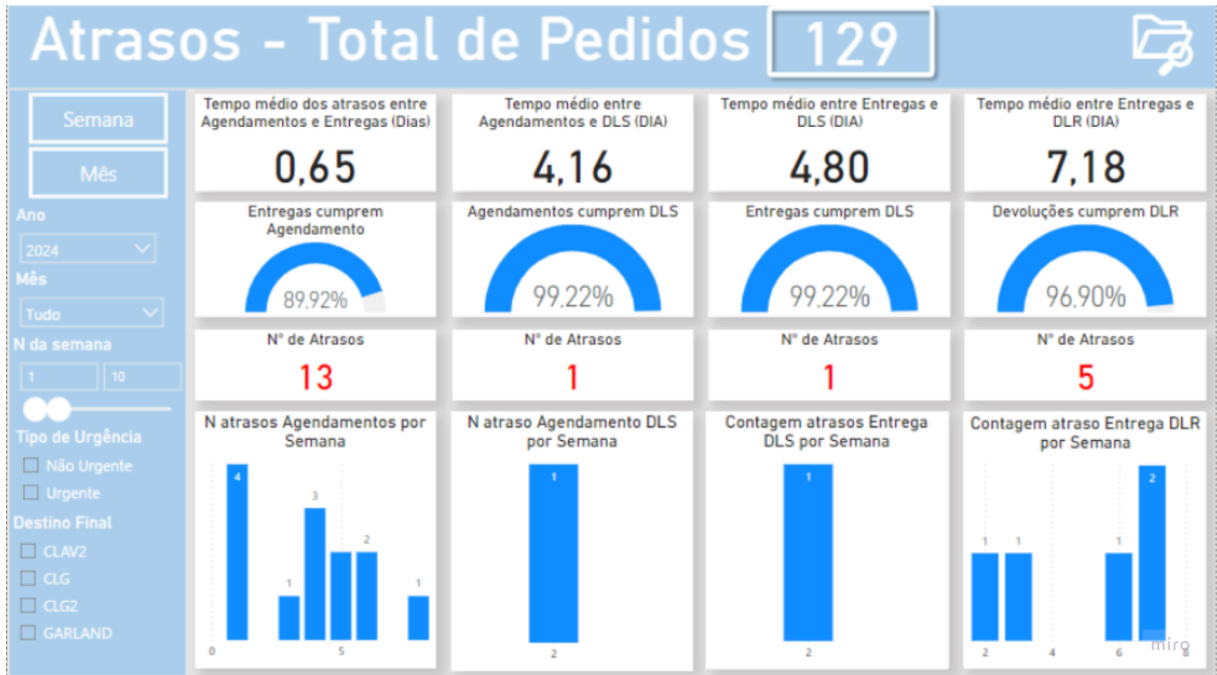


Figure 34 - Dashboard regarding Order Preparation Delays for the Components Operation



Figure 35 - Daily Loading Plan for the Components Operation

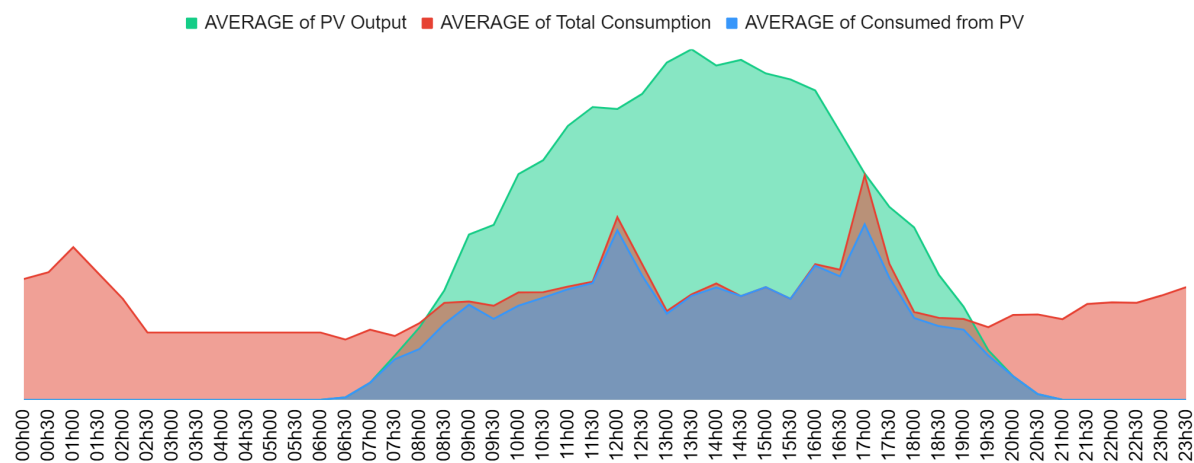


Figure 36 - Average measurements of "PV Output", "Total Consumption" and "Consumed from PV" for May 2024 at 30-minute intervals

