The importance of visual working instructions in standardization

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Declaração

Declaro que o presente documento é um trabalho original da minha autoria e que cumpre todos os requisitos do Código de Conduta e Boas Práticas da Universidade de Lisboa.

Declaration

I declare that this document is an original work of my own authorship and that it fulfills all the requirements of the Code of Conduct and Good Practices of the Universidade de Lisboa.

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The last five years have been a journey of so much more than words can express and they have flown by. It was 5 years of sharing joys and sorrows, achievements and failures, nights spent studying, and projects in which every minute counted.

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Abstract

Given the growing business competitiveness, quality and efficiency became key drivers to assure a company's success, within the current industrial context. With roots in the late 20^{th} century, Lean methodology has been used widely across industries and is focused on increasing efficiency, by eliminating waste and focusing on value-added activities. Standardization has also proved to be essential when improving organization and increasing productivity within companies.

ABC company has been facing inefficiencies on the shopfloor, associated with significant variability in the duration of its activities and on the products' quality, and presents a low standardization level. Therefore, the company has requested the intervention of Lean professionals to develop a viable solution.

The solutions developed rely on a bibliographic review and a study of the markets' tendencies, allowing for framing with existent approaches. Afterward, a diagnosis of the initial situation is made, based on the employees' perceptions and the methodology defined. Lastly, the root causes are identified, to assure that the solutions are adequate.

This is followed by the presentation of concrete and well-founded solutions – the development of working instructions and an improvement to the maintenance management, based on the Lean methodology, which aimed to increase the standardization level of ABC. Additionally, the impact of other possible solutions, with a greater degree of digitalization, is studied.

The implementation of the solutions will bring benefits in terms of improving process efficiency, cost reduction and compliance with sustainable metrics.

Key-words: Lean, SOP, Working Instruction, Standardization, Continuous Improvement

Resumo

No atual contexto industrial, com a crescente competitividade empresarial, a qualidade e eficiência revelam-se essenciais para o sucesso das empresas. Com raízes no final do século 20, a metodologia Lean visa o aumento de eficiência, através da eliminação de desperdícios e do foco em atividades de valor acrescentado e tem-se vindo a tornar cada vez mais popular. A estandardização, um dos componentes do Lean, também mostra ser fundamental na organização e produtividade das operações.

Enfrentando ineficiências no chão de fábrica, associadas a variabilidades significativas na duração das suas atividades e qualidade dos seus produtos, e um baixo nível de estandardização, a empresa ABC recorreu a profissionais Lean para o desenvolvimento de uma solução viável, que permita colmatar os problemas.

O presente trabalho tem as soluções assentes numa revisão bibliográfica e num estudo às tendências do mercado, permitindo o enquadramento de abordagens existentes. Posteriormente, é feito um diagnóstico à situação inicial na empresa, baseado nas perceções dos trabalhadores e na metodologia definida. O diagnóstico termina com a identificação das causas-raiz, que permite conhecer as causas dos problemas e atuar sobre elas.

Segue-se a apresentação de soluções concretas e fundamentadas, que visam o aumento do nível de estandardização na empresa – o desenvolvimento de instruções de trabalho e a melhoria da gestão da manutenção, baseadas na metodologia Lean. Adicionalmente, é estudado o impacto de outras possíveis soluções, com maior grau de digitalização.

A implementação das soluções trará benefícios em termos de melhoria da eficiência dos processos, redução de custos e cumprimento das métricas sustentáveis.

Palavras-chave: Lean, SOP, Instrução de trabalho, Estandardização, Melhoria Continua

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TPS	Toyota Production System
JIT	Just in Time
TWI	Training Within Industry
WI	Working Instruction
SWI	Standard Working Instruction
SOP	Standard Operating Procedure
QS	Quality Standard
KPI	Key Performance Indicator
VSM	Value Stream Mapping

1. Introduction

Nowadays, customers are more demanding, requiring shorter lead times, customized products, and greater variety. Globalization has enhanced the competition, as now it is possible to choose suppliers from any part of the globe and receive the goods in reasonable lead times. To fulfill those needs, supply chains must adapt and be at the forefront of the latest trends and technologies, [1]. Lean methodologies and standardization are key concepts when aiming to increase productivity, improve flows and minimize waste, allowing companies to easily adapt to new situations, [2].

The scope of this dissertation relies on a real case study: a project for a company, designated as ABC. The company can either sell or rent its products and, in the latter case, the recovery of the components represents an essential activity. In its area, factors such as the response time, the flow of operations, and the recovery of materials are key drivers.

Lately, the company has been facing obstacles in its operations flow, including low efficiency rates and lack of consistency in its core processes, which have been limiting its production capacity. These obstacles regard the recovery phases of the process – after being rented to a customer, the product is returned to the company, where it is recovered to be able to be used again.

The aim was to increase the efficiency and performance, based on Lean methodology, as well as the quantity of material recovered, to then be incorporated into new products, allowing an improvement in terms of costs and sustainability, and minimizing the need of purchasing new materials. Furthermore, the company intends to uniform its processes and have a greater perception of the work done on Gemba.

However, ABC did not present defined or documented procedures on how to recover the components, nor mechanisms to allow the consistent implementation of these practices. Consequently, a great variability is felt in the duration and process itself. Different procedures often correspond to different quality levels, leading to an inconsistent final quality of the product.

Regarding the recovery of one specific component – the panels, which present a very significant impact on the costs, the company cannot monitor the activities and, consequently, the impact of the recovery in terms of economics and sustainability is not considered.

These problems required an extensive analysis to enable a deeper knowledge and assure the solutions are proposed based on the needs and requirements. For that, the company has requested the intervention of an external entity – a consultancy company, to support the employees of the company during the analysis of the problems felt. The author of this master's thesis has accompanied the consultancy company for three months, during an internship, to assess the problem, validate and gather information on the processes and flows, and develop solutions that would fit the needs and requirements of the company. The increase of the standardization level constitutes the main focus of this dissertation.

A bibliographic review is carried out in Chapter 2, intending to identify the current tendencies in industries and the impact of standardization on companies. Lean methodology has been widely used across different types of industries, to improve flows and the efficiency of companies. Lean creates value with fewer resources, minimizes waste and relies on a continuous improvement policy, [3], so it is considered a potential solution. The research also covered Standard Work, which intends to standardize and unify processes, through the implementation of working instructions.

Chapter 3 starts by providing an overview on the challenge faced by the company, followed by an introduction to the company and its' operations. The workers from ABC were interviewed, to understand the needs and difficulties across the shopfloor and their perceptions on the problems. Based on that, a methodology was developed, which allowed to validate the perceptions and identify other possible issues. It included visits to the company, meetings, observations and even consultancy to documentation. Considering all the findings and after analyzing the situation in the company, a diagnosis was built and allowed to confirm the low standardization level within ABC, as there is lack of defined and documented procedures and standards for the recovery process. It was also concluded that, besides not having defined procedures, the company could not monitor the recovery of the panels, some of the most impactful components in terms of costs. Finally, the root causes were identified, to assure that the solutions act on the cause of the problems.

Minding the problems gathered, in the chapter 4, different well-structured solutions are presented. The solutions aim to mitigate the issues faced and improve the company performance and focus on three axes: standardization, maintenance, and organization. To increase the standardization level of the company, Working Instructions were developed for the components, where the activities to be performed and the quality levels to achieve are detailed. Besides, to enable ABC to account for the recovery of the panels, the maintenance sheet was updated, to include the number and type of panels as well. Although the solutions were paper based, as the company preferred, the possibility of digitalization was assessed and evaluated, given the growing tendency for digital tools.

The impacts were estimated and the solutions are expected to impact positively the company and improve its performance. Both solutions have numerous advantages and impact different areas. The development of SOPs should decrease the variability, improve the final quality of the components, and increase the efficiency of the recovering phasis. Regarding the maintenance sheet, it allowed the company to have greater control over the activities happening on Gemba and to account for the very significant impact of recovering the panels, in economic and sustainability terms.

Ultimately, in chapter 5 the main findings of each chapter are highlighted. For each problem, the diagnosis, solution, and impact are summarized.

2. Bibliographic Review

Along this chapter, a brief history of Lean, as well as its principles and philosophy will be explored. Those concepts, applied to a real case study, were pillars during the development of the project.

This chapter also covers a study on standard work, the documents and instructions that assist its implementation and an analysis to the importance of digitalization. Standard work is linked to Lean practices, as it is a part of Lean Manufacturing.

2.1. Lean

2.1.1. Contextualization

In the last few years, the world has been under dramatic changes. Although those changes embrace very distinct areas, consumer behavior has been one changing significantly. Facing more demanding customers, who require shorter lead times, more varied and customized products, the companies must adapt to overcome those needs and to be able to provide an adequate response. As a response for the new demand, and aiming to improve their processes, more and more companies are implementing Lean and Just in Time principles and working according to Lean philosophy, [4]. Continuous improvement is an essential pillar for Lean implementation, [5].

The concept of Lean has its roots in America, back in 20th century, when Henry Ford built a continuous assembly line, to increase the production volume and decrease the assembly time of the "Model T". Ford's strategy was a major step towards the development of Lean principles and methodology. He has based his method on F.W. Taylor, who, in 1890, intended to achieve Economic Efficiency Improvement by shortening the processes and eliminating waste, [6-7].

> Around three decades later, the Toyota Production System (TPS) introduced a similar system, to maximize the economic efficiency, by minimizing the resources. TPS's main objective regarded eliminating any kind of waste through continuous improvement and was initially called Just-in-Time Production. While Ford had engineers to define the processes, TPS allocated this responsibility to the operators working on Gemba, who had direct contact with the operations, [6]. Gemba is a Japanese word for "real place", and in the Lean context, it refers to the place where the value is created, [8]. In case of industries, it regards the shopfloor.

Nowadays, Lean is used widely around the world and has applications in different areas within companies, from production to distribution. Companies intend to eliminate all kinds of waste, as those are sources of losses in terms of time and cost, while increasing production efficiency, through continuous improvement and pursuing perfection, [6, 9]. Linking Lean to continuous improvement techniques and even to Industry 4.0 technologies, the potential for developing new solutions and enhancing productivity in companies increases exponentially, [10]. Despite the enormous potential to explore the benefits and impact of Industry 4.0, this master's thesis is focused on Lean and continuous improvement principles.

2.1.2. Lean Principles

After the successful introduction of the Lean concept, the Lean principles were defined as a structured and standard way to improve the company's well-functioning. Throughout the implementation of these five principles, companies are able to identify value-added and non-value-added activities and focus on the operations which create value for the product and the customer. This way, Lean principles, together with other tools, help companies identifying wastes and, consequently, lead to an increase in efficiency, [2, 4].

- **Specify Value**

This should be the first step to implement Lean philosophy. According to Womack and Jones, [2], "value can be defined only by the ultimate customer". Being the ones that need and will pay for the final product, the customers should define the requirements they value and the price they're willing to pay. Therefore, the value of a product is defined through the customers' eyes.

- **Value Stream Map**

  The value stream of a product includes all the activities which add value to it and, therefore, cannot be discarded, and allows the company to understand the product life cycle. Moreover, it is an essential step to identify wastes and non-value-added activities.

- **Flow**

  The third step for implementing Lean intends to create a smooth flow of the activities that were identified and considered to add value to the product. The goal is to create an end-to-end continuous process, that allows to transform the raw materials into the final product efficiently.

- **Pull Production**

  The production of goods is based on the demand – this means that the goods are only produced when the orders are placed by the customers. Pull production demands a very flexible supply chain and efficient management. Regardless, it allows to decrease the work-in-progress and final product inventory, and better distributes the work along the supply chain, avoiding bottlenecks. In this system, the information flows from the final customer until the first activity of the chain, while the materials flow in the opposite direction, as presented in figure 1.

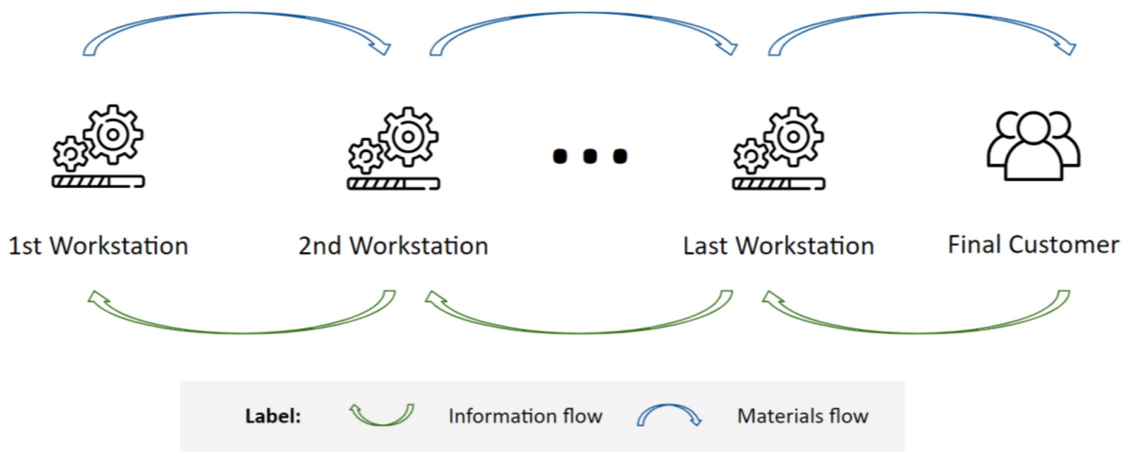

Figure 1: Information and Materials flows in pull systems

- **Pursue Perfection**

After implementing the first four steps, it is critical to keep improving the processes, by reducing waste, time and costs. Womack and Jones, [2], state that continuous improvement and the strive for perfection are essential when eliminating non-value-added activities, leading to an increasingly fluid and efficient production.

2.1.3. Wastes

One major goal for TPS regarded minimizing waste and optimizing the process flow. During his professional path, Tauchii Ohno, an executive member from Toyota, has identified three types of bottlenecks that negatively affect the performance of a company, [11-12]:

- Muri – Overload

It regards both human and machinery resources. Overloading people or machinery beyond their capacity may affect their performance, deteriorating the production quality.

- Mura – Inconsistency, variability

It is related to irregularities in the operations and very unstable work rhythms, leading to peaks of work, followed by waiting times. This variability is caused by poor management and planning and not by variations in the demand. Therefore, it can be mitigated by planning and standardizing the production levels.

- Muda – Waste

Muda regards wastes, which are defined as non-value-added activities or processes, that consume resources, and, therefore should be discarded in order to maximize efficiency. Note that there are two types of Muda – type 1 refers to activities that, for any reason, cannot be eliminated and, type 2 refers to activities that can and should be eliminated.

Given the importance of focusing on the activities that bring value to the customers and improve the processes within a company, Ohno, has observed and analyzed the processes which led to the distinction of seven types of wastes (Muda), that are described below. The previously presented Lean principles are an important tool to help identify waste, [4, 13-14].

- **Transportation:** concerns unnecessary transport of raw materials or materials under production.
- **Over-Processing:** steps or processes that are repeated or do not add value to the product.
- **Over-Production:** producing in excess or too early, leading to an increased inventory of goods, resulting in greater costs for the company.
- **Inventory:** stock of material (raw, under production or finished products), entails costs for the companies and takes up space.
- **Defects:** may be a waste hard to correct, as it can have different causes. Nonetheless, it requires a double effort in terms of time and consumption of resources.
- **Waiting:** represents the waiting time either by products to start the next phase, by people to start the next task or even by processes that must have authorization from the departments.
- **Motion:** unnecessary movements by people or machinery.

Recently, some authors, namely James P. Womack and Daniel T. Jones [2], and Jerry Kilpatrick [13], have recognized the underutilization of people as another waste to be considered.

2.1.4. Lean Tools

Depending on the specific goal of the implementation - decrease set-up times, redesign work cells, decrease costs, eliminate non-value-added activities, etc, the process of implementing Lean and continuous improvement may follow different methods, tools and involve different parts, [9].

Although there are over 10 techniques, this dissertation is focused on two of them, which were the basis for the work developed.

- **5S**

This is a systematic methodology, with Japanese roots. Being one of the simplest methods to implement, it's usually one of the main choices when aiming to organize and standardize the workspace and eliminate non-value-added activities. Applying 5S leads to tidier, simplified and more productive workspaces, [9].

Each S stands for the initial letter of a Japanese word, which are presented below and, respectively, translated to English, [4,9,15]:

1. <u>Seiri – Sort:</u> Aims to analyze and separate the materials within the workspace, to identify the necessary ones. The remaining ones should be eliminated to free space and don't confuse the workers.
2. <u>Seiton – Straighten:</u> After eliminating the materials not needed, it is important to organize and identify the ones needed, so they are easily displayed and ready to be used.
3. <u>Seiso – Shine:</u> Stands for cleaning and inspecting the workplace regularly, avoiding anomalies.
4. <u>Seiketsu – Standardize:</u> Concerns the standardization of the three first presented steps.
5. <u>Shitsuke – Sustain:</u> Highlights the importance of applying consistently the 5S methodology and of preserving what was previously established.

6. Over the years, 5S has proved to be successful, easy to adapt to different environments and to impact positively companies. It helps decreasing waste, eliminating waste and is a fundamental tool for the company's management to increase productivity, [15]. Also, 5S is related to other Lean tools and is a strong basis to implement several of them. Keeping the workspace clean and organized is

essential to improve different aspects of a company, including communication, efficiency, and data management.

Recently, a sixth S was added – Safety – and led to a significant decrease on the rate of injuries, by improving health and safety measures within a company. It is referred to as Lean "6S" or "5S + Safety", [16, 17].

- **Value Stream Mapping (VSM)**

According to Rother and Shook, on "*Learning to See: value stream mapping to add value and eliminate muda*", [18], the value stream of a given product includes all the related activities – both value and non-value-added. It represents the path followed by the goods, from raw materials to being transformed into the final product and delivered to the customer.

For the initial step – identifying the current value stream, a macro point of view should be adopted – the goal regards improving the whole process, instead of focusing in optimizing parts. Providing an overall view of the activities, it becomes easier to identify wastes and non-value-added activities and their respective sources, which should be quantified and eliminated. In contrast, the activities that bring value to the customer should be improved. The information flow should also be mapped and connected to the materials' flow, aiming to enhance the overall understanding of the process, [18].

The second step concerns identifying the product family to focus. A product family concerns a "group of products that pass through similar processing steps" in the downstream chain. Besides selecting a family, other several aspects should be defined, namely the number of finished parts, and the quantity and frequency demanded by the customer, [18].

Afterward, it is of great importance to define a person who is responsible for the end-to-end process and knows the entire flow. As the companies are usually divided into departments, it is frequent that each department is focused on its own tasks, leading to gaps of information or repeated tasks (wastes) due to the lack of communication. Therefore, companies should allocate one person – the Value Stream Manager – who is responsible for having complete knowledge of the material and information flow, aiming to optimize the process from a general perspective, [18].

Finally, the last step regards the use of the mapping tool, which works as presented in figure 2. After defining the product family, the current value stream must be identified. It is essential to understand the current state, by gathering the information available about the shopfloor and the details of the productive process. Then, the current Value Stream Map should be drawn, and will expose the wastes and inefficiencies along the chain. At this point, the company is able to design the future state it would like to achieve. The new Value Stream Map aims to achieve an optimized chain, by focusing on the value-added activities, improving the value stream, and eliminating the inefficiencies. This should be a continuous and repetitive process, allowing continuous improvement, [4, 18].

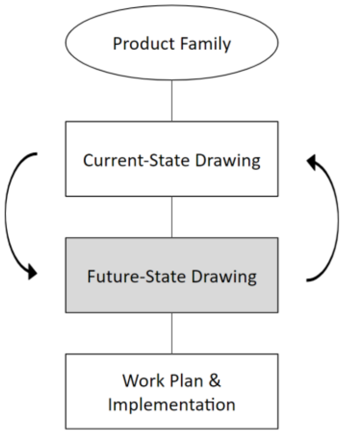

Figure 2: Value Stream Mapping methodology, [18]

2.2. Standard Work

Standardization refers to established procedures that describe the best method to follow to complete a repetitive activity, aiming to improve the respective activity and/ or the associated flow. Therefore, standard work regards the consistent implementation of the defined procedures and contributes to achieving higher levels of efficiency and, safest and fastest results, while minimizing waste, [19-20]. According to Ohno, standardization is the first step to implementing continuous improvement, [14, 19].

Assessing the advantages, standardizing the procedures has been revealed to be crucial when eliminating human errors, as it acts directly over the root causes, [21], and when decreasing the variability from manufacturing and service procedures within companies, as it helps coordinating all the operations, [21]. Moreover, it contributes to improving the performance, also associated with a reduction in production time, makes waste more visible on Gemba, and helps to even the production with the customer demand (through the pull system), [19]. According to Hesser W. and Inklaar A. [20], there are three main elements for standard work, linked together, represented in figure 3:

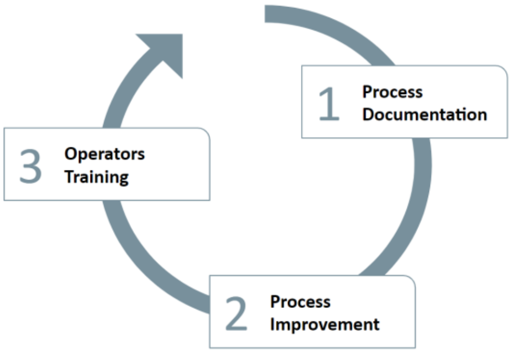

Figure 3: Main elements for Standard Work

The emergence of Standard Work is associated with a training program – Training Within Industry (TWI), developed by the USA during World War II, which intended to improve the supervisor-worker relationship and systematically train the operators of an industry.

The implementation of TWI in companies is based on the use of Working Instructions (WI), which serve as tools that help to achieve the objective, [22]. It intends to promote engagement with the tasks, and can be applied to different organizational levels, from top management to frontline leaders and, finally, to operators, [21]. Training consists in providing the employees with the required tools and knowledge to develop specific skills and perform certain tasks. TWI defends that the success of the operations is directly related to the performance of the employee and, therefore, the management team must invest time in preparing and educating their operators. In order to be accurate, the training must be based on the problems identified by the operators on Gemba, to develop a specific skill and improve the results, [21-22].

2.2.1. Working Instructions

One of the tools used in the realm of Standard Work is the Working Instructions (WI), which are essential to assure standardization.

WIs are documents where the processes and activities are detailed and explained to the operator, and, as the name states, function as an instruction manual for guiding the work. Therefore, companies guide their operations through the defined procedures on WI to minimize variability and standardize the work in Gemba, [23 – 25]. WIs are essential to increase efficiency, productivity and quality, [3].

These documents may include different levels of details and information on the operations, as described in figure 4, [26]. While the simplest documents only present a list with the description of each task to complete, the more complex ones can interact with the operator and present extra information on the task – duration, the person responsible, materials, storage place, etc. According to different sources and authors, it was possible to understand the different types of WI used, its characteristics and details levels. Gathering this information, the author of this master's thesis was able to build the following pyramid, represented in figure 4, where the WIs are separated depending on the information they contain and its complexity.

1. **Text-based description:** List with the description of the steps needed to complete a task, without any complementary information or images.
2. **Text and image-based task description:** List with the description of the steps needed to complete a task, with auxiliary images, without any complementary information about the activities.
3. **Text-based task information:** Description of the steps needed to complete a task (list), accompanied with more information - responsible, storage place, materials, duration, etc, but without auxiliary images.
4. **Text and image-based task information:** Description of the steps needed to complete a task (list), accompanied with more information and images, charts, standards, etc.
5. **Interactive Information:** Description of the steps needed to complete a task, accompanied with interactive information, according to the progress and performance - checklists, alarms, videos, reminders, etc.

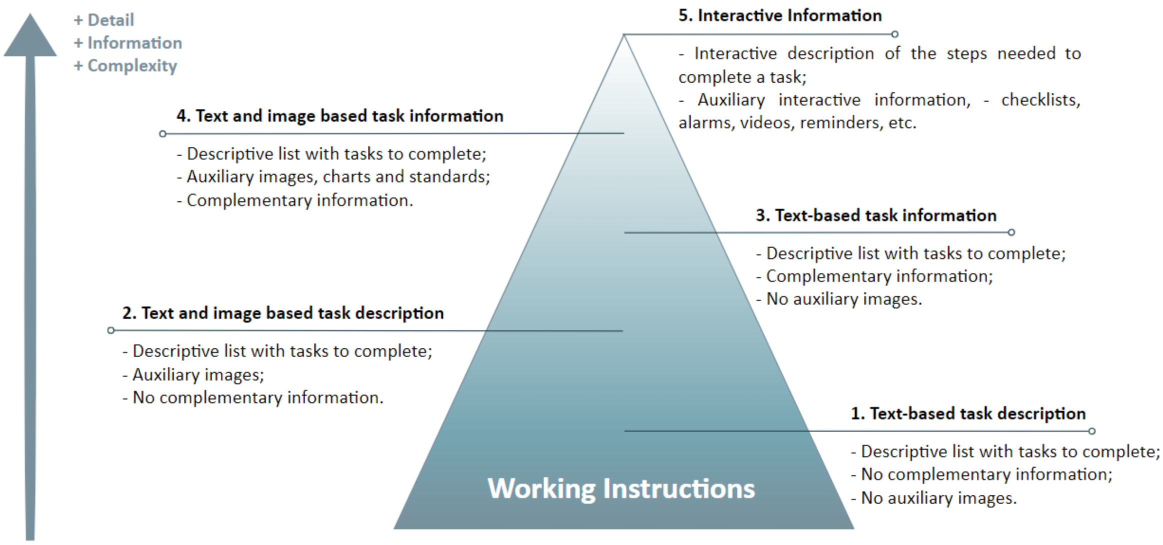

Figure 4: Levels of information and detail on Working Instructions

Each level of the pyramid regards a particular case of Working Instructions, with specific characteristics.

It is important to highlight that WIs can be either paper-based or digital.

Several advantages have been associated with the use of WI in companies, as stated by diverse authors, [23, 27]:

- Reduces the time required for training;
- Decreases the number of errors and job accidents;
- Increases productivity and quality;
- Increases the engagement of the operator with the task, increasing his level of satisfaction;
- Contributes to standardizing the procedures and the quality to achieve.

These advantages of WI are aligned with the objective of the implementation of standard work and contribute to achieve the goals proposed. It matters to highlight that Standard Work and WI are not equivalent terms as they do not refer to the same thing, but that WIs work as a tool/ method to implement standard work, [20].

During this bibliographic review, it was possible to understand that there is no consensus on the nomenclatures of the documents related to standard work, among the scientific community. Different terminologies are used to refer to the same or similar documents.

Regarding the third and fourth levels, while some authors name the documents as Standard Working Instruction (SWI), others name it as Standard Operating Procedure (SOP). Nonetheless, both are tools to implement standard work, serve the same purpose and contain similar information, despite the different names, [23, 28]. Both refer to a specific case of WIs.

Along this master's thesis, the focus will be the fourth level of the pyramid, although the impact of digitalization, represented on the fifth level, will also be considered. The nomenclature adopted will be Standard Operating Procedure.

SOP regards a particular case of WI and refers to a set of guidelines and rules to help employees complete a repetitive task. Besides guiding operations, SOPs have an essential role to define quality standards and health policies within a company. The development of SOPs assures that the instructions are suited for the employees and their jobs and, will help improve the work, by correcting errors and clarifying their responsibilities, [23]. SOPs are an essential part of the main goal – production standardization and process uniformization and are widely used across industries.

2.2.1.1. Standard Operating Procedure

Aiming to improve their processes and stabilize the work, the number of companies implementing SOPs, which have already proved to present very positive results, has been increasing, [29].

SOP regards a written document with detailed and specific instructions to help workers perform repetitive tasks, more autonomously and comply with the quality standards of the company. In the document, it should also be identified who – the person responsible, when – conditions that should be gathered, what – the objective of the job and how - the description of the tasks to be done, [23]. The final aim regards the standardization of a given procedure, [30]. An example of a SOP is provided in figure 5.

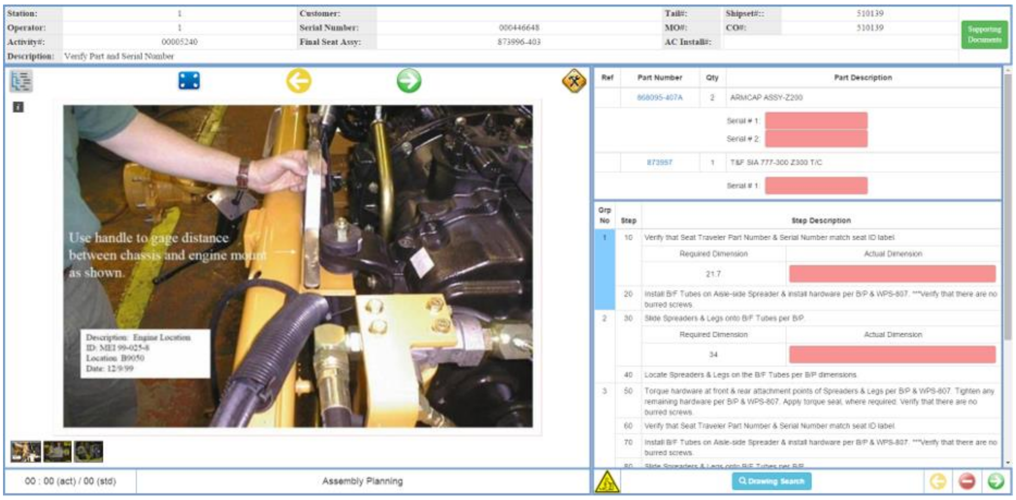

Figure 5: Example of Standard Operating Procedure, [31]

SOPs can either be text-based descriptive or image-based and, describe the procedures or serve the purpose of a quality standard, [25].

The description of the tasks must be clear and easy to understand by any operator. Besides the tasks, SOPs should also include the materials and resources to be used and can include quality standards to achieve, [23, 25]. For developing the list of tasks and resources, it is necessary to observe the procedures multiple times to reduce variability in the process and duration, and the operators on Gemba, responsible for the respective task, must be included and heard. Due to their practical knowledge, the operators can provide highly detailed descriptions of the job and valuable insights and must be the ones to validate the final document – if the descriptions and images are clear and correct. When completed, SOPs should be displayed in Gemba, on the spot where the work happens, and are expected to be visual and easily accessible and perceptible, as exemplified in figure 6, [23].

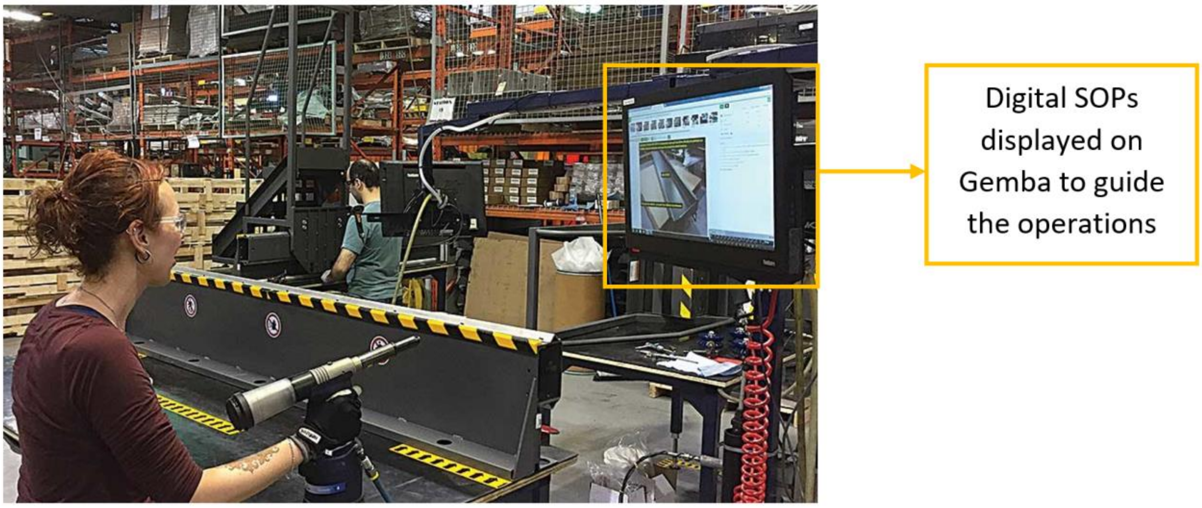

Figure 6: Example of SOP displayed on Gemba, [32]

Ideally, SOPs should be accompanied by images, whenever possible, to ease the understanding and to clarify the activities described, [25].

The information present in the SOPs available at the workplace for consultation should be:

1. Correct and updated, controlled by the company to assure the compliance with quality and safety standards;
2. In compliance with the legal regulations of the country.

Whenever any information - procedures, images, or materials – of SOPs is considered obsolete, it should be removed, to avoid misleading the operators and generating duplicate work. After the information is reviewed and modified, SOPs must be reevaluated and reapproved by the responsible team and the operators, before being implemented and disposed again on Gemba.

Several advantages are associated with the use of SOPs within companies. They contribute to reducing the work effort, in the long-run, and produce quality and reliable results, as the products were submitted to consistent processes. Moreover, it improves the workplace as the employees become more productive and the tasks more efficient. Table 1 presents the opinion of some authors on the advantages of using SOPs as tools to assure the implementation of standard work, [23, 29].

Table 1: Advantages of using SOPs

Benefit	Explanation
Consistency in the processes	Assures that each task is always done equally, decreasing the variability of the duration and final quality.
Minimization of errors	Guiding their actions through a written document decreases the probability of the operators making errors, as each step is detailed.
Reduction in employees' training time	As each step is described and constantly reminded to the operator, there is no need to memorize the steps nor to have the experience to know how to deal with the operations and different situations.
Improvement in quality levels	Quality is a competitive advantage and the trademark of a company. As customers aim for consistency, SOPs help ensuring that the quality level is achieved and maintained.
Improvement on operators' safety	Training the operators reduces the probability of health injuries and accidents. SOPs guarantee that the procedures are safe and comply with the regulations, avoiding fines and indemnities.
Compliance with Environmental Policies	Assures the procedures are according to the government laws, avoiding fines. Also, helps decreasing the environmental impact and the carbon footprint, improving the environmental performance.
Efficiency rising	SOPs eliminate hesitations and doubts the employees may have along the process. It defines exactly what must be done in each step, making the process faster and more efficient.
Easier to transfer work	As the tasks and standards are defined and documented, instead of depending on the operator's experience and sensibility, the transfer of work is simplified - the new operator must be trained and follow the SOP.
Serves as a checklist	Both for operators when the task is finished and for auditors when auditioning the performance of the job. Therefore, the document should be detailed and explicit.

In addition to SOPs, WIs can also fit another purpose – standardize the quality to achieve in a specific procedure. These are quality standards WIs and regard a different type from the previous described. Here, the content of the document intends to describe specifically the details, features and characteristics each component should have to comply with the company standards. To facilitate the understanding, the description can be accompanied by images, highlighting the points where the operators should focus, [25]. An example of not acceptable quality for the articles can also be included, to clarify dubious situations. This type of WIs is frequently used with SOPs to explain the quality to achieve after the procedure.

In figure 7, two types of quality standards are presented. While the first example is simpler, only including a line with a description and pictures to expose the conditions that the components should meet, the second one illustrates a more complex and detailed quality standard. Both examples show the coverage of quality standards and can be used in company formation actions, for example. They show the flexibility of WIs and how WIs can range from simple to more complex tasks and include different levels of detail.

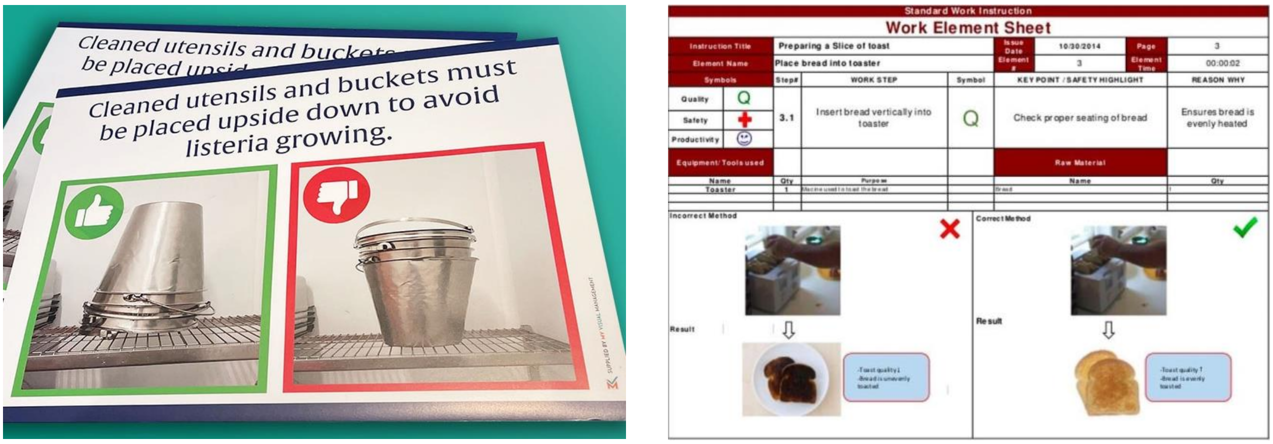

Figure 7: Example of Quality Standard, [33-34]

2.2.2. Digitalization

Besides the traditional paper-based working instructions, which are the most common in the current quality management systems, companies working in fast-changing environments require employees who can adapt and learn in a rhythm that follows, [27]. Digitalization allows for building interactive and animated working instructions, that enable quicker changes in the processes and provide tools that contribute to faster learning. Furthermore, digital WIs improve the performance of the operators in terms of duration, quality and number of defects, even when presented with new tasks. Currently, digital WI can be based on electronic devices (computers, tablets, phones, etc) or even Augmented Reality devices (eyeglasses, screens, etc), [35].

Aiming to compare which type of WI is more beneficial for the operators – digital or paper-based, and understand the advantages of digital WI, different studies have been carried out. Out of those, an experience performed by Peter Letmathe and Marc Rößler was selected, [27]. Digital WI proved to reduce the number of human errors, decrease the production time, and improve the process of learning a new skill. When comparing to paper-based instructions the results showed that the group only with digital instructions made fewer mistakes than the one only with traditional instructions. The group with combined paper and digital WIs presented better results than the paper-based group but similar results to the digital one. The group with both instructions did not present better results than the digital one in none of the performance criteria, but was harmed regarding the production time, as dealing with two sets of instructions led to consuming extra time. It also matters to note that, in both cases, the WIs had a greater influence on the first times the tasks were performed, when the operators were learning, rather than after repeating several times, as they had already memorized the steps.

Thereby, digital WI presented greater advantages over the other possible options and, ideally, should be the ones adopted by companies. Digital WIs decrease the time required for the operators to learn, allow quicker updates on the instructions, and a more interactive process, decreasing the errors [27, 35]. As it is based on digital systems, it can also help measuring metrics and monitoring the processes in terms of performance, efficiency, quantity, duration, etc, integrate with other digital tools, and display the real-time results on dashboards, for the operators and the management team to consult and accompany the evolution. This type of WI can also be useful when companies hire foreign employees, as the idiom can be adapted and the animations help to surpass the language barrier, and even to help employees with other limitations, [27, 35]. Nonetheless, digital WI also requires higher investment from the companies, namely in equipment and software, and may require training as well, especially for older employees, who are less used to dealing with digital systems. Besides, another possible justification for the low adherence to digital methods regards the inertia and aversion to adopting new procedures by the management teams, [27].

The advantages, disadvantages and respective justifications of digital working instructions are represented in table 2.

Table 2: Advantages and drawbacks of digital Working Instructions

	Impact	**Justification**
Advantages	Decreases errors and duration	Interactive process helps to learn faster; digital verification of components; highlight the main steps, reminders, etc. [35]
	Improve quality	Interactive content and clear step-by-step instructions assure that the quality standards are achieved. [27]
	Interconnection with other systems	Allows to monitor the processes and integrate with other systems in the company. [35]
	Increases safety	Operators visualize the safest way to proceed, there are warnings and reminders on safety practices. [36]
	Adaptability	Each operator only receives the information needed; easy adaptation on language and special needs. [36]
Drawbacks	Greater investment	Requires investment in digital equipment (computers, tablets, etc) and in software.
	May require training	Employees may not be used to work with digital software and solutions and require training on how to use and update the WI.

The expected course of evolution is that companies will tend to gradually abandon paper-based WI and embrace the digital ones, given the advantages they present. This process may not be immediate but, having in mind the digital transformation happening across all industries, this is expected to be one of the initial steps for many companies, [27].

3. Problem Description and Diagnosis

The development of this dissertation was based on a real case study, to the ABC company.

Aiming to improve their flows and performance and develop potential solutions, ABC company has requested support from a consulting company – Erising – specialized in Lean Manufacturing, Six Sigma and Continuous Improvement, which provides added value through efficiency rising mechanisms.

The study object was suggested by ABC, according to the needs felt, and was focused on the recovery of materials, as it was considered a critical phasis, due to the great impact on costs and metrics to achieve.

The intervention of the consulting company was divided into three main phases: diagnosis, solution development, and implementation. This Master's thesis is focused on the diagnosis and on structuring and proposing solutions, which were the phasis where the author was involved and participated actively, as part of the consultant team. The responsibility for the implementation phase regarded Erising and ABC directly, not being part of the scope of this master's thesis, nor under the author's responsibility. As the development of this project coincided with the beginning of the high season for the company, not all solutions were implemented, as the company had to focus all its efforts on production and fulfilling the orders. Nonetheless, the impacts of the solutions implemented were considered and evaluated and the impact of the ones not implemented in useful time was estimated.

Along this chapter, a contextualization of the challenge is made, and the ABC company and their respective operations are presented, followed by the diagnosis. On the diagnosis, the perceptions and insights from the workers are considered, the methodology used to build the diagnosis is explained, and an analysis of the current situation is performed, allowing to gather a set of challenges and inefficiencies. Finally, the root causes are identified, to assure that the proposed solutions act on the causes of the inefficiencies.

The impact of alternative solutions, broader than the ones defined by the two companies, was also estimated, for comparison and validation purposes. Given the growing tendency of digital and informatics tools, besides the traditional paper-based documents, other possible solutions, digitally based, were studied, according to recent developments and trends, verified in the bibliographic review, in the previous chapter. This search and comparison with other possible solutions was not part of the scope of the consultancy project and was carried out by the author of this master's thesis, independently. It intended to perceive the differences between both options, assessing the advantages of each and understanding which one would be most beneficial. Although the company has expressed its preferences for paper-based solutions, the other ones were evaluated to assess the impact of digitalization.

3.1. Challenge

ABC Company is a well-established company on the national market and has been operating for several years. Recently, the company has identified obstacles and improvement points to their daily operations, which were felt to prejudice the performance and limit the results. The challenges faced can be described in two axes:

1. The challenges faced by ABC, which regard the issues and obstacles to their production efficiency;
2. The challenge proposed to the consultancy team, which regards developing a solution that fulfills ABC' needs.

Recently, the company has been facing obstacles to its flow of operations. Some difficulties have been felt at different levels of the organization – from the management to the operational team. One major problem felt within the company regards the great variability of their activities – ABC lacks standard and documented procedures and, consequently, the activities are performed according to different principles, leading to a variation in the processes and duration. Another issue concerns the poor organization across Gemba, which is a cause of errors, doubled work, confusion and even wastes in terms of time, when looking for a specific article, and space, as the use of space could be optimized.

During the involvement in the project, the author was also challenged to propose adequate solutions for the difficulties faced by ABC. The author was responsible for analyzing the problem and identifying the root causes, gathering the different problems and inefficiencies faced by the company, developing the diagnosis, and leading the data collection and processing phases. These activities included understanding and validating the processes, collection of tasks' durations and consultation of documents. Concerning the solution development, the responsibilities regarded finding the most suitable solution for the company's needs and developing different types of documents, for different purposes, which were validated and approved by the team, before being implemented. This was a three months-long process of almost daily presence in the company.

3.2. The Company

ABC company has been operating for over six decades and is a market leader in its area. It is focused on selling and/ or renting products, and it is responsible for all the industrial activities related: after being ordered by a customer, the company proceeds to the assembly of the different parts and, once the product is ready it is delivered to the customer. In the case of renting contracts, at the end of the defined period, the product is returned to ABC' installations, where it is recovered. The product can fit different purposes, from construction support to temporary schools or hospitals, and, according to that, it can present different levels of finishes and be customized in terms of size, materials, and furniture.

The product is formed by panels, that can be of different types according to the fit (with or without windows, bigger or smaller, higher or lower range, etc), assembling components, which allow to keep the structure of the product, and other components and materials in the inside, that vary according to the purpose of the product. The assembling components, the panels and the ones inside can be recovered within the installations and were the focus of the work developed.

The company has over 60 employees in Portugal and has been increasing this number in the last few years.

In the installations of the company, there are areas with different functionalities, for each part of the process. The layout is presented in figure 8.

As for the indoor locations, it has an <u>indoor warehouse</u>, where both already recovered and new materials arriving from suppliers are kept and, within the same space, and wait to be used in an order. There is the <u>recovering area</u>, which is where most of the recovery activities take place and is the main workstation for the workers assigned to those tasks. As it is an indoor area, it is also used to store some materials that, ideally, would be stored on the outdoor assembling components' storage area, but, for different reasons – e.g. being electronic - cannot be left on the outside. Furthermore, there is a <u>painting area</u>, designated for painting the components and materials and an <u>indoor assembling area,</u> where the products are prepared according to the requirements of the customers. The company operates under a pull system, as the products are highly individualized and customized, and, consequently, the assembly only takes place after receiving the orders from the customers.

Regarding outdoor spaces, the <u>storage park</u> stores the structure of the product, after being returned from the customers, without any components on the inside, and the <u>storage area</u> stores the components already disassembled, while waiting to be recovered. The <u>outdoor assembling area</u>

serves the same purpose as the indoor and is used as an alternative when the indoor area is full and does not have the capacity to fulfill more orders.

The recovery activities are centralized in two out of the presented areas: the Recovering Area and the Assembling Area. It also matters to highlight that the recovery of the components is majorly focused on only one operator and his supervisor.

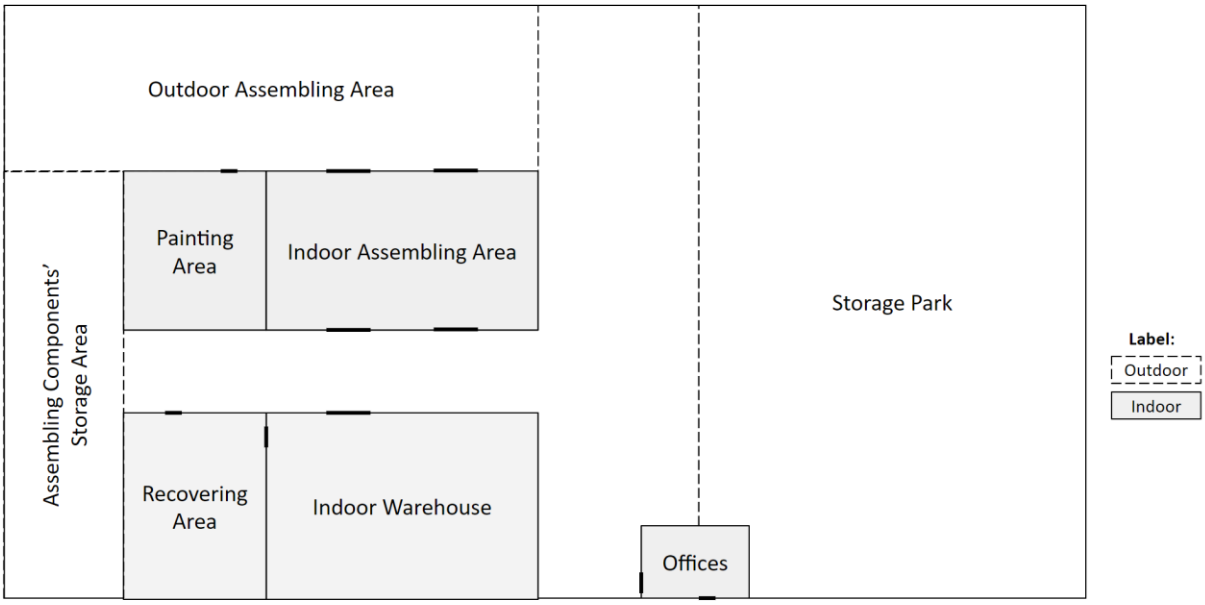

Figure 8: Installations Plant of ABC company

3.2.1. Operations and Flows

ABC company has its peak of activity during the summer period. This demands, especially during that time, a strict management and control over the operations happening on the installations. The processes must be defined and respected, to ease the flows and decrease the obstacles.

It is important to note that, unlike most companies, ABC rarely produces new structures for their products when an order is placed, only when absolutely needed. Instead, the structures used and returned by previous customers are readapted, recovered, and reused. This regards almost the totality of the company's activity. The assembly components and the remaining materials can either be new or recovered and reused as well.

The flow of materials in the company is presented in figure 9. When the renting period of the product reaches the end, the ABC team visits and disassembles it on-spot, in order to ease the transportation to the installations. While the structure of the product is kept, with the panels on, the assembling components are stored inside the product. When arriving to the company, the structure of the product is stored in the Storage Park (1) until needed by the team, to satisfy an order. Also, the assembling and other components stored inside the product are kept in the Storage Park (1) while waiting to be collected and then are transported to the assembling components' storage area (2).

After being transported, when the operator is available, and according to the orders, the assembling components and the furniture from inside of the product, stored in the assembling components' storage area (2), are recovered in the recovering area (3). Given the variety of materials and components, the recovery process can be very different, while in some cases cleaning and scraping is enough, in others it requires replacing parts, painting or even plastering. Afterward, the recovered materials and components are correctly stored in the Warehouse (4), awaiting to be used in the new assemblies. Here, the recovered materials are stored in the beginning of the aisles, to prioritize its use instead of the new ones, as it benefits the company, in terms of costs and sustainability.

Later, when receiving an order from a customer, it is assigned to the responsible team, which starts by visiting the storage park (1), where the products are stocked, and picks the most suitable for the order. Following, the product is inspected, the structure with the panels is recovered and the whole product is assembled in the assembling area (5), according to the specifications from the customer, prioritizing the use of the recovered assembling components, stored in the warehouse (4). When ready, the product is sent to the customer, for sale or rent. As for the second case, where it is rented, at the end of the contract, it is returned to the company and the process is repeated.

In the company, there is a circuit, related to the recovery of materials and that includes some of the previously described steps. The "Yellow Circuit", as it is called, is a route done weekly by the operators to collect material that needs to be recovered. This route starts at the storage park, where the operators collect the assembling components and materials, stored temporarily inside the structure, and bring them to the warehouse, both indoor or outdoor (2) or (3), where they will wait to be recovered. When the operator is available, the recovery takes place in the Recovering Area (3) and for some components, it is necessary to visit the Painting Area (6). After being recovered, the materials are correctly stored (4) and await to be used in the new assemblies.

For a clear visualization of the process and movements within the company, figure 9 presents the flow of the materials during the recovery process, as described above.