ANNEX B: Additional Information

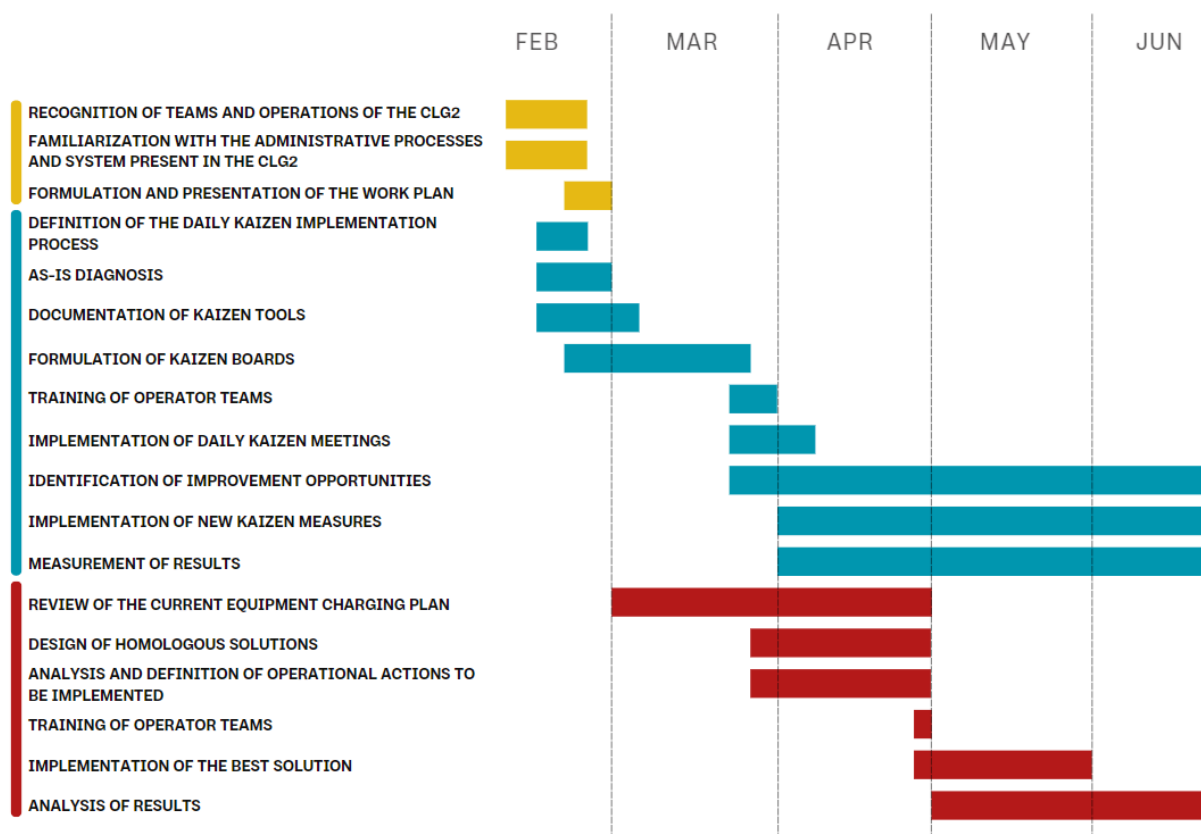


Figure 37 - Gantt Chart illustrating the initial stages undertaken in a business environment