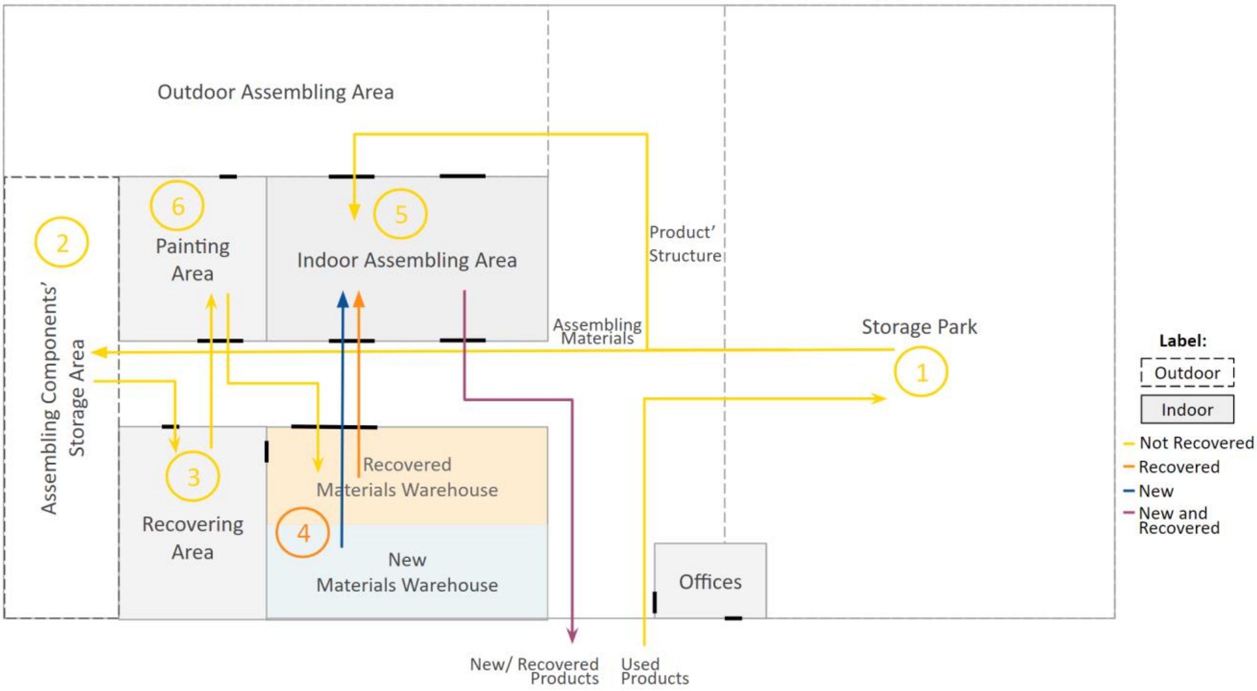

Figure 9: Materials' Flows

The recovery process is constituted by three main phases:

1. The triage of the components which are or are not able to be recovered – it is mostly done according to the sensibility and experience of the operator, although some materials have defined criteria. It usually involves visual control, verifying whether the components comply or not with the defined criteria.
2. The recovery activity itself – the materials that comply with the triage criteria are then submitted to the recovery process, which involves a set of activities aiming to achieve a quality similar to the original. The recovery includes activities such as cleaning, painting, scraping, and hammering, among others.
3. Verification of the final quality – regards assuring that the component, after being recovered, complies with a set of criteria, in order to be able to be used again in new products. It also involves storing the recovered components in their correct and assigned location, to be available when needed, tidying up the tools used and cleaning the workspace.

Currently, after the operational team recovers the materials, the components and respective quantities recovered are registered on an appropriate sheet and delivered to the management team, so the company is able to account for the job done by the operational team and measure, in terms of economics and sustainability, the savings achieved by reusing instead of buying new. This register is done for all the components, except for the panels, whose recovery is not recorded anywhere.

3.3. Diagnosis

The sub-chapter that follows is focused on the diagnosis. After knowing the flows of the company, it was important to understand the obstacles and difficulties that the operators faced in their daily operations. First, their perceptions were considered and then, a methodology to gather and process the information was developed, which allowed to build the diagnosis and perceive the current situation. Finally, the diagnosis of the initial situation was made and allowed to validate the insights from the workers.

3.3.1. Employees' perceptions of the problems

In order to identify improvement points and inefficiencies, employees of different positions were heard.

Initially, the ABC company was visited to gather information and interview the employees. The interviewed expressed that a great variability was felt in the duration and in the activities, as a consequence of the inexistence of documented procedures to guide the operations. It also causes the operators to have little autonomy, as they are not able to proceed on their own. In general, the lack of space and compliance with the labels was also pointed out as an obstacle to the good functioning of the operations.

ABC believes there is a wide potential for cost reduction and efficiency increase due to the lack of consistency in the recovery process, which often leads to lack of incorporation of recycled components, using new components instead of recovered ones. The operators and the management team expressed their will on increasing the efficiency and improving processes.

Below, the critical aspects to focus on are presented, aggregated into three main areas, which were identified by the employees together with the consultant team.

Lack of documentation for the recovery tasks

This issue regards, from a major point of view, the nonexistence of processes for triage and recovery. The triage criteria of the components which are proper or not to be recovered and the recovery activities are not documented nor defined by the company, meaning that it's done according to the operators' sensibility and experience. In addition to that, the company claims that during times of higher pressure and overload, the procedures followed tend to vary and follow different criteria, as the operators try to shorten them, leading to different quality levels. Those situations expose a great potential for uniformization of the procedures within the company, which would assure that the same criteria and principles are followed and equal the final quality.

Moreover, the responsibility for the triage and the recovery relies only on two people. From a positive perspective, these activities being done always by the same operators reduces the variability of the final quality of the materials, as the procedure followed tends to be similar and the triage is done according to the same criteria. However, those workers claimed to be overloaded, especially during peaks of activity in the company, as described above, which generates major constraints on the days they don't work, due to vacations or leaves, as the other operators are not trained to perform these activities. During that period, the company must assign other operators for those tasks who, due to the inexperience and lack of registered procedures, always require one experienced operator to accompany the new one full-time. Consequently, the company feels a great variability in the duration of the tasks, both due to inexperience and because different procedures are followed to recover the same components.

Both regarding the recovery of components and panels, the operators feel lack of autonomy when performing the tasks, and that the lack of instructions negatively influences their work. As the activities and standards to achieve are not documented, frequently, the operators have to consult the responsible for the recovery or other more experienced operators, to validate which procedure to follow for a given state of the components, as they cannot proceed on their own. Those situations are aggravated in cases with new employees as they are not familiarized with the process nor with the standards and require full-time assistance. Besides, the recovery responsible claims to be repeatedly interrupted from his tasks, having to visit the recovery workstation and assist with the activities. The low independence also extends to the compliance with the criteria, as the operators do not know the standards the components must meet to be able to be recovered nor the final quality they must achieve to be used in the products.

Lack of control and procedures for the panel's recovering

Another issue identified regards the recovery of the panels. The panels account for over 50% of the total cost of a standard product, highlighting its importance and impact on costs for the company.

As for the remaining components, described above, the recovery of the panels follows different criteria, depending on the operator's experience, leading to different quality levels on the final product. The operators also feel that the lack of instructions leads to a lower product quality and that they cannot perform the tasks independently, as the recovery activities are subjective.

For tracking and quality purposes, all the activities performed on the product, when preparing the orders, must be registered on a maintenance sheet, where the operators must sign the activities done. However, these maintenance sheets do not include the type of panels on which the activities took place, nor the quantity recovered, preventing ABC to track them. Consequently, the management team does not count nor control the recovering of the panels. Even though it was possible to know if that activity happened on each product, it was not possible to know how many panels or their type were used, or even if the panels were new or recovered. As the company expressed, being one of the materials with greater impact on costs and that take longer to recover, demanding time and effort from the operators, reusing them instead of buying new ones involves several hours of work and the savings of thousands of euros. Despite being recovered on the shopfloor, the impact of recovering is not considered by the company on their metrics. Accounting for those components would allow significant savings for the company, to improve its environmental metrics and have a better perception on the work done on Gemba, as the management team has stated.

Currently, the recovery of the panels is done in two ways, as described by the operators. The panels are recovered, mainly, on the assembling area, during the assembly of the product, but can also be recovered in advance on the recovering area, more rarely, and to expedite the assembly process.

1. The most common consists of recovering all the panels that are part of the product at the same time, when they are already assembled – in the **assembling area**. Here, as the products are assembled based on the orders, the recovery is only done according to the demand, exactly when the company needs it. At the end, the painting is done, and it is assured that the color is uniform.
2. The second one takes place on the **recovery area** and happens prior to the assembly. According to the need and availability from the operator, the panels are recovered individually in advance, stored until needed and, then, they must only be assembled and painted.

Most frequently, and whenever possible, the structure of the product is stored with the panels on and, for that reason, the recovery in the assembly area is the one that happens more often. In more rare situations, the panels have to be disassembled, either for transportation or because they are too damaged.

The management team does not have information on the recovery process of none of the options and, consequently, cannot choose one the most beneficial to adopt. It is not known which option is more efficient, takes less time or allows to better achieve the desired quality. Furthermore, as the processes are not defined, the activities performed tend to be different between areas and even within each area, and according to the workload, so, the management team does not know which one is more beneficial.

The great impact on costs for the company highlights the urgency on controlling the activities associated with that component, to create a process, measure the times and define the quality standards. The company aims to find a solution that permits to account for the impact and monitor the activities happening on Gemba.

Other flow related problems

Besides the major problems identified within the company, other relevant ones were also pointed. Even though they did not constitute the focus of the consultancy project neither of this master's thesis, they were still addressed and taken into account, and were verbally discussed with the company.

Another issue identified by the operators regards the failure to comply with the materials' location. Given the lack of storage space and of proper labeling, the operators claim that different components and in different states (recovered and not yet recovered) tend to be mixed, hampering the search for the components and its triage. In fact, the operators confessed paying little attention to the labels as, frequently, they were outdated or there was no other empty or assigned location to store the component, leading to mixed components in a single location. The operators expressed that this causes confusion and leads to errors both when searching, picking and storing the materials.

Regarding the yellow circuit, the operators stated that it is not performed with the due frequency, initially expected to be done twice a week, leading to components accumulation and lack of storage space. The fact that the components are not collected with the expected frequency also makes it difficult for the responsible for the recovery to schedule which components must be recovered first, according to the demand.

Final remarks

Table 3 summarizes the problems identified by the workers and stated above.

Table 3: Summary of the perceptions and problems identified by the workers

Problems Identified	ABC' will	Team involved	Where it happens
Lack of defined and documented processes to recover each component, including the panels	Aims to uniform and document the processes, to guarantee the same quality level	Operational team	Recovery Area (shopfloor)
Not accounting for the panels recovered	Develop a solution that accounts for the economic impact of recovering the panels and monitors the activities on Gemba	Operational and management team	Recovery and Assembly Area
Wrong/ outdated labeling	Organize and clean the workspace; implement measures to keep it as desired	Management Team	Gemba
Lack of compliance with the defined locations		Operational Team	Gemba

Overall, the company feels a great fluctuation in the recovery process, due to the inexistence of defined procedures, and therefore, they believe there is a significant potential for standardizing the recovery process for each component. Thereby, all the operators would follow the same criteria when recovering the same components, leading to more similar durations and quality levels. The company also believes it is essential to account internally for all the recovered components, to keep track of the metrics defined, and be aware of the operators' performance in the different areas.

Minding these major pain-point, both the operators and the management team expressed the will to uniform and document the operations and procedures, to decrease the variability verified and to assure that activities and quality standards are the same for each component, to develop a solution that permits to monitor the activities happening on Gemba and present more realistic results, regarding sustainability and savings on costs, derived from the recovery. Being aware of the low level of organization verified on Gemba, ABC aims to keep the workspace cleaner and more organized.

3.3.2. Methodology

After gathering a set of problems and difficulties faced on Gemba, it was defined a methodology to build the diagnosis that enables to validate the perceptions from the workers and identify other additional obstacles that may be conditioning the performance of the company.

The methodology to develop the diagnosis was based on three main work envelopes: several meetings with different team members, analysis to documents and company information provided by the team, and visits to the shopfloor, that allowed to observe the activities performed and perceive the flows, obstacles and needs (figure 10).

Initially, and intending to better understand the processes, activities and responsibilities within the company, there were held meetings with the ABC team. Members from different hierarchical levels were involved, from operators to the CEO, aiming to perceive their point of view on the different aspects and allowing to understand the needs across the whole organization. The meetings were both formal and informal. The formal meetings were previously agreed, had a defined agenda, and were directed to administrative and management roles – the Operations Director, the Warehouse Administrative Responsible, the Park Responsible, the CEO, among other roles. The objective regarded comprehending the flows from an administrative perspective and understanding the major pain-points felt by the management. On the other hand, in the informal meetings, the information gathering was done on Gemba, as the activities were being observed, and the present were the Warehouse Operational Responsible and other operational workers, who were part of the warehouse and/or the recovery team. Here, the focus was to understand the difficulties felt on the shopfloor and the differences between the theoretical flows, defined by the management, and the ones that were actually verified on Gemba, to understand the motives which justify the lack of compliance. Both meetings were held initially and then along the project, whenever there was felt the need, leading to a total of 12 formal meetings and over 24 informal ones.

Apart from the verbally transmitted information during the meetings, about the flows and processes, the management team has also made available documents from the company, related to costs, material's rotativity, purchases and impacts, that were the basis for the developed analysis, when reaching a solution. These documents tended to be requested during the meetings or afterward when there was information missing to proceed with the analysis. Most of the documents contained information regarding the previous year of activity, including input and output of goods, materials' consumption, costs, etc, and supported the decisions and recommendations from the consulting company to ABC. This information was essential to order the components by the impact on costs and rotativity and identify which ones play a critical role for the company.

Another important step for the diagnosis relied on the observations made. For that, the installations were visited between two to three times per week, by the Erising team and the author of this master's thesis, intending to collect information and observe the whole recovering process for the different components – from the triage to storing the recovered component. Apart from listing the different activities and materials associated with each component, the aim of the observations relied on identifying value-added activities and wastes, as well as which components are worth to recover, based on its cost, time spent, material consumption and sustainability goals. During the observations, both experienced and inexperienced operators performed the recovering, which enabled to notice the variability in terms of time, processes, and efficiency, and understand what type of support and information the operators miss when performing the tasks on their own. The inexperienced worker could not proceed on his own, as he was not familiarized with the tasks and they were not described in any document he could access and, consequently, required full-time accompaniment, leading to two workers occupied with the same task instead of one. It also matters to highlight that the recovery of each component was observed, at least, three times (when possible), aiming to achieve a realistic average and to decrease the variability depending on the initial state.

The methodology used is summarized in figure 10.

Method	**Meetings with operational and Management team**	**Consultation to documents**	**Observations on Gemba**
Information gathered	❖ Understand the differences and obstacles between the theoretical and real flows. ❖ Difficulties felt in the communication and perception of the work done on Gemba. ❖ Priority problems to solve and goals to achieve.	❖ Know the purchases, sales, consumption and rotativity of materials. ❖ Sort the most critical components by impact on costs and rotativity. ❖ Evaluate which components are or not worth to recover.	❖ Difficulties during the activities and complying with the theoretical flows. ❖ List the activities, materials and tools used. ❖ Identify value-added activities and wastes.

Diagnosis

Figure 10: Methodology summary

Besides the methodology presented, used to gather information, the improvement of processes and development of solutions relied on the methods explored during the bibliographic review. The 5S method and the Value Stream Mapping were essential to optimize the activities and improve the flows. While the first was crucial to organize the workspace, the later contributed to visualize the current processes and the ideal one to achieve.

3.3.3. Analysis of the current situation

Listening to the insights and opinion from the operators enabled to have an overall view of the problems faced, daily, by the company, and the ones more critical to solve. To evaluate and analyze the current situation in ABC, the methodology was used to build a diagnosis, which allowed to quantify and express the dimension and impact of each problem.

Lack of documentation for the recovering tasks

Intending to perceive the impact of the lack of documentation about the daily activities in the recovery area, some informal interviews were held with the responsible of the warehouse and with the operator responsible for the recovery.

In fact, the meetings confirmed that the lack of standardized procedures was a cause of entropy within the company. ABC works with over 370 different components on its products and, over the last few years, due to environmental and economic concerns, has been increasing the number of components that are recovered in their installations. Out of those, the company currently recovers 221 materials (Figure 11), around 60% of the total, which are registered in their systems, measured by the KPIs, and present a significant impact on their results. The remaining are not yet recovered, either because a process was not defined, the rotativity was too low, or because it regards single-use materials. Nonetheless, only six out of the 221 components presented standardized and documented procedures – around 2% of the total. The remaining components that are recovered (221-6 = 215) only have a verbally discussed process, between the operator and the responsible and, frequently, the recovery relies on the experience and instinct of the operator. It matters to highlight that this percentages regards the number of components for which there is a recovery process defined. Nonetheless, it does not mean that 100% of the use of each component with a defined recovery process is recovered – actually, on average, only around 28% of the total use of each component is recovered. In figure 11, it is schematically represented the number of components with and without processes defined for the recovery and the ones that, out of those, are recovered or wasted.

These percentages were estimated based on the documents provided by ABC. To calculate the number of components with defined procedures, the employees responsible for the recovery were interviewed and identified, one by one, if the component had a defined procedure or not, as there were no registered information regarding this topic. Afterwards, it was calculated the quantity of each material recovered, based on the previous year. For that, it was estimated the amount of each material recovered, based on the documents filled by the operational team and delivered to the administrative team, and the total quantity used, based on the material output, allowing to calculate the percentage recovered of each material. Finally, an average between the percentage of recovery of each component was made, and it was achieved the value of 28%, previously presented.

The main causes for the low average value of components recovered regard the lack of available labor to perform these activities, the lack of space to store and the components not meeting the triage conditions, to be able to be recovered.

Currently, only 16,8% of the totality of the materials used are recovered, being the remaining 83,2% discarded, including components with and without the processes defined. The low percentage of recovery expresses the enormous potential to improve this area and increase the sustainability performance, while reducing costs. Given that most of the components is not yet recovered and the low number of components with standardized and documented processes, the enormous gap for standardization becomes very significant.

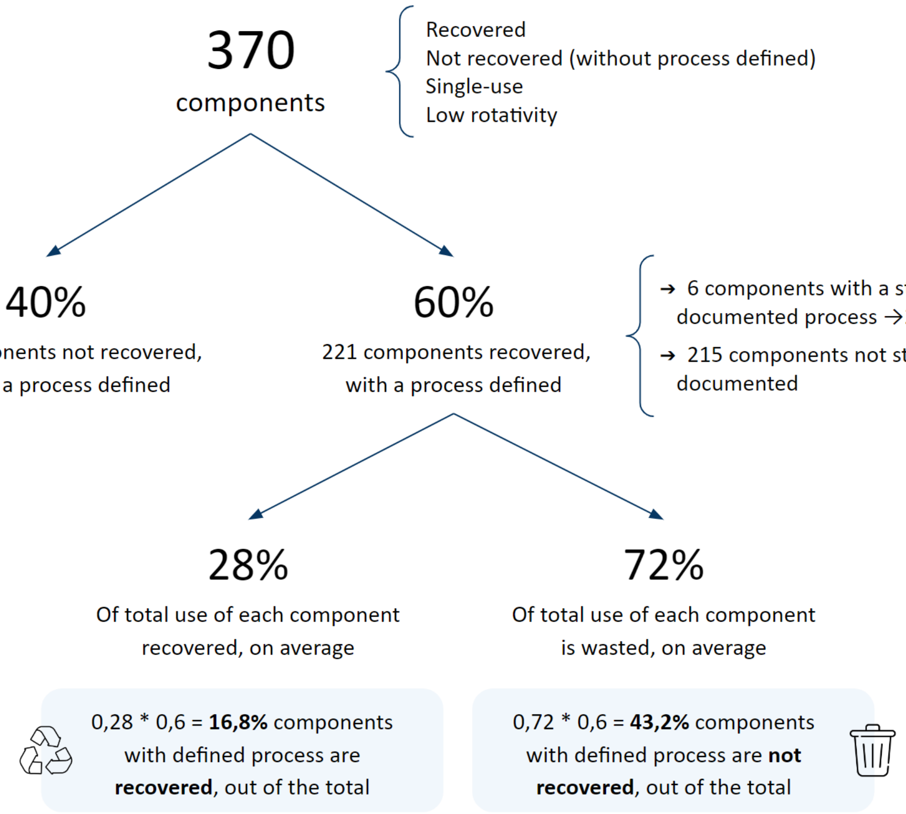

Figure 11: Schematic representation of the recovery percentage of the components

When interviewing the operator responsible for the recovery, the negative impact of the lack of documentation was corroborated as it was felt that the components with standardized processes permitted uniform the work and the operator to be more autonomous, given that the document could be consulted and there was no need to approach the superior.

The inexistence of those documents also led the triage of the components to be assigned only to the responsible for the warehouse, overloading that person, as it seems to be the only way the company can assure that the same criteria are followed, for each component.

As previously stated, the operators exposed that the variability in the duration and in the activities performed to recover the components is very significant, depending on the experience of the operator. On the one hand, the operator who is usually responsible to recover the components demonstrated to be comfortable and autonomous, know the locations of the materials, components, and tools, and to be familiarized with the process, being capable of dealing with different and specific situations and solve the problems faced through his sensibility. On the other hand, when other operators, who were not aware of the procedures to follow, were asked to recover the components (e.g. to fulfil leaves or vacations), they have presented great difficulties. The operators did not know the components nor the locations, leading to time wasted when looking for it, were not able to sort according to the triage criteria, always requiring an experienced worker to perform this task, and were not familiarized with the activities to do, nor quality standards to achieve. For this reason, these operators demanded full-time monitoring and accompaniment, to guide them, explain the tasks and validate the quality at the end of the process. Besides the hindrances described, the operators also tended to take longer to complete the tasks, due to the lack of experience and having no example to base it on.

To validate this insight, observations were made to both types of operators and the durations, activities, and difficulties were registered. The variability was considered to be expressive and was felt in three axes: differences in the durations, in the processes, and regarding the triage criteria. The results are presented in table 4.

Table 4: Variability felt on Gemba

Variability		
Duration	**Process**	**Triage**
17% The activities performed by the inexperienced worker were, on average, 17% longer.	**65%** Of the recovery process for the same component followed different procedures.	**12%** Of the components followed different criteria for the triage

The duration variability was achieved by estimating the difference between the longer time and the shorter time verified for each activity, which was divided by the average duration for that given process.

The differences in the activities performed, in 65% of the observations, the procedure followed by the inexperienced operator was different from the one initially done by the responsible for those tasks.

The variability verified when switching operators contributes to exposing the low level of standardization and the impact that the lack of documentation has on the daily operations of the company.

Besides, it was also verified that the triage criteria for the same components were different and depended on the experience of the operator.

Lack of control and procedures for the panels' recovering

As for the panels, it was easily possible to conclude, after consulting the documents, the impact on the costs and results. The panels account for over 50% of the total cost of a standard product, highlighting the importance of strict management of those components for the company.

To assess its impact, a list with all the materials used in the company was made, and the items were ordered according to the respective impact on costs, based on the previous year's reports. Out of the 20 more impactful materials on costs for ABC, 13 were panels, enhancing the relevance to the company and the urgency to account for its recovery on the company's metrics. When assessing the monetary value, the top 20 materials represent around 55% of the total costs with materials, and, out of that 55%, the 13 panels referred are responsible for around 70%. This means that, overall, only those 13 panels represent almost 40% of the material costs to ABC. It has made evident the need to find a solution that would allow ABC to account for the great impact associated with the panels.

Another problem related to the panels regards the uncertainty of the most effective way to recover them, given the two possibilities that are currently implemented in the company. Observing the recovery in both places has permitted to conclude that the recovery area has the advantage of creating stock of recovered panels allowing, during times of greater activity, the assembling process to happen at a higher rhythm, as it only requires the assembly and paint. Also, the quality achieved in this process tends to be higher, as the operators are not working under pressure nor have strict deadlines to comply with. However, recovering in advance demands a safe space to keep the panels until needed by the assembly team and, currently, the installations have a very reduced capacity, limiting the number of panels that can be recovered in advance. In this option, the panels are recovered but cannot be painted until assembled, to assure that all the panels from the same product have the exact same ink shade.

Recovering the panels in the assembly area does not require this extra space but makes it more difficult to deal with the high season, as all panels have to be recovered during the assembly and preparation of the order. Besides, it allows each task to be done straight away in all the panels, avoiding the repetition of the preparation time (e.g. plastering all the panels at once only requires preparing the mass and cleaning the tools once, while plastering one panel at a time, requires preparing and cleaning each time). During the peaks, the operators tend to lower the quality standards and pay less attention to the details, to be able to produce greater quantities. This leads to the management team being unsatisfied and, sometimes, to complaints by the customers. Besides, as the panels usually are not dismantled from the product, this option avoids the time associated with disassembling the panels to be recovered in the recovery area and, when needed, assembling again.

To compare both options, the recovery of the same type of panels was observed three times in each location. The results are presented in table 5.

Table 5: Comparison between recovery on the Assembly and Recovery Area

	Preparation time (min)		**Recovery time (min)**		**Total time (min)**		**Benefits of recovering on the Assembly area**
	Recovery Area	Assembly Area	Recovery Area	Assembly Area	Recovery Area	Assembly Area	
Type A	4,2	3,5	15,5	14,2	19,7	17,7	10%
Type B	19,8	5,4	35,3	21,8	55,1	27,2	51%
Type C	6,0	3,4	13,4	13,5	19,4	16,9	13%

To estimate the benefit of recovering on the assembly area instead of on the recovery area, the formula represented in Equation 1 was used. It calculates the difference in the durations between recovering in the recovery area and in the assembly area, which corresponds to the time saved – the benefit of recovering in the Assembly area in terms of minutes. Then, the difference was divided by the longer time (Recovery time), in order to, percentually, understand how representative the difference is, compared to that option, and what is the advantage.

$$Benefit = \frac{(Recovery\ total\ time - Assembly\ total\ time)}{Recovery\ total\ time} \quad (1)$$

Analyzing the results, it becomes evident that recovering the panels in the assembly area shows to be more benefic, in terms of duration, than in the recovery area. As the recovery is done by the operators, the duration is also associated with labor costs. Especially for type B panels, the difference is very sharp. Regardless, the company is facing a trade-off between time and cost – which present better results for the assembly area; and quality – which is higher in the recovery area. ABC should weight the advantages of each option, as the one to go is not obvious, and choose the one that better represents its interests and preferences. It is also possible to continue exploring both options - recovering in advance in the recovery area, whenever there is availability from the operator, to help dealing with the high season, but, mostly, recovering on the assembly area, after the customer' order, when assembling the product.

Other flow related problems

The lack and wrong labeling constitutes a constraint at the shopfloor, as there are shelves without labels or with outdated labels or ones that, due to lack of space, are not respected, as presented in Figure 12.

Figure 12: Lack of labeling (right) and label not respected (left)

In addition, to each materials' location, it is assigned a color, which identifies its state. While the new materials and the ones to recover (not able to be used) are always identified by the same color across the installations, respectively blue and yellow, the recovered present different colors in different areas. While on the outdoor storage area, the locations are identified in green, on the indoor warehouse, the assigned color is orange. The operators have stated that this is a cause of errors and it is not intuitive, hampering the search and storage process. Besides, the lack of storage space obliges to mixing the recovered with the ones to recover in locations which should be assigned to only one of the options, again hampering the search and storage.