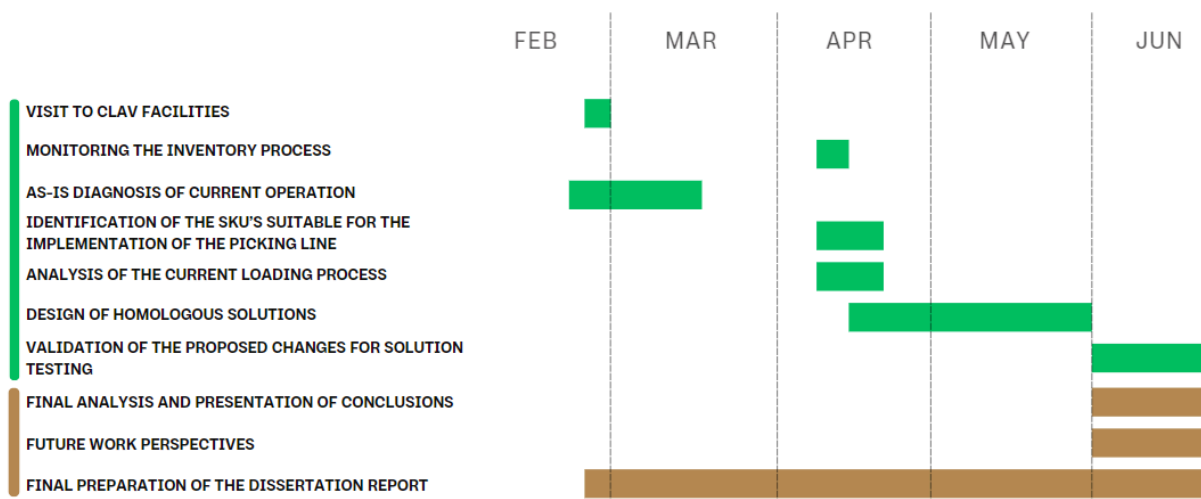


Figure 38 - Gantt Chart illustrating the final stages undertaken in a business environment

ANNEX C: Photographs



Figure 39 - Yellow Tape Markings for identifying an area occupied by a fire extinguisher



Figure 40 - Yellow Tape Markings for identifying an emergency exit



Figure 41 - Yellow Tape Markings for identification of waste segregation



Figure 42 - Blue Tape Markings for identification of E-commerce pallets

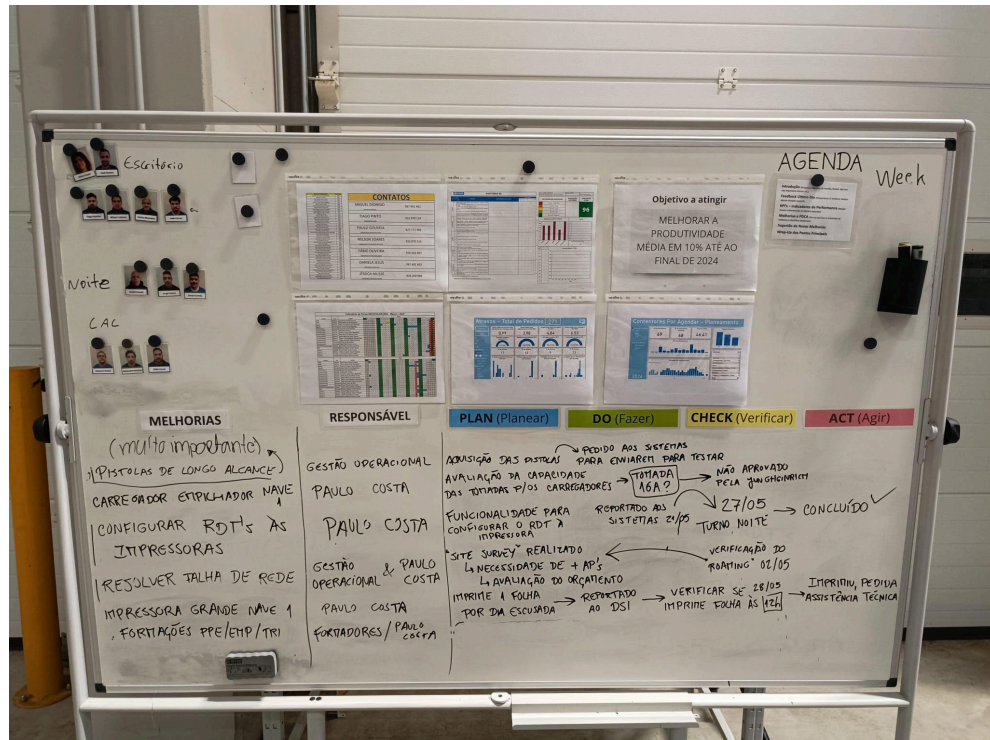


Figure 43 - Kaizen Board of the Components Operation

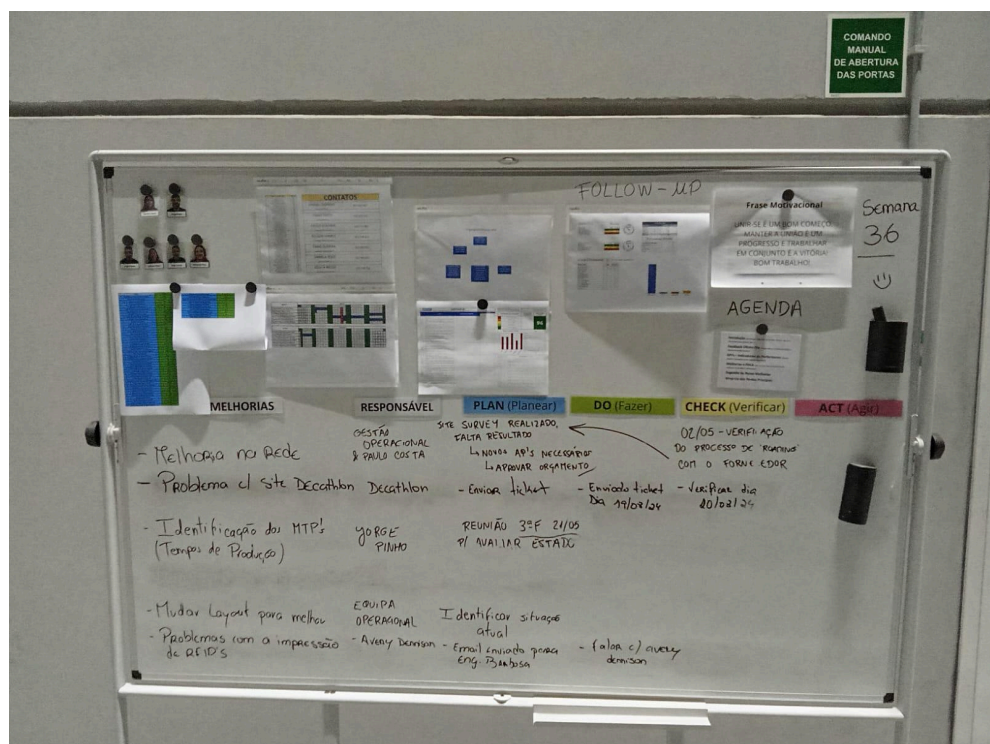


Figure 44 - Kaizen Board of the SAV Operation

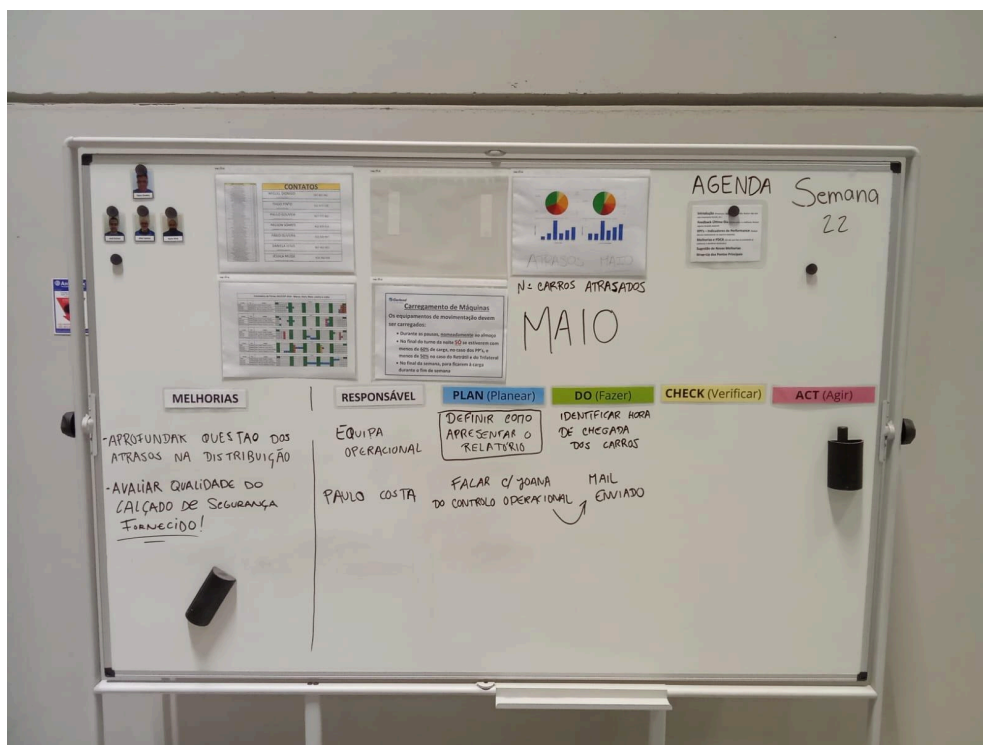
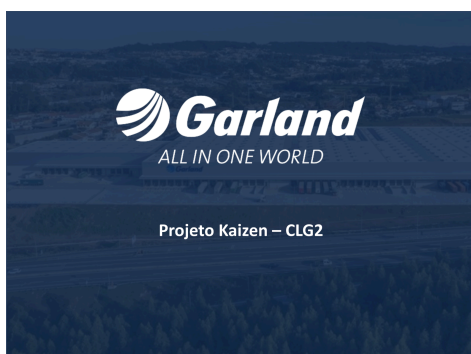