Regarding the yellow circuit, initially, the route was expected to be executed twice a week, to avoid materials cumulation and to allow the schedule of the recovery, according to the demand. However, due to the operators being overloaded, it is done according to their availability –

approximately once every two weeks, during periods of low activity, and once a week during the peaks and does not permit to schedule in advance or to prepare the work to be done on the recovery for a determined period. Consequently, it is visible across Gemba heaps of components waiting to be collected or wrongly located while wait for the recovery and, frequently, these materials are needed to fulfil new orders and should be recovered. However, as they are scattered, it is not possible to schedule the recovery and new materials from suppliers are used.

3.3.4. Root Causes

After having clearly identified the problems on the previous subchapter, it matters to understand the principal causes of each one, aiming to act over those issues, solving the problems in a more direct and oriented way.

Below, in figure 13, it is listed the difficulties faced by the company. Aiming to achieve the root-causes that leaded to this problem, it is asked "why" a given problem happens at each step.

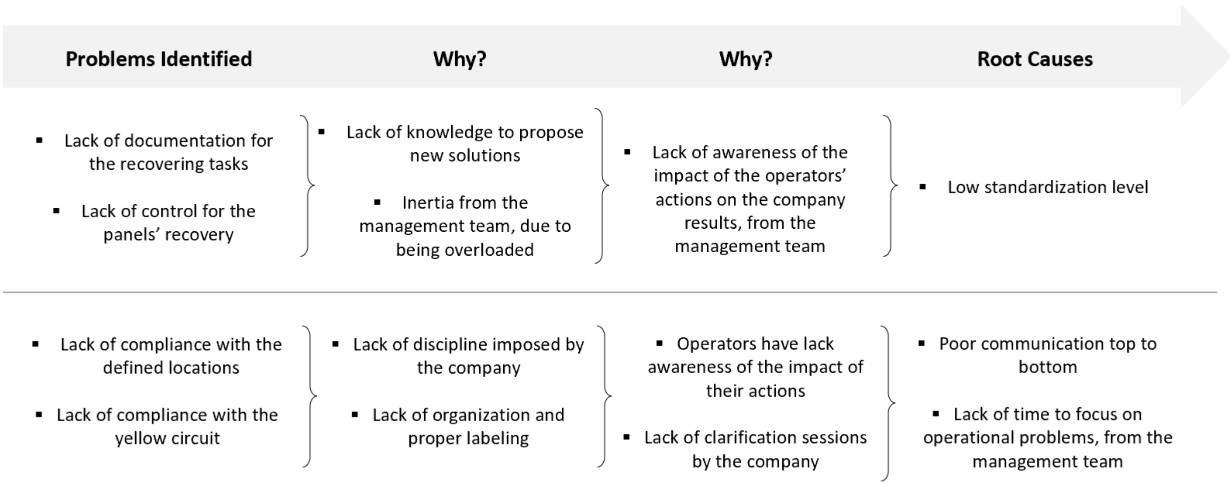

Figure 13: Identification of the root-causes

Concerning the major problems faced by ABC – lack of documentation for the recovery tasks and lack of control for the panels' recovery, in the first iteration, it was clear that, although the company had the will to define and document the processes and to develop a way to account for the panels, the management team did not have the necessary time nor knowledge to come up with a solution. Besides, due to being overloaded, the management team presents some inertia in solving these issues and ends up postponing them. However, the inertia and postponing when trying to find a solution derives from the lack of awareness of the impact that those problems have for the company – if the management team quantified the possible improvements on performance, daily operations, costs and sustainability, this subject would be a priority. Furthermore, the management team tends to be focused on higher-level problems, disregarding operational problems, as they think those will have a less significant impact. Finally, this is justified by the low level of standardization within the company, for processes and criteria. The operators decide according to their knowledge and experience, causing different standards and procedures for the same operations. The operators are not used to following defined or strict processes, which generates an increased entropy and disorder in the company, leading to the absence of good working practices.

It is frequent, within the company, that the defined areas for storing, the procedures and the registers of the materials/ components are not respected by the operators. Aiming to understand the causes, it became evident when interviewing the operators on Gemba that there is no strict control from the responsible and that there is no proper labeling, generating errors on storage. When questioning why, it was clear that the operators are not aware of the impact that their actions have on the results of the company and to the management team. The lack of awareness derives from the low communication top-to-bottom, from the management to the operational team, to explain and expose the impact and importance of their actions on the final results of the company, and from the lack of recalling sessions from the defined procedures. This happens due to the lack of time from the management team. In turn, this leads to the conclusion that not even the management team realizes the importance of the operators' actions and, consequently, cannot explain to them the importance of complying with the procedures and locations. The lack of awareness from the management team and the poor top-to-bottom communication were identified as the root causes.

Although the company has expressed the will to increase its' standardization level, the fact that they were going through the high season has resulted in no time left for new projects. Also, they did not feel they had the necessary knowledge for such project and to implement the necessary changes, resulting in some inertia from the management team to request the project to an external consulting company.

After identifying the major bottlenecks for the flow of the activities of ABC, it was concluded that poor communication, the low level of standardization, and the lack of time from the management team were the root causes for the issues felt.

4. Solution proposal

4.1. Solution Overview

Given the findings of the previously made diagnosis, it became clear that standardization is important for the company, both for the recovery process and for the accounting of the recovered panels. The employees expressed their will to implement changes, intending to improve the flows within the company.

It was necessary to develop solutions that would not disturb the daily operations of ABC but would still fulfill the requirements and allow a meaningful increase in the efficiency. The solutions had to be simple to implement and to be used by the operators on Gemba, not consuming much time from the activities they are already assigned. Furthermore, the solutions must be adapted and customized to the needs and guarantee that the associated problems are mitigated. The solutions proposed are summarized in figure 14.

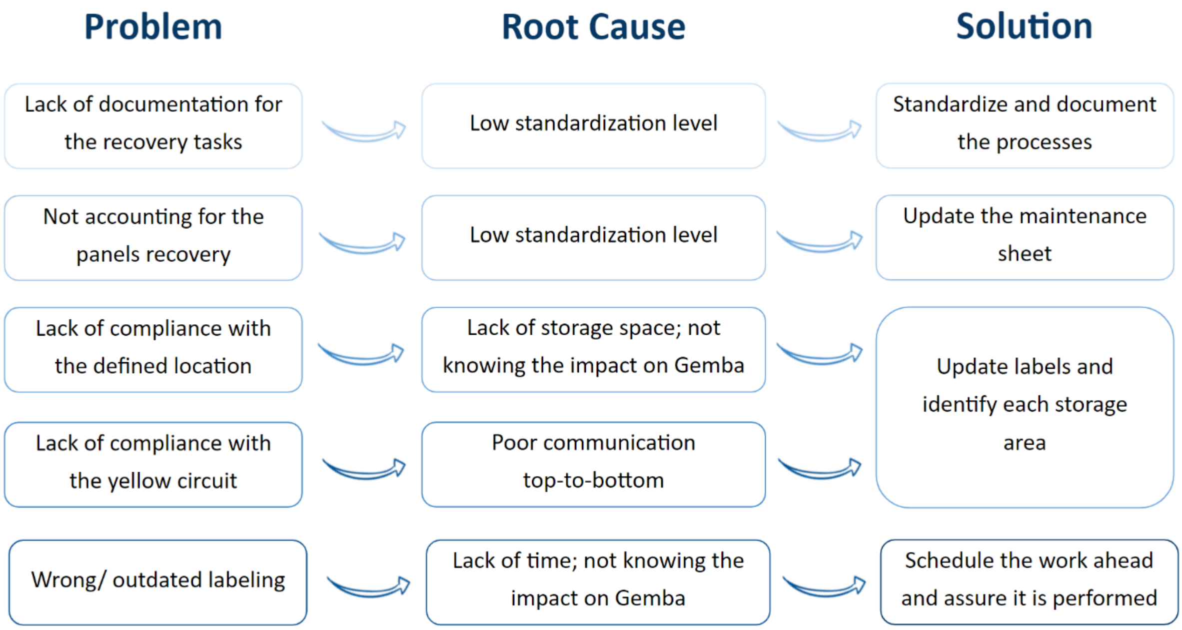

Figure 14: Summary of problems, root causes and solutions

In order to be standardized, the recovery process required the creation of a template, where the activities should be described, as well as all the relevant information associated with the recovery of each component, to be consulted by the operators assigned to the respective tasks. For that, auxiliary documents – Working Instructions – with the required information were created.

Whereas, for the panels to be considered by the management team and to be accounted in the performance of the company, it was necessary to register the type and recovered quantity of each. Besides being simple to comply with on the workstation, the solution developed also had to be aligned and contain the information required by the management team, so the team would be able to account for the recovery and savings, after receiving the sheet. Aiming to allow this register, the maintenance sheet had to be adjusted and a field to describe the details of the panels recovered was added.

Note that, as ABC maximizes the recovery, the need to purchase new components decreases and the company becomes almost self-sustainable, only having to purchase single-use materials, components not recoverable and, filling the gap between the needs and the recovered components.

4.2. Standardization

4.2.1. Working Instructions

Standardization and defined processes, accessible to any worker, were claimed to be essential to promote independence among the operators recovering the components, to guarantee uniform processes and, to assure the compliance with the quality criteria. To assure these requirements were fulfilled, Erising together with the author of this master's thesis, decided to develop specific Working Instructions for each component, describing all activities needed to be performed to recover that component, including other relevant information related, and the quality standards to achieve.

The template for the WIs was defined and agreed upon with the company, as well as what information was considered relevant for the operators on the shopfloor. After analyzing it with ABC, it was decided that each WI would be constituted by three documents: one SOP, describing the procedure, and two quality standards:

1. **Triage quality standard** – A document to guide during the triage, explaining the requirements that the component should meet, to be able to be recovered, described in text, and accompanied by images to clarify. Situations where the components meet the requirements and where must be discarded are presented, to clarify dubious cases. The technical drawing is also presented, to expose the measurements the component should have, in case it has been cut. Finally, the location to keep the component after the triage is also mentioned. An example is provided in figure 15.

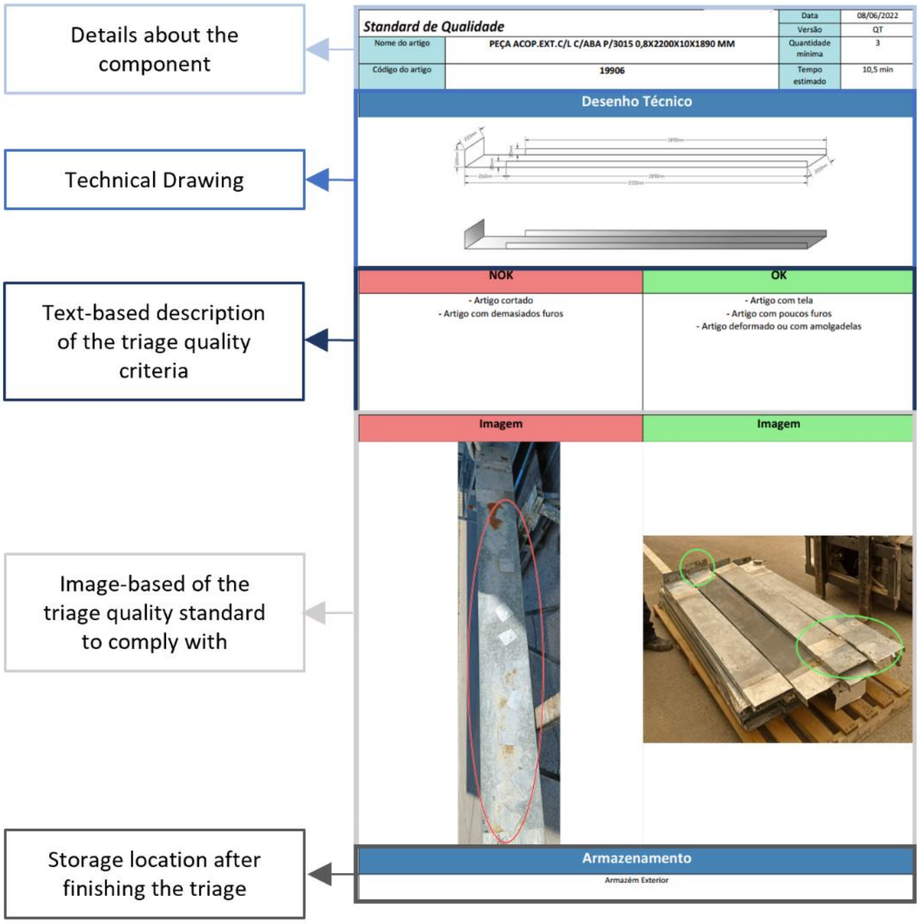

Figure 15: Example of Triage Quality Standard

2. **Standard Operating Procedure** – The second document details the activities to be performed for the recovery and the materials and tools to be used. The description is accompanied by images to explain the techniques and how the materials should be handled. Moreover, the average duration is presented, for the operators to estimate how long they will take and if they have enough time to start that operation, as well as the minimum batch recommended, for the recovery to pay off. An example is provided in figure 16.

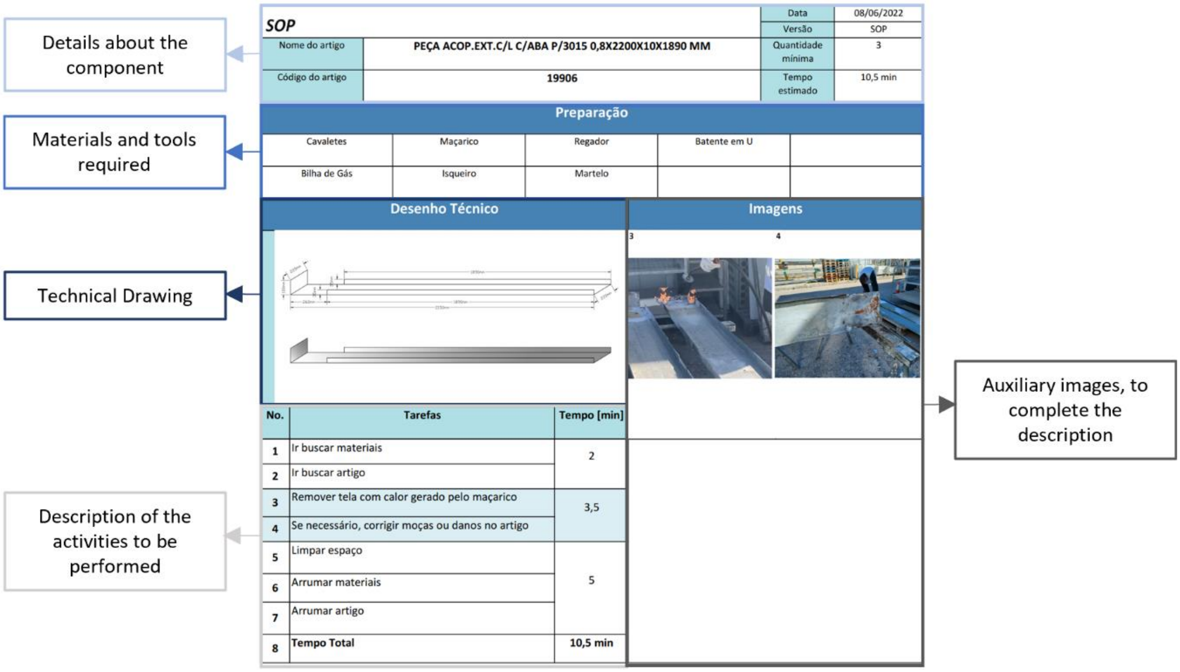

Figure 16: Example of SOP

3. **Final quality standard** - The third document states the quality standards to achieve for the component after the recovery process. It highlights the essential features and characteristics and shows examples of ok and not ok components. The location to keep the components is presented, so the operators know where to place them after the recovery. An example is provided in figure 17.

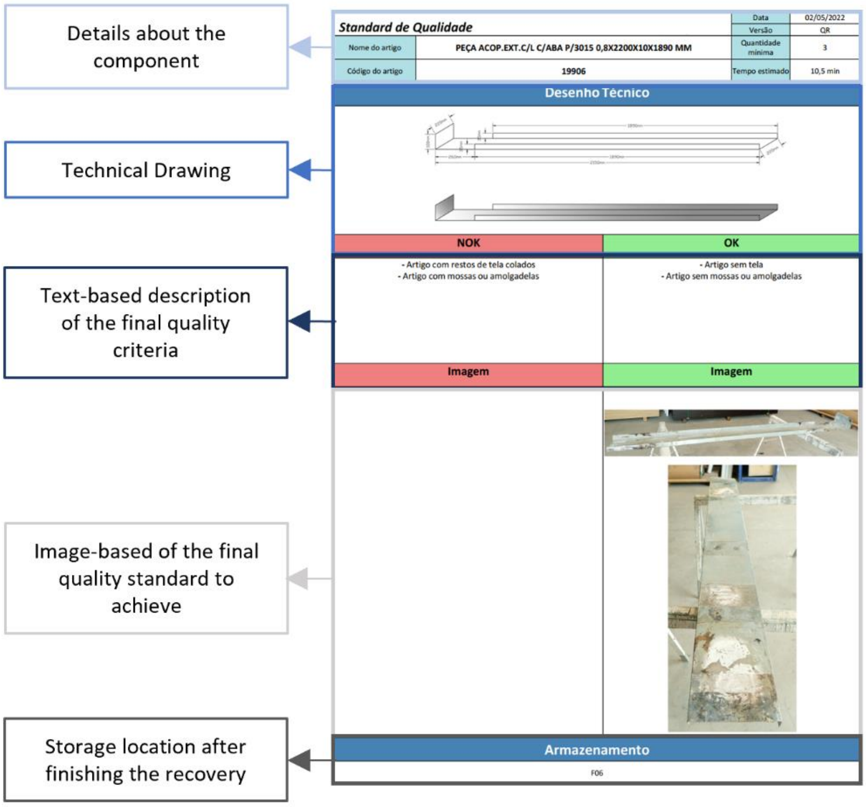

Figure 17: Example of Final Quality Standard

All documents contain the name and code of the component, the technical drawing, and photos, to ease the understanding of the tasks and the standards.

After being displayed on Gemba, the process to consult the WI should be simple to follow. The three documents associated with the same component should be together and, whenever it has to be consulted, the operators should follow the steps described in figure 18, below. The first step regards consulting the Triage Quality Standard document and performing the respective tests or activities to assure that the component meets the necessary conditions to be recovered. Then, the operator should consult the SOP and start the recovery activities, according to the instructions. When finished, the Final Quality Standard document should be consulted and, if the conditions and standards are respected, the operator should stow the component and the documents.

Figure 18: Procedure to follow to consult and use the documents

To build the SOPs, the recovery process of the different components had to be observed, to allow the consultant team to collect information about the criteria for quality standards, the activities, materials, tools, locations, and average duration. During the observations, the activities were listed as well as other relevant information, and the photos for the different documents were collected. The recovery for each component was observed at least three times, when possible, to decrease the variability on the duration and on the processes themselves, and also to record different possible initial states (before recovery). After finishing the observations, the average duration for each component was estimated and the information was cross-referenced to understand the standard process to follow. The consultant team has built each document with the information gathered and selected the most suitable photos for each situation. The technical drawings were asked to ABC and then added to the WI. At the end of the process, the WIs were presented to ABC, both the management team and the responsible operator, for validation of the processes, criteria, images, and overall information, before being implemented on the shopfloor.

Appendices 1 and 2 present the WIs developed for several components, with different levels of detail and complexity, which expose the work involved in developing this solution. For each WI, the materials and tools associated had to be considered, specific pictures were taken and highlighted, the activities and standards were described and the locations were considered.

4.2.2. Working Instructions' Development Analysis

The company has expressed the will to standardize and document the process of 35 components on this project, with the possibility of increasing this number in the future, depending on the implementation and results. Therefore, the observations had to be done to 35 different components and, for each one, one document of each type was built, resulting in the development of 105 documents, in total. The components to be considered could include any component used at the company, and therefore, included panels – WIs were also developed for panels, to standardize its recovery.

According to the information shared by the team, some analyses were performed to make the diagnosis more robust and help decide which components should be prioritized. An ABC and a cost-benefit analysis were built, whose output was the 35 more impactful components in terms of costs for the company and, therefore, should be the ones to focus, standardize the processes and develop the WIs. The analysis, objective, and output are summarized in table 6.

Table 6: Analysis performed to select the 35 components to develop WIs for

Analysis	Objective	Factors considered	Output	Considerations
ABC Analysis	Order the components from the most to the least impactful on costs and split them into classes	Unitary Cost, quantity purchased	Most impactful components, in terms of costs	Considering the available components to observe ↓
Cost-benefit Analysis	Evaluate which components are worth recovering (comparison between the selling price and recovery price)	Materials consumption, activity duration, Overhead costs, sustainability	Components worth being recovered	**35 most impactful components, worth to be recovered → to develop WIs for**

Initially, an ABC analysis was built, to categorize the components and understand which ones are the most important to the company, in terms of impact on costs. For that, it was calculated the annual value of each component for the company, based on the unit cost and in the rotativity during the previous year. The list was then ordered by descending order, highlighting the components with greater total impact. According to that list, the components were classified as type A, B, or C, from the most to the least impactful. Based on the Pareto Rule, A were responsible for 80% of the costs to the company, B represented the next 15% (80-95%) and the C category regarded the final 5% of the costs (95%-100%), as presented in table 7. The percentage of the cost regards the cumulated value, which is achieved as followed: the total cost associated with each class A component and the value is calculated as a percentage of the total components' cost. To divide the classes, the values of each component were summed, one by one, until reaching the "cut" defined for that class. The list was organized by descent order in terms of costs and, for example, to understand which components were part of class A, the value of each was summed until the cumulated value reached 80%. After that, components were allocated to class B and, after reaching a cumulated value of 95%, the components were considered as belonging to class C.

It is evident that, although class A has the fewest components, it is responsible for the largest share of costs, while class C has almost four times more components but is only responsible for 5% of the costs. It justifies the huge impact of class A components for the company and why those were defined as priority, when choosing the components to build WIs for.

Table 7: Division of components by classes

Class	Nº of components	Percentage of cost
A	48	80%
B	84	15%
C	182	5%

The analysis includes the total annual cost of each component, the percentage that the cost of that component represents on the total cost, the cumulated value and, finally, the class attributed. As stated, until reaching 85% of cumulated value, the components belong to class A.

From that list, the A and B components were prioritized for the observations and for building the WIs. Ideally, the WIs would have been developed for the 35 more impactful components – all type A - however, due to regarding single-use items or due to the low rotativity, the company did not have all the components on the installations, waiting to be recovered and, consequently, some had to be skipped and the next ones on the list were considered. It would be essential to understand if the recovery of each of those first 35 components is worth it in terms of time and costs, but it was not always possible as not all components were available to the observations.

After sorting the components, it was developed a cost-benefit analysis, to balance if the recovery was or not beneficial for each component, in terms of costs. Considering the variables defined, this analysis allowed to calculate the recovery cost of each component and compare it to the unit cost when buying. For that, a detailed analysis of the recovering procedures of each component had to be made. As so, the cost-benefit analysis considered the following factors:

- **Recovery time:** refers to the time of the end-to-end process, from the triage to the recovery and finally to storing the recovered component in the warehouse. To that time, it is associated the human labor, with a given salary. Therefore, the recovering time will allow to calculate the cost associated with the labor of recovering the material.
- **Used materials:** while some components consume more materials during the recovery (ink, glue, …), others only require the use of tools to fix deformations or to clean. Bearing this in mind, to estimate the benefit of recovering each component, it was considered the materials' consumption. The materials' consumption of the recovery process had to be analyzed individually, for each component, together with ABC' team, to estimate the correct cost involved with the recovery of each component. The total cost of materials consumed in the previous year was split by all the components recovered in that period that consumed materials as well.

- **Overhead costs:** considers the costs of the installations, utilities, and operations of the company and it is estimated as a percentage of the salary per hour.
- **Decision factor:** it's a factor defined by the company, which analyses until which point it is worth recovering, in terms of costs, by comparing the unit cost when buying a new component to when recycling one.
- **Sustainability factor:** minding the sustainability concerns and goals for ABC, it is possible to adjust the weight that such factor must have in the decision of buying or recovering.

The recovery of a component was considered beneficial when the conjugation of all these factors would still lead to a recovery price inferior to the selling price * decision factor.

Therefore, the application of this formula to the previously obtained list, from the ABC analysis, allowed understanding which components were worth recovering. Out of the first analysis, it was possible to infer that 8 out of the first 35 components were not worth it. Then, instead of analysing by unit, the analysis was repeated by functional lots – for that, the components were grouped in lots depending on the number of components required to build a standard product, and each time, the quantity recovered, should be, at least, equal to the functional lot. This permits diluting the material preparation time at the beginning and cleaning and tidying time at the end by all the units recovered, as those times will always be the same, despite the number of units recovered. From this perspective, only four out of the initial 35 were still not worth it, and, as so, those were ignored and the next four components that were worth it on the ABC list were considered.

The comparison between the recovery cost and the buying cost was extended to all the components that the company works with and are possible to recover, to highlight the great impact it would have on the company's costs to recover instead of buying.

During the observations, components from class A of the ABC analysis were given priority, due to their greater impact on the company. However, as the observations were made to the available components, the WIs were not built for the first 35 components out of the total, but for the most impactful 35 components, that were worth recovering and possible to observe, out of the observed. The value saved per component recovered was estimated and, the value can be very expressive for some components.

Table 8 presents the number of components in each class, the number of components observed from each class and, finally, the number of WIs developed for each class. The number of WIs from class A does not correspond to the number of components observed because, in some cases, it was only possible to do one observation and the team was not able to collect enough information to assure that that was the standard process or to decrease the variability. To find a reliable solution, the analysis were performed to over 300 components and demanded analyzing into detail each of the 51 components observed.

Table 8: Comparison between the number of components existing, observed, and with documents developed

Class	Total Nº of components	Nº of Observed	Nº WIs developed
A	48	23	21
B	84	18	11
C	182	10	3

For creating the WIs, a digital software was used – Soft4Lean – which presents a template with the fields to be filled and helps to gather the information, even during the observations. Further in this dissertation, a deeper analysis regarding the level of digitalization of this solution is provided. This was a month-long process and required the validation of the ABC team at the end. When finished, the WIs were impressed, plasticized, and placed in the warehouse, to be consulted when needed. The template was passed to the company, for future updates or changes.