Figure 45 - Kaizen Board of the Exportation Operation



Figure 46 - Kaizen Board of the EDC Factory Operation

ANNEX D: Training sessions presentation slides



Âmbito:
Implementação Kaizen – CLG2

Agenda:

1. O que é a cultura KAIZEN?
2. Principios Kaizen
3. Ciclo PDCA – Melhoria contínua
4. Implementação KAIZEN – CLG2
5. Ferramentas KAIZEN

1. O que é a cultura KAIZEN

MUDAR

+

MELHOR

=

MELHORIA CONTINUA

2. Quais são os Principios Kaizen

1. Melhoria contínua

1- Melhoria contínua – O Kaizen baseia-se na melhoria contínua com experimentação em vez da melhoria pontual e disruptiva

2. Cultura

2 – O Kaizen é uma filosofia que pretende criar uma cultura e não apenas uma metodologia. Sendo uma cultura exige o envolvimento de todos na Organização desde o pessoal que está mais ausente do chão do armazém até aqueles que estão na linha da frente.

2. Quais são os Principios Kaizen

3. Foco no Cliente

3 – Foco no Cliente: Só devemos fazer aquilo a que o cliente dá valor e o que o cliente dá valor é aquilo que o cliente paga. Em tudo o que fazemos devemos perceber se o cliente pretende esse serviço e se paga por ele.

4. Fluxos eficientes e seguros

2. Quais são os Principios Kaizen

5. Eficácia nos processos

5 – Eficácia nos processos (diferença entre eficácia e eficiência)

Os erros são fonte de retrabalho e ineficiência. Os erros devem ser endereçados num âmbito de causa raiz e a solução deve ser padronizada. Não podemos estar sempre a resolver o mesmo problema

Ex: Diagrama de Ishikawa => causa efeito

6. Ser factual e transparente

Dados e medições correctas e transparentes são a única forma possível de aferir se existiu ou não melhoria nas alterações implementadas. A cultura kaizen pressupõe experimentação e tentativa e erro, até que se consiga melhorias nos resultados.

3. Ciclo PDCA

1. Planeamento

O ciclo PDCA é uma ferramenta essencial para a melhoria contínua.

Embora possa ser usado como ferramenta para atingir um objectivo definido, a sua natureza cíclica permite que se auto alimente sem um fim definido, tornando-o um instrumento contínuo de melhoria contínua em linha com a cultura Kaizen

2. Execução

3. Check (validação)

4. Actuar / agir

3. Ciclo PDCA

1. Planeamento

1. Planeamento – Análise das causas, desenvolvimento de correcção e planeamento

Ferramentas de análise às causas

- Caça aos Desperdícios (MUDA)
- Diagrama de Ishikawa
- Método dos 5 porquês

Ferramentas de desenvolvimento e correcção

- Analisar processos semelhantes, no sentido da normalização
- Listar possíveis soluções, numa perspectiva de raciocínio vertical e lateral