After implementing the documents, the operators must be gathered for a clarification session to inform them that the activities and processes are now documented and able to be consulted, to promote independence among the operators. Each type of document should be explained, to clarify how they should be used together, during each phase of the recovery.

4.3. Maintenance Sheet

Currently, in the company, when a customer places an order, the responsible for the assembly visits the storage park and picks the most suitable product for that order. However, as other customers already used that product, it requires maintenance and to be recovered, before being delivered again. The responsible for the assembly defines the activities that need to be performed on the product, to achieve the standard quality level, and marks those activities on the maintenance sheet, to guide the operators. The maintenance sheets only presented a general description of the activity to perform on the panels, instead of specifying the type or number to recover.

In order to allow the accounting, the maintenance sheet had to be adjusted and reviewed. It was verified, together with the ABC team, that there were repeated and obsolete tasks, which were removed and/ or updated, aiming to free space and increase the accuracy of the sheet. Instead, a field with a list of each possible panel on each type of product was added, which was considered essential by the team. The operators were responsible to describe how many panels of each type were recovered, at the end of the activities. Daily, the maintenance sheet would be delivered to the administrative area, so that team would be able to insert the data about the panels on the system and account for the recovery. In figure 19 it is highlighted the before and after differences on the referred sheet. The red boxes on the first picture identify the activities removed, and the green boxes on the second picture highlight the tasks added/ updated. On the right side of that picture, it is listed the most common panels, so the operators can indicate the respective quantity recovered of each and there is an empty space for other less common operations to be manually added and described as well. Based on the operators' records, the management team would be able to register the panels recovered and account for that impact.

N.º Orçamento:		Matricula :	
Contrato : WallUP		Empreiteiro:	
Data final trabalho:		Resp.Obra:	
Data entrega ficha:		Ass. Resp:	

Operação		
06	Preparação	Qt
002	Preparação Módulos	
020	Retirar grade janela	
022	Colocar Grade janela lacada	
035	Retirar / colocar paineis movimentados	
041	Retirar plástico painel	
042	Isolar AL1 Grande	
043	Isolar AL2 Pequeno	
044	Colocar canto	
045	Retirar canto	
055	Abertura janela basculante anodiz.	
070	Levantar Estrutura	
09	Trabalhos Esepcificos	Qt
005	Trabalhos Parque (1 Hora)	
12	Divisórias	Qt
001	Col.Div. Transv. Porta 0,83 Esq	
002	Col.Div. Transv. Porta 0,83 Dta	
005	Col.Div. Transv. Porta 0,63 Esq	
006	Col.Div. Transv. Porta 0,63 Dta	
010	Fornecimento e montagem divisória	
015	Colocar Porta 0,83 Esquerda	
016	Colocar Porta 0,83 Direita	
020	Colocar Porta 0,63 Esquerda	
021	Colocar Porta 0,63 Direita	
040	Desmontagem Divisória (ml)	
042	Desmontagem de Porta	
045	Desmontagem rodapé ml	

Operação		
15	Electricidade	Qt
001	Colocar/substituir Quadro electrico	
003	Substituir interruptor	
005	Colocar/substituir tomada embeber	
007	Colocar/Substituir tomada estanque	
009	Substituir caixa derivação	
011	Ensaio electrico	
013	Rectificação cabo electrico 2 x 1	
015	Rectificação cabo electrico 3 x 1,5	
016	Rectificação cabo electrico 3 x 2,5	
017	Rectificação cabo electrico 3 x 4	
030	Colocar lampada esferica	
031	Colocar lampada fluo	
035	Mudança interruptor	
037	Retirar armadura	
039	Substituir armadura régua 1 x 36 W	
040	Substituir armadura Dupla 2 x 36 W	
041	Substituir armadura Estanque 1 x 36 W	
042	Substituir armadura Estanque 2 x 36 W	
043	Substituir armadura olho de boi	
075	Substituir diferencial 30 mA	
076	Substituir disjuntor 10 A	
077	Substituir disjuntor 16 A	
201	Substituir Cablagem	
	PROGRAMAR COMANDO	
30	Pintura	Qt
001	Pintura painel divisória	
003	Pintura painel exterior / Interior	
006	Pintura canto (pintado solto)	
010	Pintura estrutura cinza (1 Demão)	
015	Pintura estructura azul (1 Demão)	
040	040 Pintura de elemento de tecto	
045	Retocar painel	
050	Retocar estrutura cinza	
052	Retocar estrutura azul	
060	Raspagem estrutura	
062	Decapagem de estrutura	

Operação		
33	Revestimento solo	Qt
001	Retirar vinilico	
005	Colocar vinilico	
010	Colocar remendo vinilico	
201	Soldar Vinil	
45	Limpeza	Qt
001	Limpeza interior	
005	Limpeza exterior	
010	Limpeza telhado e desentupimento	
015	Limpeza de AL'S	
030	Limpeza de Janelas	
60	Manut.Préfa.	Qt
001	Substituir Puxador Janela	
003	Isolar Janela	
006	Revisão de Janelas,portas e estores.	
009	Substituir canhão c/chave universal	
010	Substituir canhão c/chave individual	
012	Subst.canhão Univ.c/ Apro. fechad.	
013	Subst.canhão Ind.c/ Apro.fechad.	
015	Colocar dobradiça porta dupla preta	
017	Colocar dobradiça porta dupla Branca	
019	Colocar pemo dobradiça Macho	
021	Colocar pemo dobradiça femea	
023	Colocar fiel de porta exterior	
024	Colocar dobradiça	
025	Colocar puxador	
028	Colocar Fechadura universal	
030	Colocar Fechadura individual	
032	Colocar/substit. Chapa de matricula	
035	Colocar autocolante	
036	Retirar autocolante	
038	Colocar Tampas (Un)	
040	Colocar tubo Descida água 50 mm	
042	Colocar tubo Descida água rectang.	
045	Colocar rodapés (ml)	
050	Substituir telhado completo	
	Soldar Peças Teto Falso (Origin)	
	Reparar telhado	
	Aplicar lã rocha nos pilares (por pilar)	

Operação		
60	Manut.Préfa.	Qt
053	Substituir Chapa de telhado pequena	
054	Substituir Chapa de Telhado Grande	
058	Substituir elemento tecto	
060	Regular tecto	
065	Colocar canto cego	
066	Colocar canto 1 buraco	
068	Colocar canto 3 buracos	
070	Reparar canto interior	
077	Reparar painel	
080	Substituir chão completo	
082	Substituir 1 elemento chão	
084	Susbtituir Travessa chão	
086	086- Rebitar chão	
100	Substituir folha de janela	
120	Substituir estore porta Dupla Dtª	
122	Substituir estore porta dupla vid.	
124	Substituir Estore Standard	
126	Substituir estore painel vd.	
128	Substituir estore p/MB	
130	Substituir estore painel semi-vidr.	
132	Substituir estore porta dupla esqu.	
140	Colocar soleira	
152	Colocar respirador	

OUTROS TRABALHOS	
Tempo	DESCRIÇÃO

Nota: Alteração Configuração

Anterior → Nova → V Verso →

N.º Orçamento:		Matricula :	
Contrato : WallUP		Empreiteiro:	
Data final trabalho:		Resp.Obra:	
Data entrega ficha:		Ass. Resp:	

Operação

06	Preparação	Qt
002	Preparação Módulos	
020	Retirar grade janela	
022	Colocar Grade janela lacada	
035	Retirar / colocar paineis movimentados	
041	Retirar plástico painel	
042	Isolar AL1 Grande	
043	Isolar AL2 Pequeno	
044	Colocar canto	
045	Retirar canto	
055	Abertura janela basculante anodiz.	
070	Levantar Estrutura	
09	**Trabalhos Esepcificos**	**Qt**
005	Trabalhos Parque (1 Hora)	
12	**Divisórias**	**Qt**
001	Col.Div. Transv. Porta 0,83 Esq/Dir	
005	Col.Div. Transv. Porta 0,63 Esq /Dir	
010	Fornecimento e montagem divisória	
015	Colocar Porta 0,83 Esq/Dir	
020	Colocar Porta 0,63 Esq/Dir	
040	Desmontagem Divisória (ml)	
042	Desmontagem de Porta	
045	Desmontagem rodapé ml	
30	**Pintura**	**Qt**
001	Pintura painel divisória	
003	Pintura painel exterior / Interior	
006	Pintura canto (pintado solto)	
010	Pintura estrutura cinza/azul	
040	Pintura de elemento de tecto	
045	Retocar painel	
050	Retocar estrutura cinza /azul	
060	Raspagem estrutura	
062	Decapagem de estrutura	

Operação

15	Electricidade	Qt
001	Colocar/substituir Quadro electrico	
003	Substituir interruptor	
005	Colocar/substituir tomada embeber	
009	Substituir caixa derivação	
011	Ensaio electrico	
016	Rectificação cabo electrico 3 x 2,5	
017	Rectificação cabo electrico 3 x 4	
031	Colocar lampada fluo	
035	Mudança interruptor	
037	Retirar armadura	
040	Substituir armadura	
043	Substituir armadura olho de boi	
075	Substituir diferencial/ disjuntor	
201	Substituir Cablagem	
	PROGRAMAR COMANDO	
33	**Revestimento solo**	**Qt**
001	Retirar vinilico	
005	Colocar vinilico	
010	Colocar remendo vinilico	
201	Soldar Vinil	
45	**Limpeza**	**Qt**
001	Limpeza interior	
005	Limpeza exterior	
010	Limpeza telhado e desentupimento	
015	Limpeza de AL'S	
030	Limpeza de Janelas	

Operação

60	Manut.Préfa.	Qt
001	Substituir Puxador Janela	
003	Isolar Janela	
006	Revisão de Janelas,portas e estores.	
009	Substituir canhão c/chave	
024	Colocar dobradiça	
025	Colocar puxador	
028	Colocar Fechadura	
032	Colocar/substit. Chapa de matrícula	
035	Colocar autocolante	
036	Retirar autocolante	
038	Colocar Tampas (Un)	
040	Colocar tubo Descida água 50 mm	
045	Colocar rodapés (ml)	
050	Substituir telhado completo	
	Soldar Peças Teto Falso (Origin)	
	Reparar telhado	
	Aplicar lã rocha nos pilares (por pilar)	
60	**Manut.Préfa.**	**Qt**
053	Substituir Chapa de telhado pequena	
054	Substituir Chapa de Telhado Grande	
058	Substituir elemento tecto	
060	Regular tecto	
070	Reparar canto interior	
077	Reparar painel	
080	Substituir chão completo	
082	Substituir 1 elemento chão	
084	Susbtituir Travessa chão	
100	Substituir folha de janela	
124	Substituir Estore Standard	
140	Colocar soleira	
152	Colocar respirador	

Recuperação

	Origin	Qt
19874	PAINEL CEGO M1 041 0491X2520 GOF/GOF	
14521	PAN M1 95 GG41 881/2536 PLEIN	
17843	PAINEL CEGO M1 041 0981X2520 GOF/GOF	
17845	PAINEL JANELA (1606X950) CEGO M1 041 1962X2520 G/G	
17826	P. PORTA 1F CEGA DIR. 041 0981X2520. R9010	
35566	PORTA SIMPLES CEGA LAC BRANCO REV. 1081X2520X41MM	
	Advance Comfort	
25297	PAN ADV CEGO 55 M0 0981X2520 LR	
20381	PAN ADV 55 M0 1962X2520 LR P/ JAN. PVC 1612X1287	
32769	P.PORTA ADV 1F REV CEGA M0 55LR 0981X2520.R9010	

OUTROS TRABALHOS

Tempo	DESCRIÇÃO

Nota: Alteração Configuração

Anterior → Nova → V Verso →

Figure 19: Maintenance sheet improvements

The maintenance sheet serves two purposes: serves as a communication and check point between the assembly responsible and the operators – indicating which tasks must be performed and assuring that the quality standards and criteria are the same, and permits the management to have control over the activities happening on Gemba and account for the recoveries on the company's Key Performance Indicators. Thereby, the solution acts exactly on the causes previously identified, by increasing the standardization level of the company, through the definition of a process to account for the panels, that includes the operational and the management team, and by allowing the management team to assess the significant impact of the panels for the company.

Regarding the functioning of the maintenance sheet, the operators will receive the sheet from the responsible with the tasks to be performed marked. The operators are responsible to perform those tasks and, additionally, to describe how many panels of each type were recovered, at the end of the activities. Daily, the maintenance sheet would be delivered to the administrative area, so that team would be able to insert the data about the panels on the system and account for the recovery. This process is described in figure 20, below.

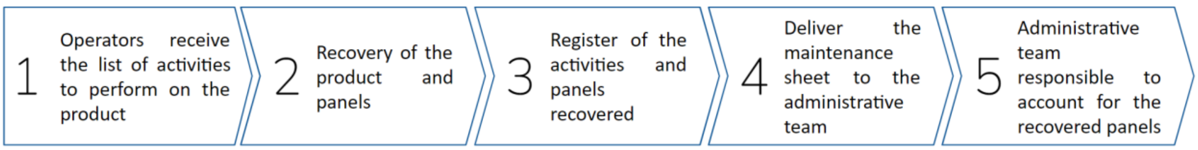

Figure 20: Procedure to follow to properly use the Maintenance Sheet

Before the implementation, the coordinators of the operational teams responsible for recovering the panels and the operators were asked for opinion, to validate if this method would be adequate to the reality of Gemba. Given the positive feedback, the presented sheet was implemented.

This way, after the implementation, the administrative responsible was able to keep track of the activities happening in the recovery and assembly area. The company will be able to monitor and account for the panels on their KPIs and measure the impact on the costs and sustainability aspects.

4.4. Other solutions proposed

Besides the major issues stated above, which are the focus of this dissertation and of the consultancy project, other constraints were identified. Given the duration of the project – three months long, it was possible to consider and suggest solution proposals for those problems identified within the company. Although those were not core issues and did not require extensive nor prolonged analysis, the potential solutions and improvements were discussed with the respective teams, in a more informal context, during the visits to the installations. These solutions are schematized in figure 14, where to each problem and respective root cause it is proposed a solution. In figure 21, the problems and respective solutions for the organizational issues felt in the company are presented in more detail.

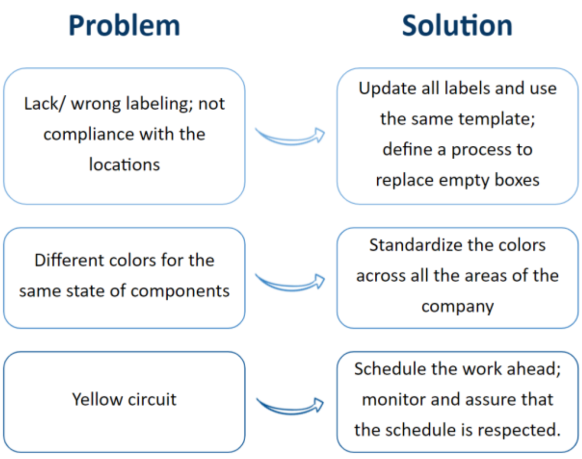

Figure 21: Summary of the other problems identified and respective solution

Assessing the lack/ wrong labeling, it was suggested to ABC a general update to their labels – switch the ones that are outdated, that refer to components that are no longer in use, by others that are missing space; print all the labels to be with the same template and contain the same type of information about respective products and define a process to replace the empty boxes. Although this solution requires the company to allocate a person temporarily to develop the labels and collect all the information regarding the components and locations, it will bring long-term benefits as it will ease the daily tasks of the operators and contribute to a cleaner and more organized workspace.

Concerning the different colors identifying the same state of the materials, it was advised that the colors should be uniformized in all the areas of the company, choosing the three more intuitive to the employees and using them to identify “New”, “To be recovered” and “Recovered” components. Once again, this solution requires recreating each label within the company, but it is simple to apply and has a significant impact on the organization and operations. It assures that components in different states are kept in different locations, avoiding situations where each component is recovered more than once or where it is used without being recovered and not complying with the standards, for being stored in the wrong location.

Finally, regarding the yellow circuit, although the circuit is theoretically well defined, in practice, the employees do not comply with the frequency. Therefore, they were recommended to schedule the week ahead, in order to define a time when the yellow circuit should be performed and assure to comply with the time set.

These three issues identified concern the poor organization and labeling within the company. As ABC is currently facing a lack of space to keep all the components and separate them according to the state of recovery, implementing measures to improve the cleanliness and organization, will help improve the use of space.

To help increase the engagement of the operators with their jobs and to motivate them to fulfill the newly defined tasks and processes, ABC was recommended to carry out a session where they would express the quantitative impact and the qualitative differences of complying with locations, activities, and defined processes. Raising awareness among the operators of the impact of their decisions and actions will make them feel more important to the company.

4.5. Digitalization

The construction of WIs was based on a software - Soft4Lean, which enabled a higher level of digitalization to the solution, compared to using more analogic methods, namely the excel.

Given the fact that the company already had SOPs developed for the referred 6 components, the employees expressed their will to have a similar template to the previous one, as they were used to it.

The software enabled adding text to describe the standards, listing the activities to follow on the SOPs, adding photos on the three documents and even to highlighting the points to focus on the photos.

However, the software already presented some previously defined templates and did not allow to change the templates or fields previously provided. For that reason, and to assure the customer had the required template, Erising had to contact the customer support team to request a specific template, equal to the one previously used in the company. Furthermore, a similar template for the Quality Standards was developed. The software team has agreed with the changes and a new template was created and added to the software, but still it was not possible to address and satisfy each detail requested by ABC.

Therefore, the documents were, almost entirely, built using the software. However, the files had to be downloaded to excel to adjust the final details, that could not be edited in Soft4Lean. It matters to mention that the low flexibility of the templates and the necessity to adjust the details on excel, which has revealed to be time-consuming, regard a handicap to the use of the software.

Nonetheless, the digitalization level of the solution could have been either lower or greater. It would have been higher if the informatics tool, which is specific for WIs, allowed the end-to-end development of the WIs and did not require the use of excel. On the other hand, the digitalization level would have been lower if the whole development of the documents had to be done and formatted manually in excel.

Comparing the excel to the software, several vantages and disadvantages could be gathered, and are represented in table 9.

Assessing the advantages of using the software, it allows to centralize all the documents developed and presents easiness on consulting and updating the existent files at any time – anyone can access the software and easily change any field of information and save it for the next time. Moreover, the user does not face any formatting issues, as the template presents empty cells to be filled, and it is even possible to fill or update them during the observations on the phone, avoiding having to register elsewhere during the observation to then insert on the software. If the user prefers, the software can also be accessed through the computer. The images to be inserted can also be added and edited on the software. The use of the software also contributes to a higher level of digitalization of the solution.

In contrast, the use of the software decreases the flexibility to adjust the layout of the WIs and Quality Standards as the template cannot be changed – neither the colors nor the fields – and the user is limited to the options provided. To overcome this issue and deliver a similar template to the one they were used to, the supplier was contacted and requested to edit some details of the current options available. Regardless it was possible to achieve a similar template, it is important to mind that this is not a scalable solution, it's not practical and may not always be possible. Apart from this, the software does not allow to calculate the average duration between observations, having these calculations to be done in excel. The use of the software requires the company to have a license for each computer that should have access to the documents. Having a fixed number of licenses limits the number of devices that can access the documents, also limiting the consultation. Unlike the excel, this software regards a new tool for most or all employees and, consequently, requires a training session for them to be familiarized and capable of using the software – to consult and, eventually, to update the documents. Excel is already installed on all devices from the company, providing easy access, and the employees are familiarized, not existing an adaptation period nor the need to pay extra licenses.

Table 9: Comparison between the use of Excel or Soft4Lean

	Soft4Lean	**Excel**
Formatting	✓ Template provided – fields to fulfill ✓ Does not require adjusts ✗ Impossibility to change the existing fields	✓ Possibility to customize all the fields ✗ Difficulties formatting manually
Construction	✓ Possibility to build the WIs on the phone, while observing the activities ✗ The average of the durations still has to be calculated in excel	✓ Allows to calculate the average duration between the observations ✗ Requires access to a computer
End-to-end	✗ Given the requirements of the company, does not allow to conclude the Wis – must be finished and customized on the excel	✓ Allows to complete all the stages and modifications required
Digitalization	✓ Higher level of digitalization	✗ Lower level of digitalization
Consultation	✓ All SOPs and documents centralized ✓ Easy to consult and edit on-spot ✗ Requires the company to have a license	✓ Simple access – no license required as it is already installed and used in ABC ✗ More documents to manage ✗ Harder to find or organize automatically
Time taken	✓ Faster to build WIs	✗ Takes longer to build the WIs, due to difficulties in formatting
Usability	✗ Requires training the employees to use it	✓ Employees already familiarized with the tool

Depending on the decision of the company to print the WIs or consult it on the computer, the choice of the tool may also be influenced. While in the first case the decision is not influenced, in the second it varies – to consult the WIs on the computer, if the software was used, the company should have a license; so an important step in the choice regards understanding if the company is willing to afford this license. For this specific case, the company decided to print the WIs and, therefore, this aspect did not weigh on the decision – Erising was the one responsible to develop the documents, so ABC did not have to afford the software and, as WIs will be printed, cannot be edited either way, so the company does not need the software to be installed on their devices. The decision to print or consult virtually must also consider the process associated with consulting the WIs on each tool – while when printing, the workers must always verify the folder, which will be shared across the operators and that will be assigned to a specific location; consulting the WIs digitally allows to do it in any location, without queues constraints, but requires the existence of individual or shared digital devices. Finally, the difficulty associated with editing printed documents is greater, as it requires editing and reprint the documents, while updating the documents on the computer does not generate anymore waste and can be done much more frequently and easily.

Besides the qualitative aspects, a key factor relies on the time each option takes to build the WIs. Aiming to understand the differences, the three documents for eight components were built on each tool, including adding the text, images and formatting. To quantify the difference on duration, the end-to-end process of developing the WI was counted when using each tool and compared, for the same component. After assessing the difference for each component, an average for the eight components was calculated. It was possible to conclude that the time was, on average, 18% smaller when using the software, leading to the conclusion that this would be faster and more efficient tool to use.

The time that each document would take to be consulted and the frequency were also considered. Having the documents printed and physically in the warehouse allows different operators to consult simultaneously different documents. Furthermore, consulting the printed documents does not require training for the employees to use the software nor requires the installation of computers on the warehouse.

Minding all the previous aspects, the WIs were developed with Soft4Lean. Due to technical limitations, as the software did not allow to implement all the ABC requirements, the template had to be downloaded to excel, where the final changes had to be done. All the final documents on Excel were made available for the company, for further updates. At the end of the process, the WIs were printed and plasticized, as the company did not want to institute the digital consultation.

4.6. Impact

Naturally, the success of a solution is measured by its impact. Therefore, the effects of the development and implementation of the defined solutions must be weighted and analyzed. Those are expected to influence different areas and people within the company and both their qualitative and quantitative impacts will be assessed. A summary of the impact of each solution, divided into three axes, is presented in figure 22.

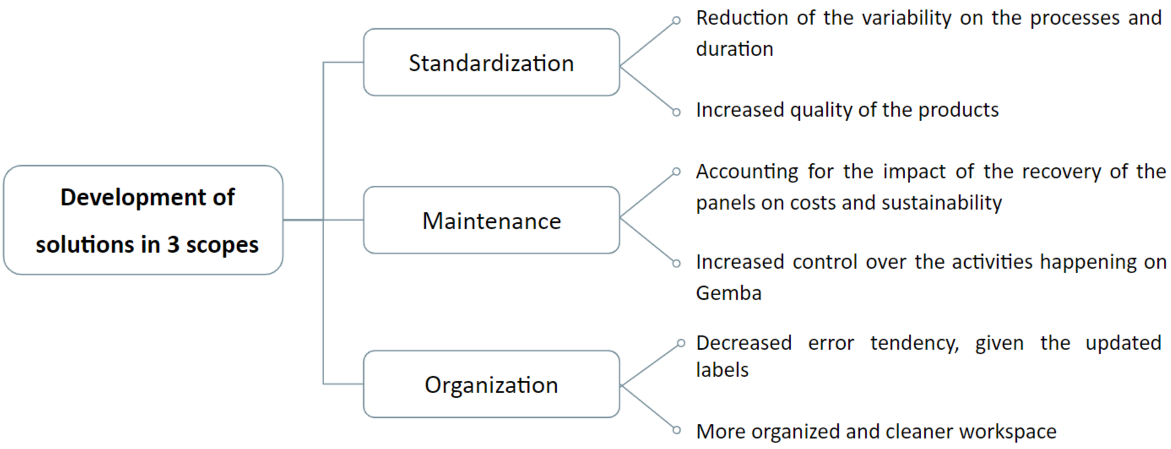

Figure 22: Summary of the impact of the solutions proposed

Although the project was carried out during the low season, its end coincided with the beginning of the high season for the company. Therefore, with the increasing workload, not all solutions could be implemented at the end of the project, and some had to be postponed to the end of the high season, allowing the company to focus all the efforts into increasing the production rate and satisfying the demand during that period.

Thereby, not all the impacts were the result of the implementation, and some had to be estimated. On the one hand, the maintenance sheet was implemented right after the project and the author of this master's thesis was able to evaluate the implementation and collect feedback. On the other hand, the company did not have enough time to implement the SOPs nor the solutions concerning the organization of the company and, consequently, the impacts were estimated based on calculations, observations and on the discussions with the company.

4.6.1. Standardization

The impact areas of standardization are expected to be extensive and include the variability felt within ABC, the final quality of the products and the safety and autonomy of the operators. Those expected impacts are quantified, to understand the real effect it should have on Gemba.

The development of SOPs and Quality Standards and the respective implementation should allow the operators to perform the end-to-end processes of recovery autonomously. Having the quality standards, the triage criteria, the processes defined, and the materials detailed should contribute to more independent workers in the recovery area, releasing the operator responsible from the triage task and from questions and doubts from the operators about the process. Furthermore, it is expected to bring greater flexibility and response capacity to the company during periods of leaves or vacations of the usually assigned workers to the recovery, as it will allow any employees to consult the documents and perform the tasks, which also has the benefit of disseminating technical knowledge among the workers and enlarging their areas of contact.

Assessing the impact on Gemba, the creation of WIs is expected to have a significant impact on the standardization of the triage and final quality criteria and on the processes themselves, avoiding situations where the components had to be recovered twice or that are used in the final product without complying with the criteria. Not only from an intern point of view but also when delivering the final product to the clients, it becomes easier to assure the quality desired is equal and achieves the same level for all the orders, depending on the purpose of the product. It also ensures that the places to keep the components before and after the recovery are respected, making the workspace tidier and the search for materials more efficient.

The fact that the documents were accompanied by images, turning the instructions more visual plays an essential role when engaging the operators. The description of the tasks was not explicit enough and there were still doubts about how to handle the materials or on the best technique to apply. The images on the quality standards present an example of which situations are acceptable or not, besides the description of the criteria, which guides the operator through his decision. Regarding the activities, when asked for their opinion and validation, the operators expressed that the images are essential, to have an example of how to proceed and handle the equipment. Moreover, as some operators are not native portuguese speakers, they struggle to understand written information. Having visual instructions also helps surpass the language barrier and makes the WI more inclusive and accessible.

The images, together with the list of materials to be used in each process, contribute to increasing the safety of the operations. As the safety equipment to be used is listed on the SOPs, it becomes easier for the operators to remember to use it. The images with examples of how the activities should be performed and how the materials should be handled help reduce hazardous situations, as the operators know the correct form to deal with each situation. Thereby, SOPs are also expected to reduce the number of accidents and health injuries.

From a management point of view, the observations of the recovery activities, besides allowing to define the processes, will also enable to estimate the duration of each process and the consumption of the associated materials, permitting a more assertive control of the activities that take place on that area and of the costs associated. Moreover, it permits to the management team to control which operators are or not efficient, depending on if they are close to the expected duration. The management team has also expressed their satisfaction with the standardization of the quality level and with the compliance with the procedures defined.

For the 35 components chosen, it was calculated the average duration of each phasis, presented in figure 23.

The triage presented an average duration of 5,28 minutes. During the observed triage activities, around 9% of the time corresponded to the operators separating different types of components that were mixed and questioning the responsible whether the component was or not able for the recovery. Those wastes are expected to be mitigated with the use of the triage quality standards and with the increased organization of ABC, decreasing each triage process in around 28 seconds, corresponding to the 9% eliminated.

To estimate the possible reduction in the recovery activities, the same method was applied. During the observations of the recovery, it was frequent that the responsible had to be consulted, as some operators were not familiarized with the process and didn't know how to proceed, and the operators would take longer gathering the materials – as they didn't know the whole process, they would pick one tool/ material at the time, instead of bringing everything needed. As expected, these leads to wastes in terms of motion. Those wastes were more representative during the recovery and accounted for approximately 15% of the recovery time. Therefore, the recovery activity is expected to decrease in 1 minute and 48 seconds.

The storage activity should be facilitated, by the better organization and updated labels, but it is not expected a significant reduction on this activity.

Overall, the total recovery process is expected to reduce its duration in **13%**.

The fact that the criteria will already be defined and not left to the discernment of the workers to decide is expected to accelerate the triage process. Moreover, the fact that the workplace becomes cleaner and more organized is also expected to contribute to decrease the average time spent searching for the components so, in fact, the decrease may be sharper than the predicted.

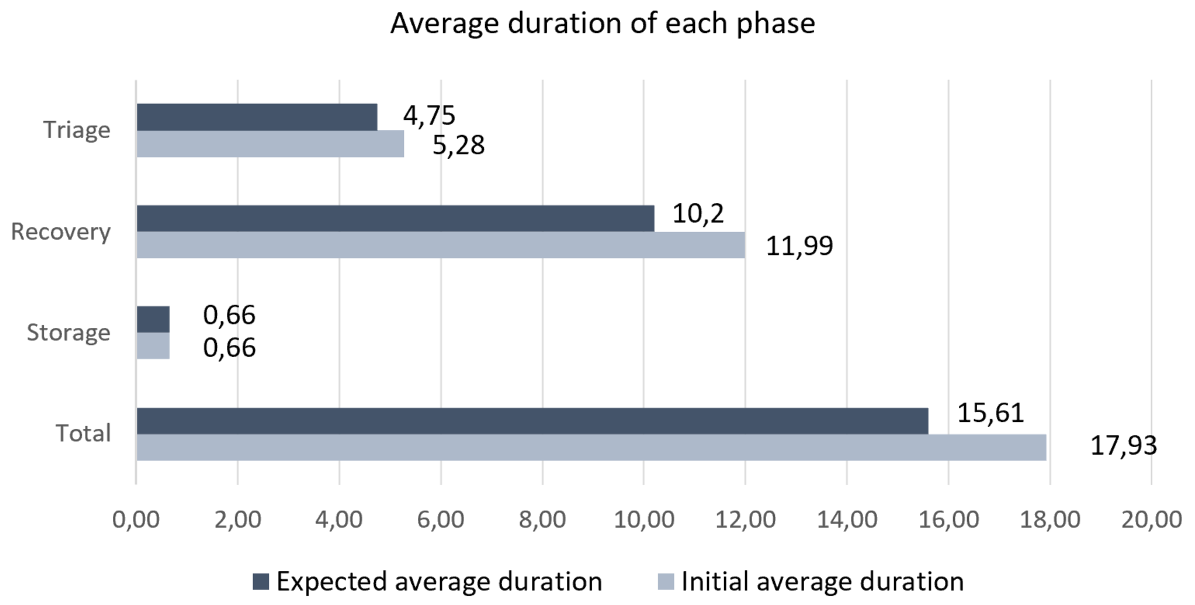

Figure 23: Comparison between initial and expected average duration for each recovery' phase

The duration of the recovery processes is expected to stabilize, and result in a reduction of the durations' variability. This is justified by the fact that now the same process is applied to each component and the activities which do not add value were removed. The operators will now be encouraged to prepare and gather all the materials and tools before starting the recovery activities, to minimize the dislocations and optimize the process. The transports between workstations and movements to gather the components and materials were also minimized.

The storage process is expected to continue with a similar duration, decreasing slightly, as the locations were already identified and it regards a very straight forward process.

From a macro perspective, the implementation of this solution is expected to permit a significant increase in the efficiency of the recovery circuit in terms of costs and compliance with the quality standards and improve the flows, regarding storage, recovery, and independence of the employees.

The estimated savings possible to achieve with this implementation were also calculated. Before starting this project, on average, around 28% of the total use of each component was recovered – while the recovery rate of some components could reach the 60%, in others it could be close to 0%. Given the aim of the company on increasing its recovery rate, due to economic and sustainable reasons, this percentage is expected to increase (recovering more quantity of components already recovered and starting to recover ones that previously were discarded, through the implementation of more WIs). Below, different possible scenarios are presented, according to the recovery rate, and its impact on costs is evaluated. All scenarios regard functional lots, as those were the ones that proved to be more beneficial. It matters to highlight that, if the recovery was done per unit instead of per functional lot, the savings would be 4% smaller, only reaching 283 776,17€ per year, on the best scenario, with 100% of all components recovered, lower than the value presented on table 10, for functional lots. It is also important to highlight that the best scenario is hard to achieve, as the company is not able to recover 100% of the returned materials, as they may not meet the triage criteria. Nonetheless, on the best scenario, the company is expected to recover 100% of the components returned and that meet the triage criteria and, therefore, are able to be recovered. The additional required working hours to deal with the increase on the recovery workload were also estimated, based on the expected duration of the tasks observed.

A likely scenario, with which ABC has agreed, regards increasing the recovery rate from 28%, current value, to 75%, and saving 211 845,59 €. This would represent a decrease of 56% on costs, which currently are 377 749,84 € per year. To estimate the value of the savings, it was considered the value the company was able to save by reusing instead of buying new – the difference between the buying and the recovering costs; which took in considerations the extra costs that the company will incur, namely with salaries, consumption of materials and overhead costs.

On table 10, the impact estimated only considers the 35 components chosen, and not the totality of the components used in the company.

To estimate the savings from the company and the extra hours needed, it was considered the following:

1. For each percentage increase on the recovery rate, ABC would stop buying the quantity that regarded that increase and would start recovering that quantity. For example, if the recovery rate was 10% for a given component and, in the previous year the company used 100 units of the component (10 recovered and 90 bought), by increasing the recovery rate to 25%, it would be considered that the company would only have to buy 75 units on the next year, allowing to save the equivalent value of 15 units, in a year.
2. Recovering more components requires more time dedicated to this activity. To estimate the number of extra hours needed, it was considered the extra quantity of components that needed to be recovered, per year, and that value was multiplied by duration of the recovery process of that component.
3. This process was repeated for each of the 35 components. For each scenario, the results were summed, regarding the savings and the extra time needed, and the decrease in the cost was considered.

4. Finally, to the savings considered, it was subtracted the labor associated with the extra hours (salary/hour * nº of extra hours), and the consumption of materials, allowing to reach the total values presented in table 10.

Table 10: Intermediate Scenarios to reach 100% of the recovery for the 35 components chosen

	CURRENT SCENARIO	INTERMEDIATE SCENARIO(1)	INTERMEDIATE SCENARIO(2)	INTERMEDIATE SCENARIO(3)	INTERMEDIATE SCENARIO(4)	FUTURE SCENARIO
COST	377 749,84 €	374 511,07 €	322 826,82 €	248 323,71 €	165 904,25 €	81 605,31 €
SAVINGS	-	3 238,77€	54 923,02€	129 426,13 €	211 845,59 €	296 144,53€
OCCUPATION / YEAR	955 h	+ 47h	+ 524 h	+ 829 h	+ 1040 h	+ 1125 h
	Average unit recuperation of 28% of each component	Recovering the remaining articles on the same proportion	Recovering, at least, 25% of each article, increasing the average to 35%	Recovering, at least, 50% of each article, increasing the average to 52%	Recovering, at least, 75% of each article, increasing the average to 75%	Recovering 100% of the 35 components on the list

Note that this analysis was performed on the first 35 components, out of the ones possible to observe. Ideally, the analysis should have been done to the 35 most impactful components, only including class A components, and, in that case, the results would be even more expressive and have a greater impact in terms of costs. If the analysis was extended to all the components used by ABC, the impact would increase exponentially and be even more significant.

To validate the alignment of expectations with the company, the team was asked what impacts they expected and anticipated for the implementation of WIs. After providing the WIs to the operators for validation, they have claimed to be very aware of the activities to be done and not having any doubt. The administrative team has stated that “WIs will clearly help us to understand if an operator is or not efficient and help the administrative team to better manage stocks, orders, and purchases”. They have also added that “We believe the intervention of Erising was very positive and will bring great benefits to our company”. Besides, given the positive expected return of this implementation, the company is already considering implementing the same solutions in other locations.

Figure 24 presents a summary of the expected impacts of standardization in the company, in terms of improving the flow of the processes and reducing the activities duration and costs for the company.

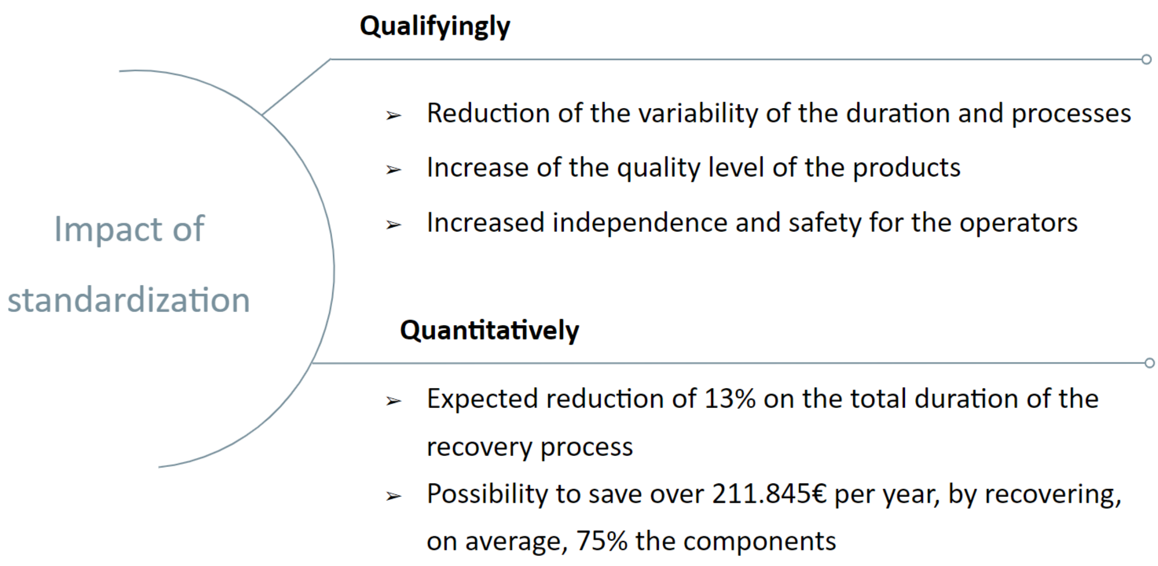

Figure 24: Expected impact of standardization in ABC

4.6.2. Implementation of the Maintenance Sheet

The implementation of the maintenance sheets intended to allow to account the panels recovered. In contrast with WIs, the company had the time to implement this solution. As ABC stated, they have faced a "significant increase on the panels recovery and are able to present much better results than the previous ones". Although the company could not quantify the difference, they assured that "it was an essential step to improve the results of the company, increase the recovery rate and allowed to understand the huge savings this activity promotes". The operators claimed that the updated maintenance sheet is very intuitive and only takes a few extra seconds to fill, giving positive feedback of the implementation.

When WIs are implemented, the benefits will be expanded, as it will also contribute to define the quality level to comply and to standardize the recovery process.

Comparing both options for recovering panels, it was possible to perceive the advantages and disadvantages of each and recommend the preferred one, according to the situation. While recovering the panels already assembled on the product, in the assembly area, has proved to be faster, the employees may have different finishing criteria, when comparing the recovery area' employees and during peaks the quality may decrease as well. Moreover, the panels can be recovered without being disassembled, avoiding wasting time. On the other hand, recovering on the recovery area, in advance, helps dealing with the high seasons. Expecting to improve the flow, ideally, the panels should be recovered assembled to the product, to decrease the times, and the operators must know the quality standards to comply. However, some panels should also be recovered, in advance, in the recovery area, to help dealing with the peaks and to assure higher quality levels.

Regarding the practical results of the implementation, the company expressed to be extremely satisfied with the achievements, shared the same solution with other locations and implemented there as well. The results were equally positive and ABC is more aware of the impact of recovering the panels and the difference it makes for the company to recover instead of using new. The operators were also alerted for the importance of their actions and effort when recovering the panels and have complied with all the indications given by the company.

Both regarding the creation of WIs and the implementation of the Maintenance Sheet, the impacts observed derive from two strands. The development of standard processes, easier to access to any worker, allows to accelerate the recovery process of the components that were already recovered and increase the quantity recovered. Additionally, the development of new WIs, for components that previously were totally discarded, permits to increase the recovery rate of ABC and improve their results.

Overall, the impact in the company was very significant and it has revealed to be essential to better manage their operations, as ABC claimed.

4.6.3. Other solutions proposed

Assessing the remaining issues identified and the solutions proposed, the main objective regarded reaching a cleaner and tidier workspace, smoothing the daily operations. Like the maintenance sheet, the company has also implemented this solution, but not totally – some labels in some locations still need to be updated. The company could not quantify the impact, and only described the benefits felt.

The update and redefinition of the labels and locations, together with the standardization of the colors that define the state of the components across the whole installations allows a visually more appealing and organized workspace, which is considered as a crucial step when applying Lean methodology.

Given the improved organization of Gemba and the different locations to keep components which are in different phasis of the recovery process, the necessary time to search for a component, either for triage or for the recovery itself is expected to decrease. The proper labelling eases the search process and the fact that it is respected - only one component and in one state is allocated to each location - allows the operator to lightly find what he is looking for.

Moreover, the correct allocation of components to the locations reduces the double work – cases where recovered components were in a location with components to be recovered – and cases where the components were used without being recovered – because components to be recovered were placed on recovered areas – resulting in fewer failures when complying with the quality criteria of the company.

It also enables a better management of the job on the shopfloor – visually, an operator is able to estimate if the quantity recovered will be enough to fulfill the demand in a given period (e.g. a day) or if it will be necessary to recover more of a given component. As the components are not mixed anymore, the operator is sure that the total quantity at a given location is ready to be recovered or used.

The compliance and signaling of each location also decreased the operators' errors when storing the materials or picking the required components for a given order.

Assuring the compliance with the due frequency of the yellow circuit will also contribute to keeping the workplace tidier and permit to schedule the recovery in advance, to better deal with the demand.

Despite concerning easier to solve issues, improving the organization of the shopfloor presents great advantages on the daily operations and results of the company. The use of the space is improved, the time spent searching for a component or material is decreased and the errors and lacks of compliance also decreased as the labels have been updated and the operators become more motivated to keep their workplace cleaner.

5. Conclusions

The work developed was based on a consultancy project for a company. ABC was facing low efficiency rates regarding the recovery process, lacking defined procedures to assure the quality levels desired and could not monitor the recovery and impact of the panels, which represented a significant part of the costs for the company. From a macro perspective, the company also felt hindrances in terms of organization, which prevented a smooth flow.

Given the economic and efficiency issues, ABC required a consultancy project, aiming to reduce their costs and improve their sustainability metrics, by increasing the quantity of materials recovered, and incorporating them into their products. The objective included identifying pain points and wastes associated with the recovery process and proposing Lean-based solutions.

Initially, to provide a theoretical framework and to understand the current context and evolution of Lean methodologies and Working Instructions, a bibliographic review was handled. Lean practices have been widely used across the globe and implemented in different types of industries with great success. Working Instructions have also presented positive results and, therefore, the conjugation of these options appeared to satisfy the requirements of the company and solve the problems identified. In fact, both solutions contributed to increase the standardization level of the company. The impacts, as a result of standardization, are aligned with the objective of the Lean methodology. The implementation of 5S, VSM and the Lean principles was essential when identifying value-added activities and eliminating waste, during the observation of the recovery process. The solutions contributed to improving the flows and increasing the efficiency of the operations.

The next step regarded analyzing minutely the operations and flows, identifying the main obstacles and the respective root causes. Interviewing employees from different hierarchical levels across the organization allowed perceiving their insights, issues felt and prioritizing the problems. By gathering their opinion, it was possible to conclude that the company presented a low standardization level, without documented or defined procedures for most activities. The management team had difficulties following and monitoring the activities happening on Gemba and could not account for the panels recovered. Moreover, there was lack of compliance with the defined locations for the materials as well as wrong/ outdated labels. Minding the pain-points, it was possible to focus the action on two axes: documenting and standardizing the recovery activities for components and improving the maintenance sheet to allow the account of the panels recovered. The involvement of the teams was crucial during the diagnosis and during the development of solutions, to assure the course of action was aligned with the needs.

The root causes were considered to be the low standardization level, poor communication between the management and the operational team and inertia from ABC to implement the necessary changes, due to constantly being overloaded. Identifying those root causes underpinned the solutions and guided ABC and the consultancy team on how to solve the problems faced and the key improvement points to focus on.

The methodology used to build the diagnosis included handling several meetings with both the management and the operational team, analyzing documents from the company to estimate costs, rotativity and needs and observing the recovery tasks. In fact, the analysis permitted to infer that, out of the 370 components, 221 are recovered according to the sensibility of the operator and only 6 have standardized and documented procedures. Overall, 16,8% of the components used are recovered, being the remaining discarded, which constituted a significant loss for the company. Due to the lack of documentation, a great variability on the duration, recovery processes and criteria was verified. It impacted not only the efficiency and production capability of the company but also the quality of the final product and, in some cases, the customer' satisfaction. Lastly, the panels account for 40% of the company costs related to materials, and represent over 50% of the final product' cost, highlighting the importance of a proper management and monitoring of these components.

ABC has identified its main priorities – reducing costs, increasing efficiency, standardizing and documenting the recovery processes and accounting for the panels recovered – which were the basis when looking for an adequate solution. The observations of the activities permitted to identify wastes and value-added activities and propose new, improved processes. Those processes were documented in SOPs and, besides this, two additional documents were created for each component: Triage QS and Final QS, where the quality that the component should meet, respectively, after each phase is detailed. The maintenance sheet was updated, removing repeated or obsolete tasks and releasing space to describe the number and type of panels recovered – enabling the management team to account for them on the company's KPIs.

For the project, the company expressed the will to document the processes for 35 components. An ABC analysis was performed, which allowed to order the components according to their impact, in terms of costs for the company, considering their price and rotativity. A Cost-Benefit analysis was also performed, that intended to understand which components were worth to recover, based on several aspects. The WIs were created for the first 35 most impactful components, that were worth to recover and possible to observe.

The implementation of the proposed solutions is recommended to be accompanied by a clarification session to the operators, to describe how to use them, and to underline the impact the operators' actions have on the performance of the company. The solutions are expected to contribute to a cleaner and more organized workspace, improving the flows and efficiency, while reducing costs. They also should contribute to more independent operators and facilitate the fulfillment of leaves or vacations. Finally, the solutions should enable the company to comply with the sustainability metrics and improve the quality of the product. The increase in the standardization level is associated with the definition of processes and uniformization across the company, including labels, colors and standards.

Quantitatively, the creation of WIs is expected to reduce the triage, recovery and storage process in 2,3 minutes and the operators' errors and the variation associated with the recovery. Increasing the recovery percentage of these 35 components to 75%, will allow savings of 211 845€ - representing a 56% reduction on costs, which would be even more expressive if all the components belonged to class A or if the standardization was extended to all possible components. Regardless, it will also require more labor to complete the recovery. Regarding the panels, the implementation of the maintenance sheet allowed a very expressive improvement in the accounting process, besides providing closer control over the operations on Gemba.

It also matters to highlight that the 35 components selected only represent 9%, in terms of quantity, of all the components that ABC works with, meaning that there is still a very

Overall, the implementation of these solutions has brought to the company very positive results and significantly impacted its operations. The impacts are expected to be maximized after the implementation of the remaining solutions. The management team has recognized the potential of Lean principles and Working Instructions and demonstrated to be extremely satisfied with the proposals.

6. Future Work

The work developed along the project and this master's thesis regards only the beginning of a long process.

Defining and developing solutions to fulfill the needs of the company constituted the first part of the project. The next step regards implementing the remaining solutions on Gemba and guiding the company towards the best practices to do it. Below, there are proposed steps to a smooth implementation, both for the SOPs and quality standards:

1. Define a procedure to follow when using the solution and a location to put the documents (with the responsible team);
2. Promote a clarifying session with the operators, explaining how the solution works, the process they must follow to use it, defined in step (1), the impact that the solutions will have on the company and the importance of complying with it;
3. Implement the solution on Gemba;
4. Monitor the operators initially and motivate them to use the solution – initially the operators may present some resistance and persist in recovering according to their sensibility;
5. Assure refreshment sessions and update the documents when they become outdated.

As stated before, there were only developed documents and standardized processes for 35 components, corresponding to approximately 9% of the total components that ABC works with. Therefore, the company was advised to define the processes for the remaining components, especially for class A, given the greater impact, and build WIs to assist the recovery. The company was also recommended to explore digital tools and implement them on Gemba, given the growing tendency for digitalization and the proven positive results of its implementation.

To increase the motivation of the company on improving its practices, ABC could create a department at a national level or allocate an employee responsible for continuous improvement and for implementing Lean practices. The department would be responsible for developing the remaining documents, monitoring the implementation and adjusting the process according to the feedback and the reality on Gemba, and even assessing other issues felt across the shopfloor and proposing solutions to mitigate them. Following the Lean Principles, companies are able to continuously improve their performance, processes and results, through the application of methods adjusted to their realities. Due to the low standardization level of ABC, the company can benefit significantly from the creation of such department.