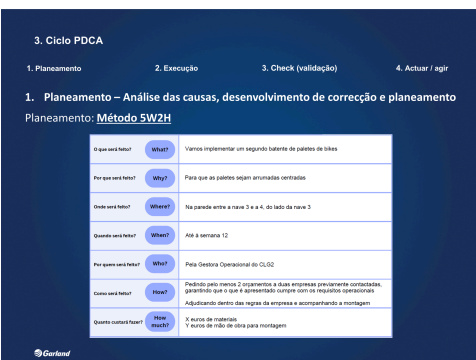
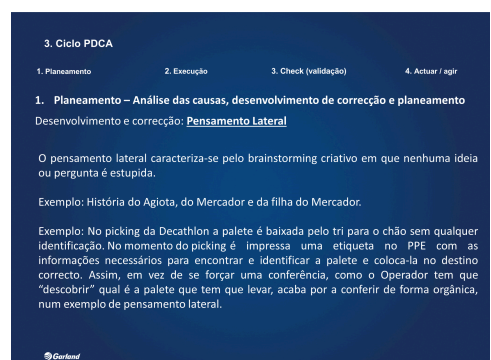
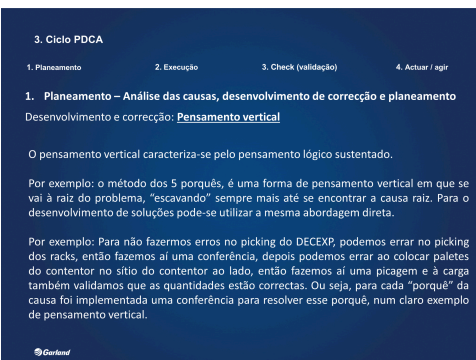
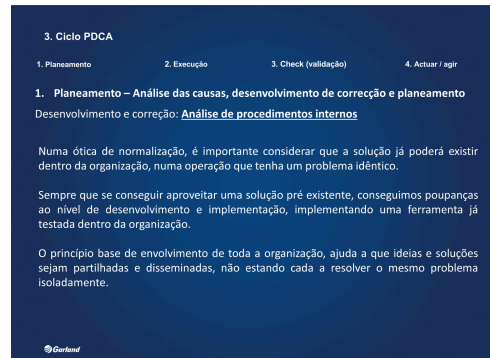
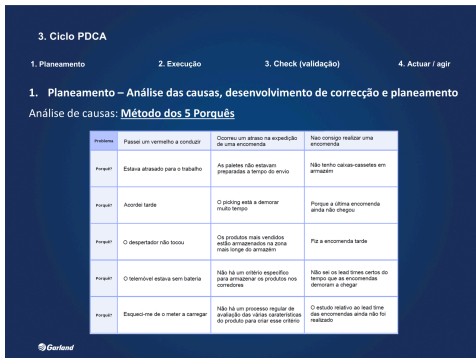
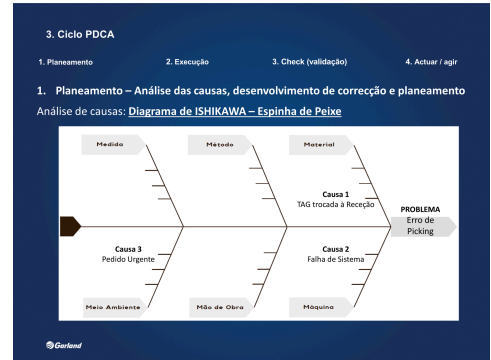
Ferramentas de planeamento:

- Método 5W2H
- Cronograma para implementações mais complexas
- Planeamento dos KPIs a utilizar

2. Execução

3. Check (validação)

4. Actuar / agir



3. Ciclo PDCA

1. Planeamento
2. Execução
3. Check (validação)
4. Actuar / agir

1. Planeamento – Análise das causas, desenvolvimento de correcção e planeamento
Planeamento: Cronograma

3. Ciclo PDCA

1. Planejamento

2. Execução

3. Check (validação)

4. Actuar / agir

1. **Planeamento – Análise das causas, desenvolvimento de correção e planeamento**

Planeamento: **Desenvolvimento dos KPIs**

A cultura Kaizen tem implícito tentativa e erro como forma de melhoria, claro que podemos acertar na melhoria à primeira, mas essa pode ser não ser o caso. Como tal, na implementação é necessário definir os KPIs que vão usar para medir a alteração proposta.

Por exemplo, aquando da implementação Onda de picking Decathlon + guia de recolha e distribuição por Rota na Decathlon, foi determinado que o KPI seria o número de paletes picadas pelo utilizador do Retráttil. Foi fixado durante o tempo da implementação o mesmo utilizador e diariamente eram analisados os dados via Query.



[illegible]

3. Ciclo PDCA

1. Planeamento
2. Execução
3. Check (validação)
4. Actuar / agir

3. Check (Validação)

A fase do Check tem como principais Objectivos os seguintes pontos:

1. Verificar se o planeamento está a ser cumprido
2. Analisar os dados resultantes da execução
3. Tirar conclusões sobre o observado

 Gartland

```
graph TD; A[Ciclo PDCA] --> B[1. Planejamento]; B --> C[2. Execução]; C --> D[3. Check (validação)]; D --> E[4. Actuar / agir]; E --> A; D --- F[Verificar se o planeamento está a ser cumprido];
```

3. Ciclo PDCA

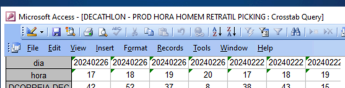
1. Planejamento 2. Execução 3. Check (validação) 4. Actuar / agir

3. Check (Validação)

Analisar os dados resultantes da execução

Para se poder tirar conclusões é necessário primeiro ter dados e analisar dados.

Como exemplo, no caso da implementação Onda de picking Decathlon + guia de recolha e distribuição por Rota na Decathlon, todos os dias a equipa olhava para os dados dos dois dias anteriores e estes eram discutidos diariamente.



dia	hora	dec	counts
20240226	17	18	19
20240226	18	19	20
20240226	19	20	17
20240226	20	17	18
20240226	17	18	19
20240226	18	19	20
20240226	19	20	17
20240226	20	17	18
20240227	17	18	19
20240227	18	19	20
20240227	19	20	17
20240227	20	17	18

```

graph TD
    A[3. Ciclo PDCA] --> B[1. Planeamento]
    A --> C[2. Execução]
    A --> D[3. Check (validação)]
    A --> E[4. Actuar / agir]
    D --> F[3. Check (validação)]
    D --> G[Tirar conclusões sobre o observado]
    G --> F
    G --> E
  
```

3. Ciclo PDCA

1. Planejamento 2. Execução 3. Check (validação) 4. Actuar / agir

3. Check (Validação)

Tirar conclusões sobre o observado

Exemplo 2: Na implementação. Onda de picking Decathlon + guia de recolha e distribuição por Rota na Decathlon, começamos por colocar a tarefa de colagem de etiqueta após picking na ser efectuada pelo operador que conduzia o retrátil, o que obrigava a que este tivesse que aguardar a impressão da etiqueta, sair do equipamento colar a etiqueta (que o fazia sem conferir, porque tinha sido o próprio a baixar a paleta) e voltar a entrar no equipamento.

Com base nos KPIs definidos concluímos que a colocação desta tarefa no operador do retrátil era não negativa para a produtividade que quase negava a produtividade da onda de picking.

Para além do observado nos KPIs, era perceptível que isto criava um bottleneck (gargalo operacional) em que os operadores de PPE começava a ficar parados à espera da operação do retrátil, o que também criava desperdícios.

 Gorland

3. Ciclo PDCA

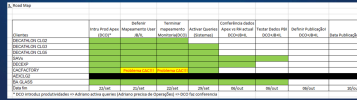
1. Planeamento 2. Execução 3. Check (validação) 4. Actuar / agir

4. Actuar/agir

Agir sobre as conclusões

Considerando que o Planeamento é a fase mais importante do ciclo PDCA, a segunda fase com mais impacto é sem dúvida de **Actuar / Agir** onde se tomam **acções** sobre as **conclusões** fase de Check (validação). Sem isso a melhor continua pára e as más medidas enraízam-se.

Exemplo 1: No caso do Projecto 20, transformaram-se os movimentos administrativos facturadas em movimentos de outros clientes, separando-o para que o seu contributo



Garland

3. Ciclo PDCA

1. Planeamento 2. Execução 3. Check (validação) 4. Actuar / agir

4. Actuar/agir

Agir sobre as conclusões

Exemplo 2: Na implementação Onda de picking Decathlon + guia de recolha e distribuição por Rota na Decathlon, passamos a tarefa de colar a etiqueta após picking para o PPE, acrescentamos a posição de onde a paleta tinha saído para o operador saber onde “procurar” paleta.

Esta alteração aumentou em muito a produtividade do retrátil, eliminou o bottle neck e os tempos de espera dos operadores de PPE e introduziu na operação uma conferência orgânica e natural, que se prende com o facto do Operador do PPE ter que fazer o match entre a etiqueta de picking e uma paleta baixada à minutos e colocada no corredor pelo colega.

Garfano

4. Implementação Kaizen – CLG2

A Implementação da cultura Kaizen segue os seguintes pontos:

1. Envolvimento de toda a estrutura
2. Planeamento dos seguintes pontos:
 - a) Rotinas Kaizen pretendidas
 - b) Ferramentas Kaizen a utilizar
 - c) Formação das equipas
 - d) Determinação dos Objectivos
3. Formação a toda a equipa com base no definido na fase de planeamento
4. Acompanhamento diário das equipas, das rotinas e ferramentas com o intuito de alcançar os Objectivos

Garland

4. Implementação Kaizen – CLG2

Envolvimento de toda a estrutura:

- **Direção de Operações** – Presente nas decisões estratégicas do projecto, execução da formação a todos os colaboradores, presente nas reuniões semanais.
- **Gestão de Operações** – Presente nas decisões estratégicas do projecto, presente diariamente com as equipas, garantindo ciclo PDCA, rotinas e utilização de ferramentas Kaizen
- **Supervisão Operacional** – Presente diariamente com as equipas, garantindo ciclo PDCA, rotinas e utilização de ferramentas Kaizen
- Todos os **Coordenadores e Operadores** formados e envolvidos na mentalidade de melhoria do seu dia a dia

Garfano

4. Implementação Kaizen – CLG2

Rotinas pretendidas a partir de 26 de Março

- Reunião kaizen diária retorno ao trabalho, de 5 a 10 minutos, com discussão do dia anterior, oportunidades do dia atual e follow up do Ciclo PDCA em curso
- Reunião semanal com toda a liderança do CLG2, de aproximadamente 30 minutos, à sexta-feira da tarde com discussão da semana que passou, oportunidade da semana seguinte e follow up dos Ciclos PDCA em curso

Ferramentas kaizen a utilizar:

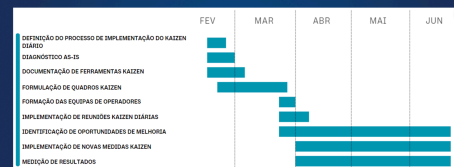
- Quadros Kaizen que contenham a informação necessário para análise da operação no âmbito de oportunidades de melhoria e seguimento do ciclo PDCA

Formação total das equipas dia 26 de Março do arranque do projeto

Objetivo de melhoria de produtividade média em todos os processos do CLG2 em 10% no final de 2024.

4. Implementação Kaizen – CLG2

Timings de Implementação do projeto


Garfano

5. Ferramentas Kaizen – CLG2 – Quadro Kaizen – Exemplo SAV

[illegible]

5. Ferramentas Kaizen – CLG2 – Quadro Kaizen – Exemplo SAV

SEMANA ACTUAL		12		
PAQ TONTE	NOK	18320		
PAQ TONTE 1/2	OK	100		
PAQ TONTE 1/4	OK	100		
PAQ FOR COMPLETOS	OK	100		
TOTAL DE REGION		OK	18520	
PAQ PETROL	OK	100		
PAQ PETROL 1/2	OK	100		
PAQ COMPLETOS	OK	100		
PAQ FOR COMPLETOS	OK	100		

SEMANA ANTERIOR		11		
PAQ TONTE	NOK	18320		
PAQ TONTE 1/2	OK	100		
PAQ TONTE 1/4	OK	100		
PAQ FOR COMPLETOS	OK	100		
TOTAL DE REGION		OK	18520	
PAQ PETROL	OK	100		
PAQ PETROL 1/2	OK	100		
PAQ COMPLETOS	OK	100		
PAQ FOR COMPLETOS	OK	100		

SEMANA ANTERIOR		10		
PAQ TONTE	NOK	18320		
PAQ TONTE 1/2	OK	100		
PAQ TONTE 1/4	OK	100		
PAQ FOR COMPLETOS	OK	100		
TOTAL DE REGION		OK	18520	
PAQ PETROL	OK	100		
PAQ PETROL 1/2	OK	100		
PAQ COMPLETOS	OK	100		
PAQ FOR COMPLETOS	OK	100		

SEMANA ANTERIOR		9		
PAQ TONTE	NOK	18320		
PAQ TONTE 1/2	OK	100		
PAQ TONTE 1/4	OK	100		
PAQ FOR COMPLETOS	OK	100		
TOTAL DE REGION		OK	18520	
PAQ PETROL	OK	100		
PAQ PETROL 1/2	OK	100		
PAQ COMPLETOS	OK	100		
PAQ FOR COMPLETOS	OK	100		

SEMANA ANTERIOR		8		
PAQ TONTE	NOK	18320		
PAQ TONTE 1/2	OK	100		
PAQ TONTE 1/4	OK	100		
PAQ FOR COMPLETOS	OK	100		
TOTAL DE REGION		OK	18520	
PAQ PETROL	OK	100		
PAQ PETROL 1/2	OK	100		
PAQ COMPLETOS	OK	100		
PAQ FOR COMPLETOS	OK	100		

SEMANA ANTERIOR		7		
PAQ TONTE	NOK	18320		
PAQ TONTE 1/2	OK	100		
PAQ TONTE 1/4	OK	100		
PAQ FOR COMPLETOS	OK	100		
TOTAL DE REGION		OK	18520	
PAQ PETROL	OK	100		
PAQ PETROL 1/2	OK			