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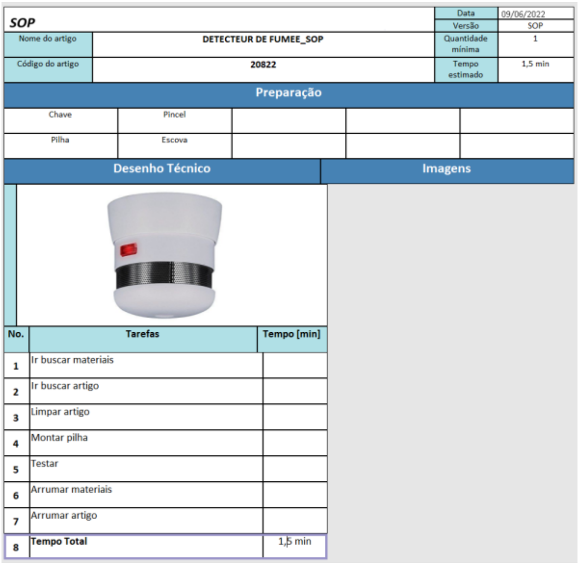
Appendix

Appendix 1. Examples of Working Instructions developed for some of the 35 components

Appendix 1.1. SOP for component 20822 (left) and SOP for component 27151 (right)



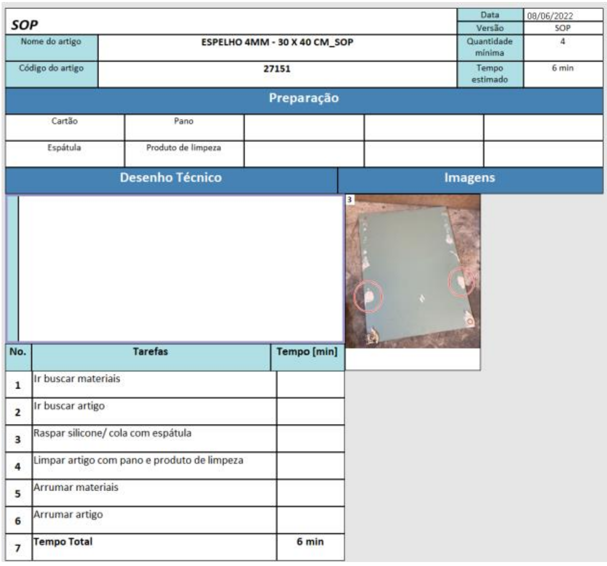
SOP		Data	09/06/2022
		Versão	SOP
Nome do artigo	DETECTEUR DE FUMEE_SOP	Quantidade mínima	1
Código do artigo	20822	Tempo estimado	1,5 min

Preparação

Chave	Pincel			
Pilha	Escova			

Desenho Técnico — Imagens

No.	Tarefas	Tempo [min]
1	Ir buscar materiais	
2	Ir buscar artigo	
3	Limpar artigo	
4	Montar pilha	
5	Testar	
6	Arrumar materiais	
7	Arrumar artigo	
8	**Tempo Total**	1,5 min



SOP		Data	08/06/2022
		Versão	SOP
Nome do artigo	ESPELHO 4MM - 30 X 40 CM_SOP	Quantidade mínima	4
Código do artigo	27151	Tempo estimado	6 min

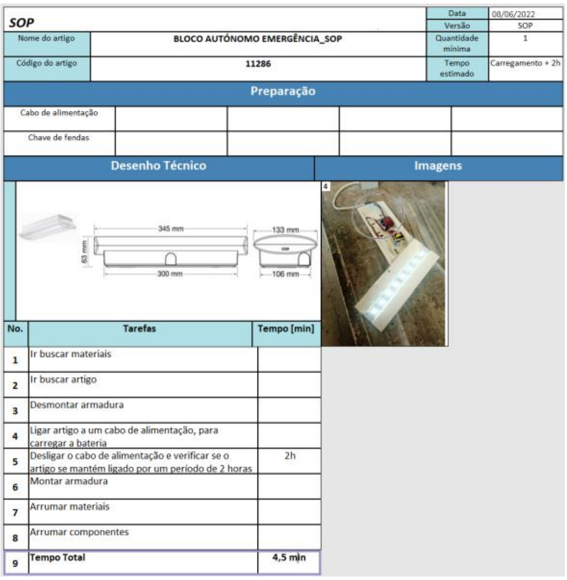
Preparação

Cartão	Pano			
Espátula	Produto de limpeza			

Desenho Técnico — Imagens

No.	Tarefas	Tempo [min]
1	Ir buscar materiais	
2	Ir buscar artigo	
3	Raspar silicone/ cola com espátula	
4	Limpar artigo com pano e produto de limpeza	
5	Arrumar materiais	
6	Arrumar artigo	
7	**Tempo Total**	**6 min**

Appendix 1.2. SOP for component 11286 (left) and SOP for component 32782 (right)



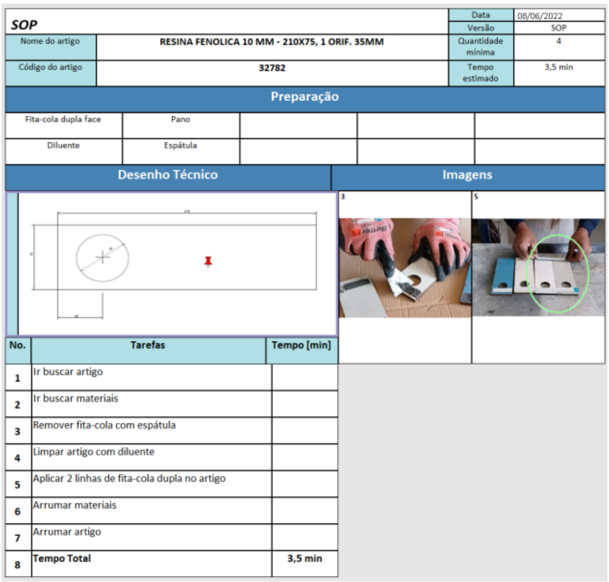
SOP		Data	08/06/2022
		Versão	SOP
Nome do artigo	BLOCO AUTÓNOMO EMERGÊNCIA_SOP	Quantidade mínima	1
Código do artigo	11286	Tempo estimado	Carregamento + 2h

Preparação

Cabo de alimentação				
Chave de fendas				

Desenho Técnico — Imagens

No.	Tarefas	Tempo [min]
1	Ir buscar materiais	
2	Ir buscar artigo	
3	Desmontar armadura	
4	Ligar artigo a um cabo de alimentação, para carregar a bateria	
5	Desligar o cabo de alimentação e verificar se o artigo se mantém ligado por um período de 2 horas	2h
6	Montar armadura	
7	Arrumar materiais	
8	Arrumar componentes	
9	**Tempo Total**	**4,5 min**



SOP		Data	08/06/2022
		Versão	SOP
Nome do artigo	RESINA FENOLICA 10 MM - 210X75, 1 ORIF. 35MM	Quantidade mínima	4
Código do artigo	32782	Tempo estimado	3,5 min

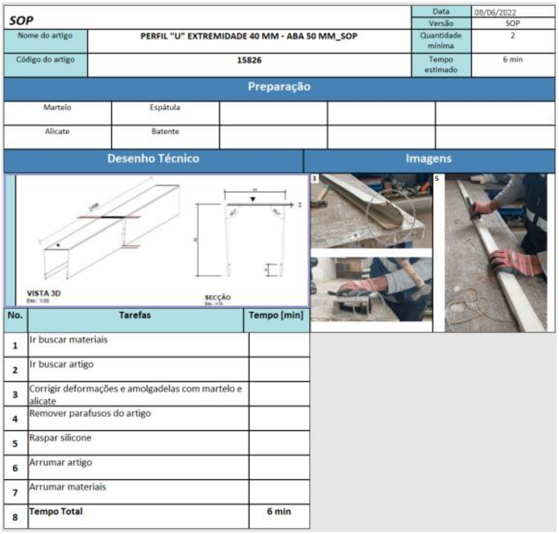
Preparação

Fita-cola dupla face	Pano			
Diluente	Espátula			

Desenho Técnico — Imagens

No.	Tarefas	Tempo [min]
1	Ir buscar artigo	
2	Ir buscar materiais	
3	Remover fita-cola com espátula	
4	Limpar artigo com diluente	
5	Aplicar 2 linhas de fita-cola dupla no artigo	
6	Arrumar materiais	
7	Arrumar artigo	
8	**Tempo Total**	**3,5 min**

Appendix 1.3. SOP for component 15826 (left) and SOP for component 11653 (right)



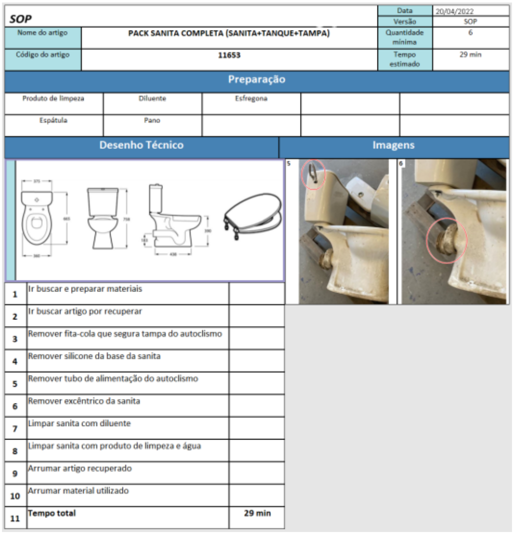
SOP		Data	08/06/2022
		Versão	SOP
Nome do artigo	PERFIL "U" EXTREMIDADE 40 MM - ABA 50 MM_SOP	Quantidade mínima	2
Código do artigo	15826	Tempo estimado	6 min

Preparação

Martelo	Espátula			
Alicate	Batente			

Desenho Técnico | **Imagens**

No.	Tarefas	Tempo [min]
1	Ir buscar materiais	
2	Ir buscar artigo	
3	Corrigir deformações e amolgadelas com martelo e alicate	
4	Remover parafusos do artigo	
5	Raspar silicone	
6	Arrumar artigo	
7	Arrumar materiais	
8	Tempo Total	6 min



SOP		Data	20/04/2022
		Versão	SOP
Nome do artigo	PACK SANITA COMPLETA (SANITA+TANQUE+TAMPA)	Quantidade mínima	6
Código do artigo	11653	Tempo estimado	29 min

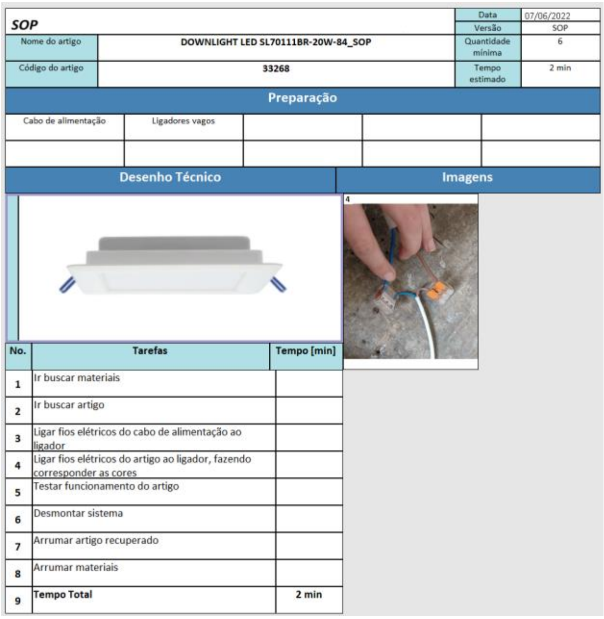
Preparação

Produto de limpeza	Diluente	Esfregona		
Espátula	Pano			

Desenho Técnico | **Imagens**

1	Ir buscar e preparar materiais	
2	Ir buscar artigo por recuperar	
3	Remover fita-cola que segura tampa do autoclismo	
4	Remover silicone da base da sanita	
5	Remover tubo de alimentação do autoclismo	
6	Remover excêntrico da sanita	
7	Limpar sanita com diluente	
8	Limpar sanita com produto de limpeza e água	
9	Arrumar artigo recuperado	
10	Arrumar material utilizado	
11	Tempo total	29 min

Appendix 1.4. SOP for component 33268 (left) and SOP for component 11709 (right)



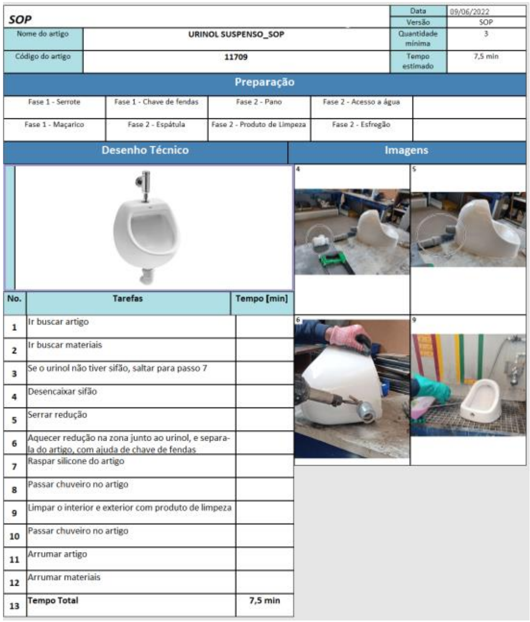
SOP		Data	07/06/2022
		Versão	SOP
Nome do artigo	DOWNLIGHT LED SL70111BR-20W-84_SOP	Quantidade mínima	6
Código do artigo	33268	Tempo estimado	2 min

Preparação

Cabo de alimentação	Ligadores vagos			

Desenho Técnico | **Imagens**

No.	Tarefas	Tempo [min]
1	Ir buscar materiais	
2	Ir buscar artigo	
3	Ligar fios elétricos do cabo de alimentação ao ligador	
4	Ligar fios elétricos do artigo ao ligador, fazendo corresponder as cores	
5	Testar funcionamento do artigo	
6	Desmontar sistema	
7	Arrumar artigo recuperado	
8	Arrumar materiais	
9	Tempo Total	2 min



SOP		Data	09/06/2022
		Versão	SOP
Nome do artigo	URINOL SUSPENSO_SOP	Quantidade mínima	3
Código do artigo	11709	Tempo estimado	7,5 min

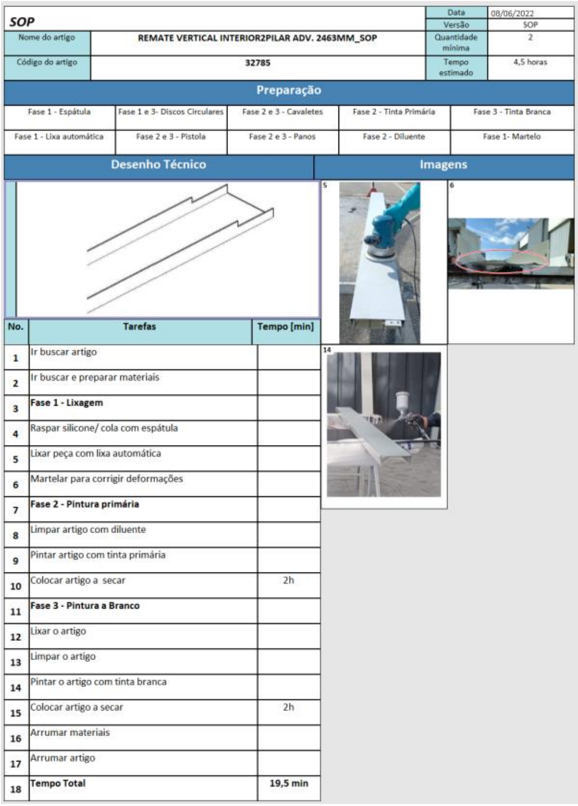
Preparação

Fase 1 - Serrote	Fase 1 - Chave de fendas	Fase 2 - Pano	Fase 2 - Acesso a água	
Fase 1 - Maçarico	Fase 2 - Espátula	Fase 2 - Produto de Limpeza	Fase 2 - Esfregão	

Desenho Técnico | **Imagens**

No.	Tarefas	Tempo [min]
1	Ir buscar artigo	
2	Ir buscar materiais	
3	Se o urinol não tiver sifão, saltar para passo 7	
4	Desencaixar sifão	
5	Serrar redução	
6	Aquecer redução na zona junto ao urinol, e separa-la do artigo, com ajuda de chave de fendas	
7	Raspar silicone do artigo	
8	Passar chuveiro no artigo	
9	Limpar o interior e exterior com produto de limpeza	
10	Passar chuveiro no artigo	
11	Arrumar artigo	
12	Arrumar materiais	
13	Tempo Total	7,5 min

Appendix 1.5. SOP for component 32785 (left) and SOP for component 19938 (right)

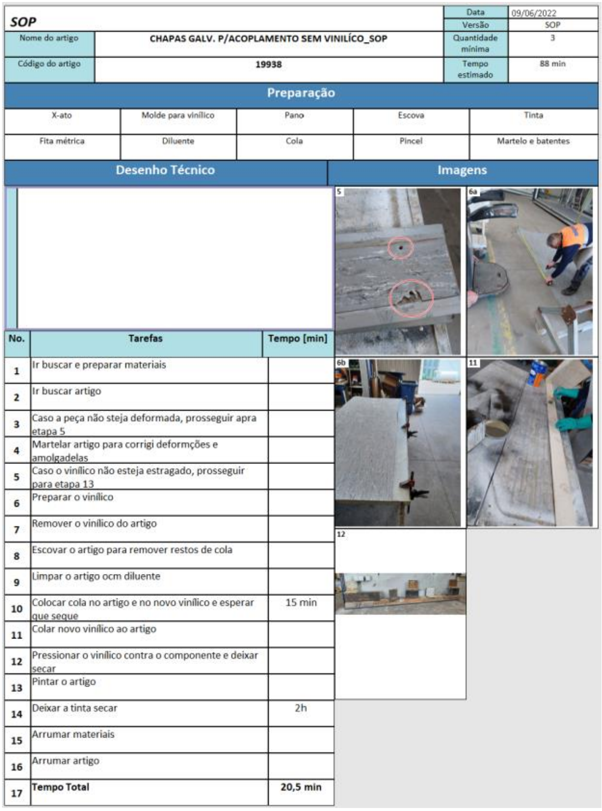


SOP		Data	08/06/2022
		Versão	SOP
Nome do artigo	REMATE VERTICAL INTERIOR2PILAR ADV. 2463MM_SOP	Quantidade mínima	2
Código do artigo	32785	Tempo estimado	4,5 horas

Preparação				
Fase 1 - Espátula	Fase 1 e 3- Discos Circulares	Fase 2 e 3 - Cavaletes	Fase 2 - Tinta Primária	Fase 3 - Tinta Branca
Fase 1 - Lixa automática	Fase 2 e 3 - Pistola	Fase 2 e 3 - Panos	Fase 2 - Diluente	Fase 1- Martelo

Desenho Técnico | Imagens

No.	Tarefas	Tempo [min]
1	Ir buscar artigo	
2	Ir buscar e preparar materiais	
3	**Fase 1 - Lixagem**	
4	Raspar silicone/ cola com espátula	
5	Lixar peça com lixa automática	
6	Martelar para corrigir deformações	
7	**Fase 2 - Pintura primária**	
8	Limpar artigo com diluente	
9	Pintar artigo com tinta primária	
10	Colocar artigo a secar	2h
11	**Fase 3 - Pintura a Branco**	
12	Lixar o artigo	
13	Limpar o artigo	
14	Pintar o artigo com tinta branca	
15	Colocar artigo a secar	2h
16	Arrumar materiais	
17	Arrumar artigo	
18	**Tempo Total**	**19,5 min**



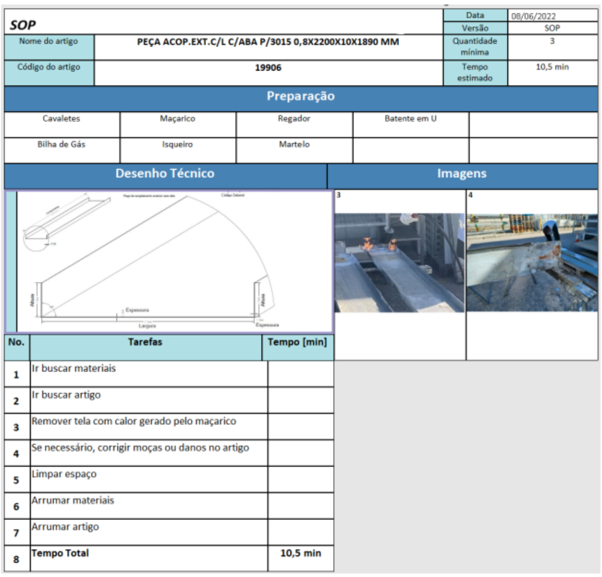
SOP		Data	09/06/2022
		Versão	SOP
Nome do artigo	CHAPAS GALV. P/ACOPLAMENTO SEM VINILÍCO_SOP	Quantidade mínima	3
Código do artigo	19938	Tempo estimado	88 min

Preparação				
X-ato	Molde para vinílico	Pano	Escova	Tinta
Fita métrica	Diluente	Cola	Pincel	Martelo e batentes

Desenho Técnico | Imagens

No.	Tarefas	Tempo [min]
1	Ir buscar e preparar materiais	
2	Ir buscar artigo	
3	Caso a peça não steja deformada, prosseguir apra etapa 5	
4	Martelar artigo para corrigi deformções e amolgadelas	
5	Caso o vinílico não esteja estragado, prosseguir para etapa 13	
6	Preparar o vinílico	
7	Remover o vinílico do artigo	
8	Escovar o artigo para remover restos de cola	
9	Limpar o artigo ocm diluente	
10	Colocar cola no artigo e no novo vinílico e esperar que seque	15 min
11	Colar novo vinílico ao artigo	
12	Pressionar o vinílico contra o componente e deixar secar	
13	Pintar o artigo	
14	Deixar a tinta secar	2h
15	Arrumar materiais	
16	Arrumar artigo	
17	**Tempo Total**	**20,5 min**

Appendix 1.6. SOP for component 19906 (left) and SOP for component 10976 (right)

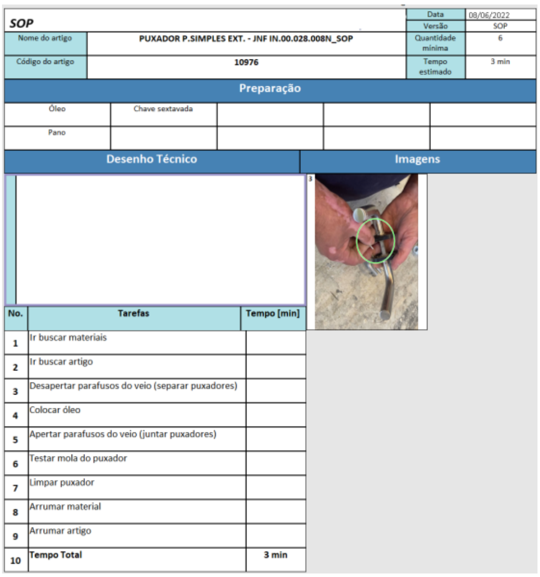


SOP		Data	08/06/2022
		Versão	SOP
Nome do artigo	PEÇA ACOP.EXT.C/L C/ABA P/3015 0,8X2200X10X1890 MM	Quantidade mínima	3
Código do artigo	19906	Tempo estimado	10,5 min

Preparação				
Cavaletes	Maçarico	Regador	Batente em U	
Bilha de Gás	Isqueiro	Martelo		

Desenho Técnico | Imagens

No.	Tarefas	Tempo [min]
1	Ir buscar materiais	
2	Ir buscar artigo	
3	Remover tela com calor gerado pelo maçarico	
4	Se necessário, corrigir moças ou danos no artigo	
5	Limpar espaço	
6	Arrumar materiais	
7	Arrumar artigo	
8	**Tempo Total**	**10,5 min**



SOP		Data	08/06/2022
		Versão	SOP
Nome do artigo	PUXADOR P.SIMPLES EXT. - JNF IN.00.028.008N_SOP	Quantidade mínima	6
Código do artigo	10976	Tempo estimado	3 min

Preparação				
Óleo	Chave sextavada			
Pano				

Desenho Técnico | Imagens

No.	Tarefas	Tempo [min]
1	Ir buscar materiais	
2	Ir buscar artigo	
3	Desapertar parafusos do veio (separar puxadores)	
4	Colocar óleo	
5	Apertar parafusos do veio (juntar puxadores)	
6	Testar mola do puxador	
7	Limpar puxador	
8	Arrumar material	
9	Arrumar artigo	
10	**Tempo Total**	**3 min**

Appendix 1.7. SOP for component 17845 (left) and SOP for component 17843 (right)

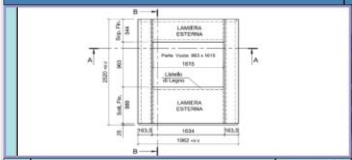
SOP

		Data	02/05/2022
		Versão	SOP
Nome do artigo	PAINEL JANELA (1606X950) CEGO M1 041 1962X2520 G/G_SOP	Quantidade mínima	2
Código do artigo	17845	Tempo estimado	75 min

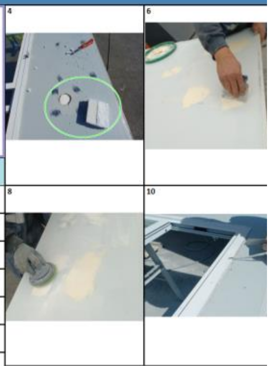
Preparação

Martelo	Betume e Endurecedor	Discos circulares P60	Espátulas	Desengordurante
Esferovite e X-ato	Lixa	Discos circulares PECOL	Soprador	

Desenho Técnico



Imagens



No.	Tarefas	Tempo [min]
1	Ir buscar artigo	
2	Ir buscar e preparar material	
3	Lixar zona onde vai ser colocado betume (deformações e furos)	
4	Pôr esferovite nos furos maiores, de forma a tapa-los	
5	Preparar o betume	
6	Colocar o betume de forma a tapar furos e deformações	
7	Deixar o betume secar	20 min
8	Lixar o betume com discos circulares	
9	Limpar artigo com soprador e desengordurante	
10	Remover silicone à volta da janela	
11	Arrumar materiais	
12	Arrumar artigo	
13	**Tempo Total**	55 min

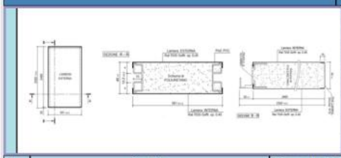
SOP

		Data	10/06/2022
		Versão	SOP
Nome do artigo	PAINEL CEGO M1 041 0981X2520 GOF/GOF_SOP	Quantidade mínima	11
Código do artigo	17843	Tempo estimado	39,5

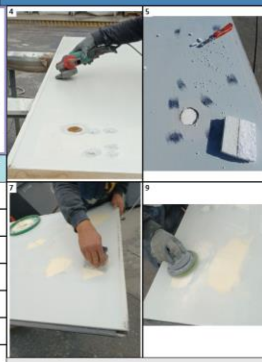
Preparação

Martelo	Lixa	Discos circulares PECOL	Desengordurante	
Betume e Endurecedor	Discos circulares P60	Espátulas	Esferovite	

Desenho Técnico



Imagens



No.	Tarefas	Tempo [min]
1	Ir buscar e preparar materiais	
2	Ir buscar artigo	
3	Martelar para corrigir deformações	
4	Lixar zona onde vai ser colocado betume (deformações e furos)	
5	Por esferovite nos furos, de forma a tapa-los	
6	Preparar o betume	
7	Colocar o betume de forma a tapar furos e deformações	
8	Deixar o betume secar	20 min
9	Lixar o betume com discos circulares	
10	Limpar o artigo com desengordurante	
11	Raspar com espátula	
12	Limpar e arrumar material	
13	Arrumar artigo	
14	**Tempo Total**	19,5 min

Appendix 1.8. SOP for component 20657 (left) and SOP for component 17826 (right)

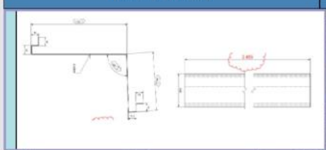
SOP

		Data	09/06/2022
		Versão	SOP
Nome do artigo	CANTO CEGO 2470X346X0.8 (6115-6117)_SOP	Quantidade mínima	4
Código do artigo	20657	Tempo estimado	4,8 horas

Preparação

Fase 1 - Lixa automática e discos circulares	Fase 1 - Espátula	Fase 2 - Tinta Primária	Fase 2 e 3 - Panos	Fase 3 - Discos Circulares
Fase 1 - Martelo e batente	Fase 1 - Suporte para artigo	Fase 2 -Diluente	Fase 2 e 3 - Pistola	Fase 3 - Tinta branca

Desenho Técnico



Imagens

No.	Tarefas	Tempo [min]
1	Ir buscar e preparar materiais	
2	Ir buscar artigo	
3	**Fase 1 - Lixagem**	
4	Martelar para corrigir deformações	
5	Raspar silicone/ cola	
6	Lixar o artigo com a lixa automática	
7	**Fase 2 - Pintura Primária**	
8	Limpar o artigo com diluente	
9	Pintar o artigo com tinta primária	
10	Colocar artigo a secar durante 2 horas	
11	**Fase 3 - Pintura a branco**	
12	Lixar o artigo com discos circulares	
13	Limpar o artigo	
14	Pintar o artigo com tinta branca	
15	Colocar o artigo a secar durante 2 horas	
16	Arrumar e limpar materiais	
17	Arrumar artigo	
18	**Tempo Total**	52,5 min

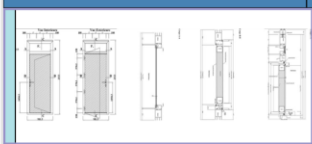
SOP

		Data	07/06/2022
		Versão	SOP
Nome do artigo	P. PORTA 1F CEGA DIR. 041 0981X2520. R9010_SOP	Quantidade mínima	1
Código do artigo	17826	Tempo estimado	55 min

Preparação

X-ato	Endurecedor	Discos circulares abrasivo	Desengordurante	Compressor
Betume	Discos circulares P60	Espátulas	Cavaletes	

Desenho Técnico

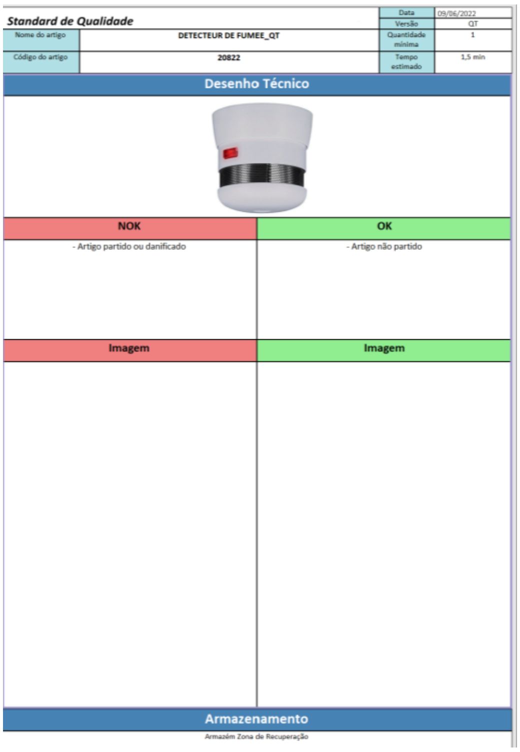


Imagens

1	Ir buscar e preparar material	
2	Ir buscar artigo por recuperar e apoiá-lo sobre os cavaletes	
3	Remover autocolantes e fita colas	
4	Desbastar zonas em que existam mossas ou furos no painél (usar o disco abrasivo)	
5	Preparar betume	
6	Colocar o betume de forma a preencher zonas com furos e deformações	
7	Repetir tarefas 3, 4 e 6 para o outro lado do painel	
8	Deixar o betume secar durante 20 minutos	
9	Lixar o betume e superfície do painel (disco P60)	
10	Remover pó da superfície recorrendo ao compressor	
11	Limpeza da superfície com desengordurante	
12	Arrumar artigo recuperado na zona indicada	
13	Arrumar material	
14	**Tempo total**	20 min

Appendix 2. Examples of Quality Standards developed for some of the 35 components

Appendix 2.1. Triage QS (left) and Final QS (right) for component 20822



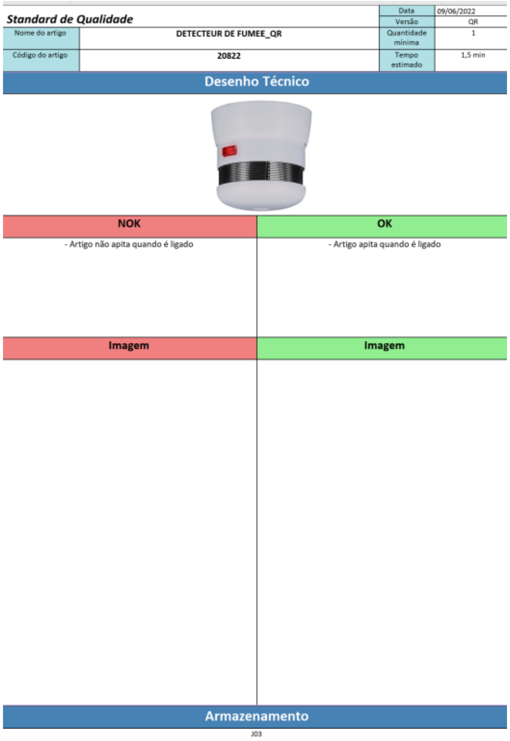
Standard de Qualidade		Data	09/06/2022
		Versão	QT
Nome do artigo	DETECTEUR DE FUMEE_QT	Quantidade mínima	1
Código do artigo	20822	Tempo estimado	1,5 min

Desenho Técnico

NOK	OK
- Artigo partido ou danificado	- Artigo não partido
Imagem	Imagem

Armazenamento

Armazém Zona de Recuperação



Standard de Qualidade		Data	09/06/2022
		Versão	QR
Nome do artigo	DETECTEUR DE FUMEE_QR	Quantidade mínima	1
Código do artigo	20822	Tempo estimado	1,5 min

Desenho Técnico

NOK	OK
- Artigo não apita quando é ligado	- Artigo apita quando é ligado
Imagem	Imagem

Armazenamento

J03

Appendix 2.2. Triage QS (left) and Final QS (right) for component 27151

Standard de Qualidade		Data	08/06/2022
		Versão	QT
Nome do artigo	ESPELHO 4MM - 30 X 40 CM	Quantidade mínima	4
Código do artigo	27151	Tempo estimado	6 min

Desenho Técnico

NOK	OK
- Artigo partido ou rachado	- Artigo sujo - Artigo com restos de cola ou silicone
Imagem	Imagem

Armazenamento

Armazém Zona de Recuperação

Standard de Qualidade		Data	08/06/2022
		Versão	QR
Nome do artigo	ESPELHO 4MM - 30 X 40 CM	Quantidade mínima	4
Código do artigo	27151	Tempo estimado	6 min

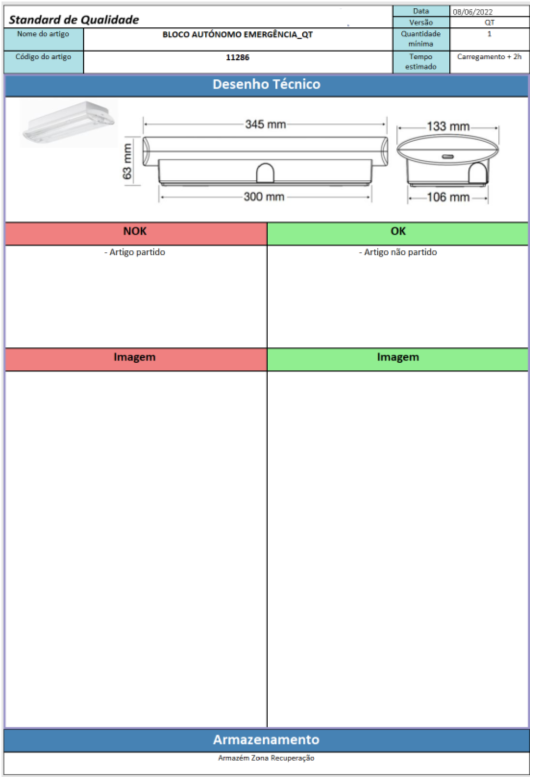
Desenho Técnico

NOK	OK
- Artigo sujo - Artigo com restos de cola ou silicone	- Artigo limpo - Artigo sem restos de silicone ou cola
Imagem	Imagem

Armazenamento

J03

Appendix 2.3. Triage QS (left) and Final QS (right) for component 11286



Standard de Qualidade		Data	08/06/2022
		Versão	QT
Nome do artigo	**BLOCO AUTÓNOMO EMERGÊNCIA_QT**	Quantidade mínima	1
Código do artigo	**11286**	Tempo estimado	Carregamento + 2h

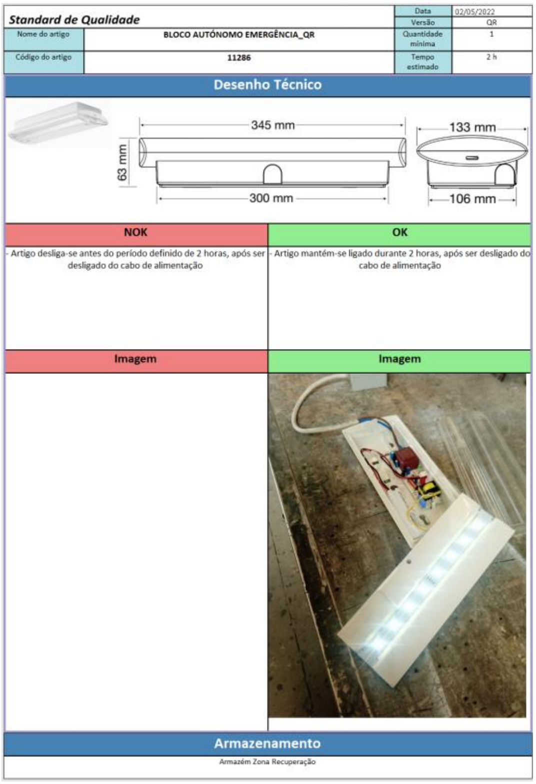
Desenho Técnico

NOK	OK
- Artigo partido	- Artigo não partido

Imagem	Imagem

Armazenamento

Armazém Zona Recuperação



Standard de Qualidade		Data	02/05/2022
		Versão	QR
Nome do artigo	**BLOCO AUTÓNOMO EMERGÊNCIA_QR**	Quantidade mínima	1
Código do artigo	**11286**	Tempo estimado	2 h

Desenho Técnico

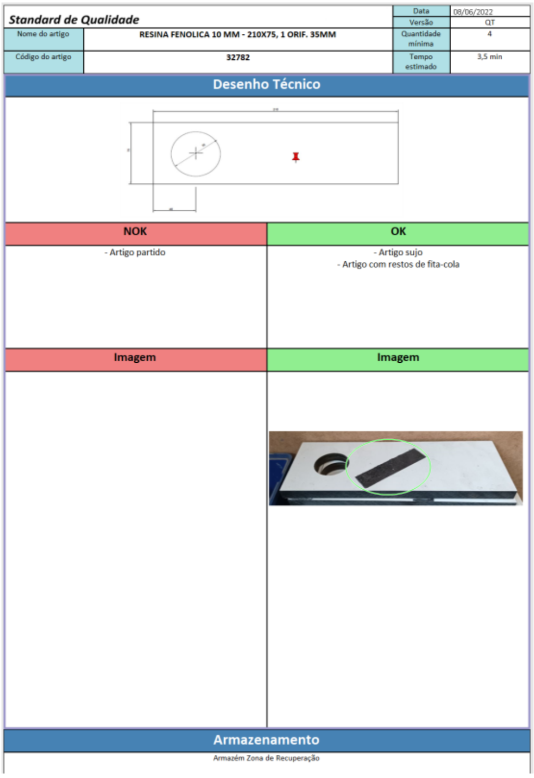
NOK	OK
- Artigo desliga-se antes do período definido de 2 horas, após ser desligado do cabo de alimentação	- Artigo mantém-se ligado durante 2 horas, após ser desligado do cabo de alimentação

Imagem	Imagem

Armazenamento

Armazém Zona Recuperação

Appendix 2.4. Triage QS (left) and Final QS (right) for component 32782



Standard de Qualidade		Data	08/06/2022
		Versão	QT
Nome do artigo	**RESINA FENOLICA 10 MM - 210X75, 1 ORIF. 35MM**	Quantidade mínima	4
Código do artigo	**32782**	Tempo estimado	3,5 min

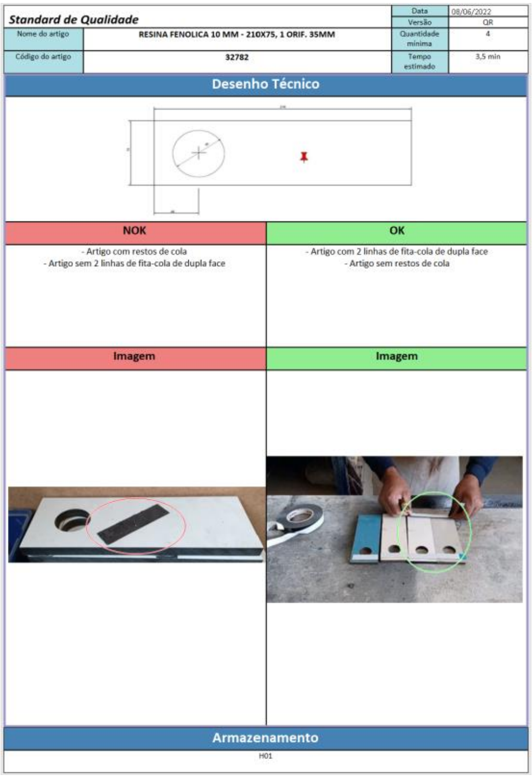
Desenho Técnico

NOK	OK
- Artigo partido	- Artigo sujo - Artigo com restos de fita-cola

Imagem	Imagem

Armazenamento

Armazém Zona de Recuperação



Standard de Qualidade		Data	08/06/2022
		Versão	QR
Nome do artigo	**RESINA FENOLICA 10 MM - 210X75, 1 ORIF. 35MM**	Quantidade mínima	4
Código do artigo	**32782**	Tempo estimado	3,5 min

Desenho Técnico

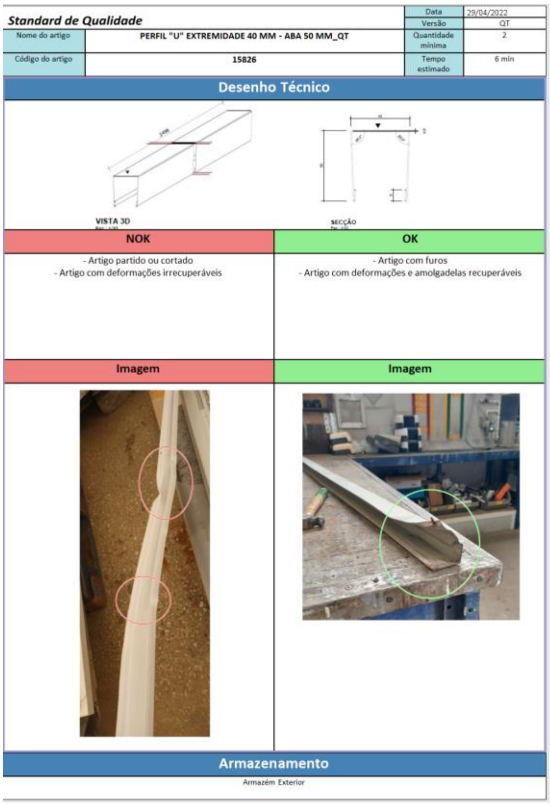
NOK	OK
- Artigo com restos de cola - Artigo sem 2 linhas de fita-cola de dupla face	- Artigo com 2 linhas de fita-cola de dupla face - Artigo sem restos de cola

Imagem	Imagem

Armazenamento

H01

Appendix 2.5. Triage QS (left) and Final QS (right) for component 15826



Standard de Qualidade		Data	29/04/2022
		Versão	QT
Nome do artigo	PERFIL "U" EXTREMIDADE 40 MM - ABA 50 MM_QT	Quantidade mínima	2
Código do artigo	15826	Tempo estimado	6 min

Desenho Técnico

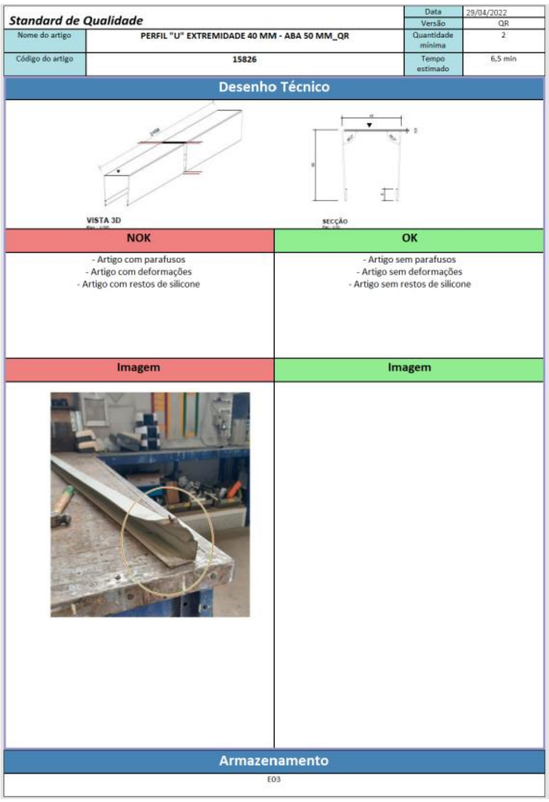
VISTA 3D

SECÇÃO

NOK	OK
- Artigo partido ou cortado - Artigo com deformações irrecuperáveis	- Artigo com furos - Artigo com deformações e amolgadelas recuperáveis
Imagem	Imagem

Armazenamento

Armazém Exterior



Standard de Qualidade		Data	29/04/2022
		Versão	QR
Nome do artigo	PERFIL "U" EXTREMIDADE 40 MM - ABA 50 MM_QR	Quantidade mínima	2
Código do artigo	15826	Tempo estimado	6,5 min

Desenho Técnico

VISTA 3D

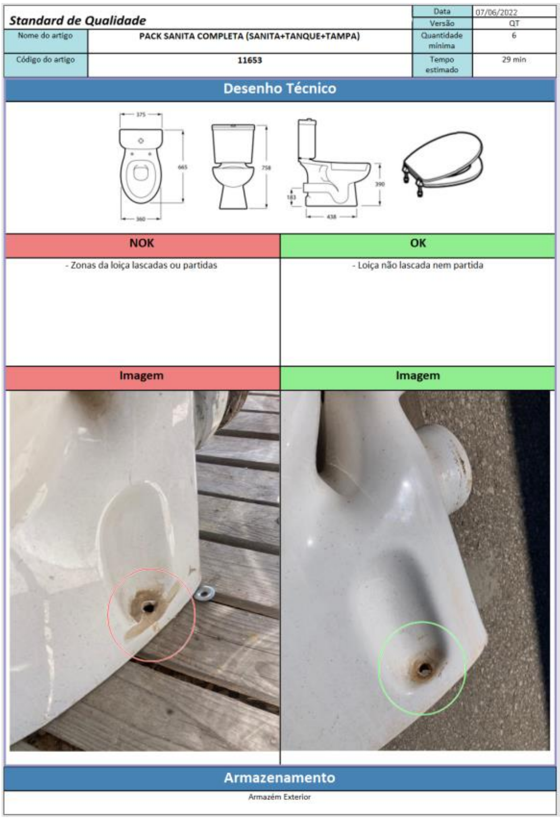
SECÇÃO

NOK	OK
- Artigo com parafusos - Artigo com deformações - Artigo com restos de silicone	- Artigo sem parafusos - Artigo sem deformações - Artigo sem restos de silicone
Imagem	Imagem

Armazenamento

E03

Appendix 2.6. Triage QS (left) and Final QS (right) for component 11653



Standard de Qualidade		Data	07/06/2022
		Versão	QT
Nome do artigo	PACK SANITA COMPLETA (SANITA+TANQUE+TAMPA)	Quantidade mínima	6
Código do artigo	11653	Tempo estimado	29 min

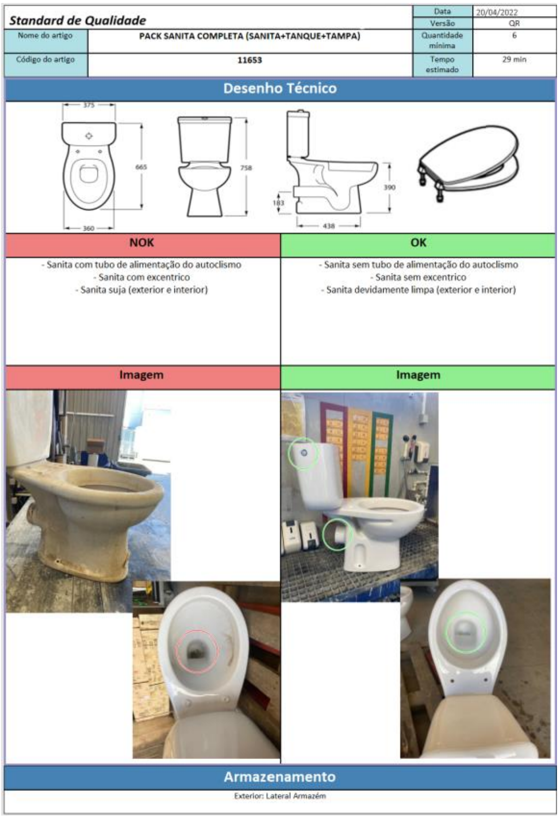
Desenho Técnico

375 665 360 758 183 390 438

NOK	OK
- Zonas da loiça lascadas ou partidas	- Loiça não lascada nem partida
Imagem	Imagem

Armazenamento

Armazém Exterior



Standard de Qualidade		Data	20/04/2022
		Versão	QR
Nome do artigo	PACK SANITA COMPLETA (SANITA+TANQUE+TAMPA)	Quantidade mínima	6
Código do artigo	11653	Tempo estimado	29 min

Desenho Técnico

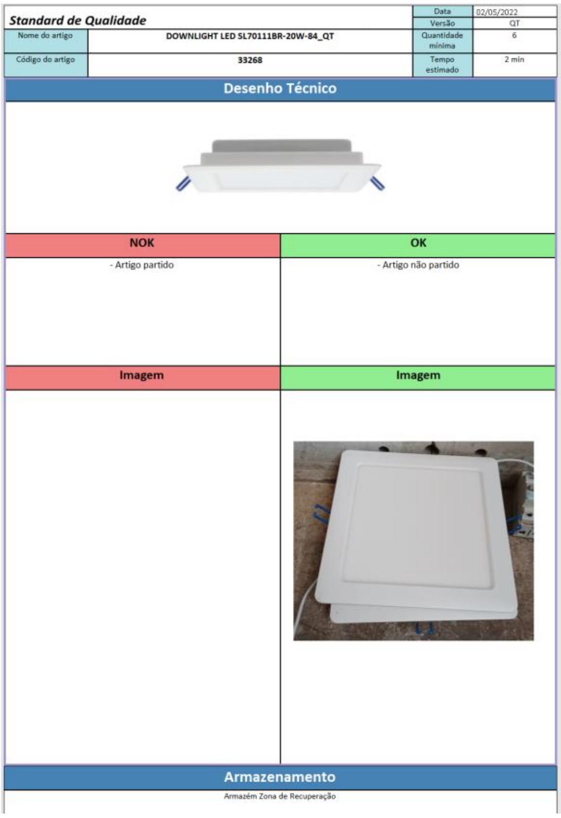
375 665 360 758 183 390 438

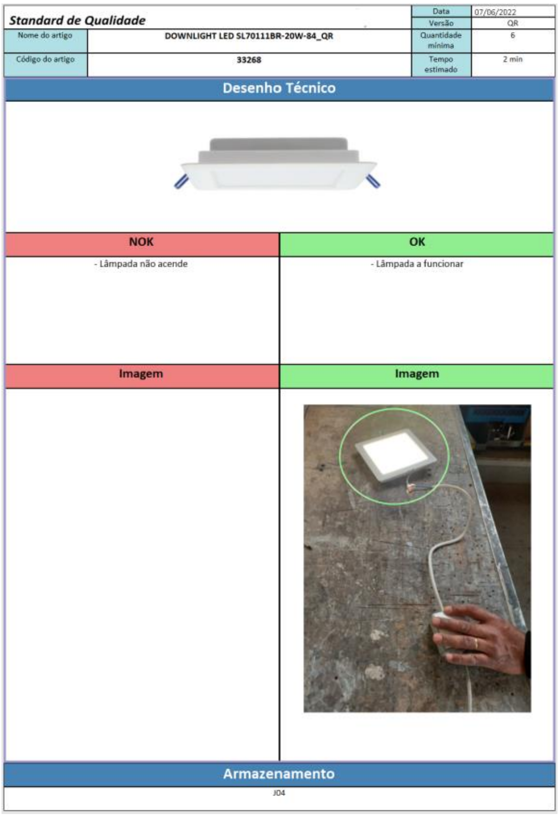
NOK	OK
- Sanita com tubo de alimentação do autoclismo - Sanita com excentrico - Sanita suja (exterior e interior)	- Sanita sem tubo de alimentação do autoclismo - Sanita sem excentrico - Sanita devidamente limpa (exterior e interior)
Imagem	Imagem

Armazenamento

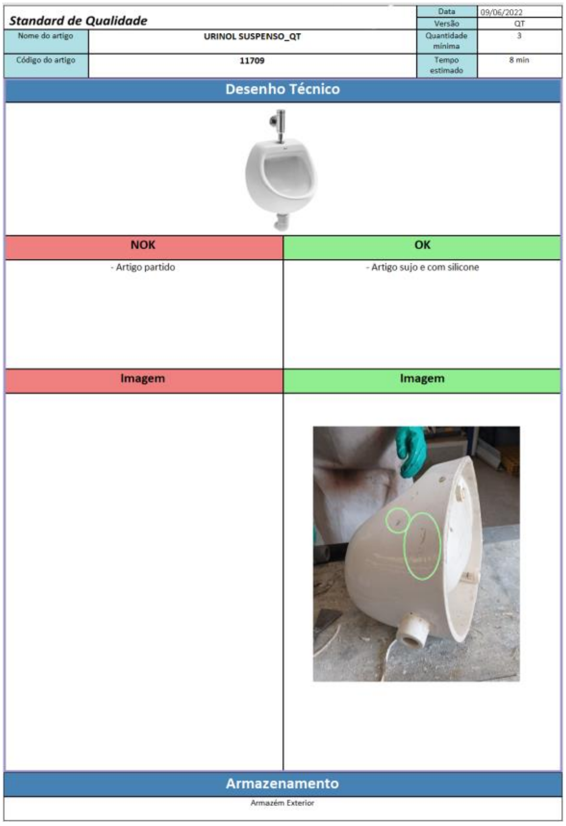
Exterior: Lateral Armazém

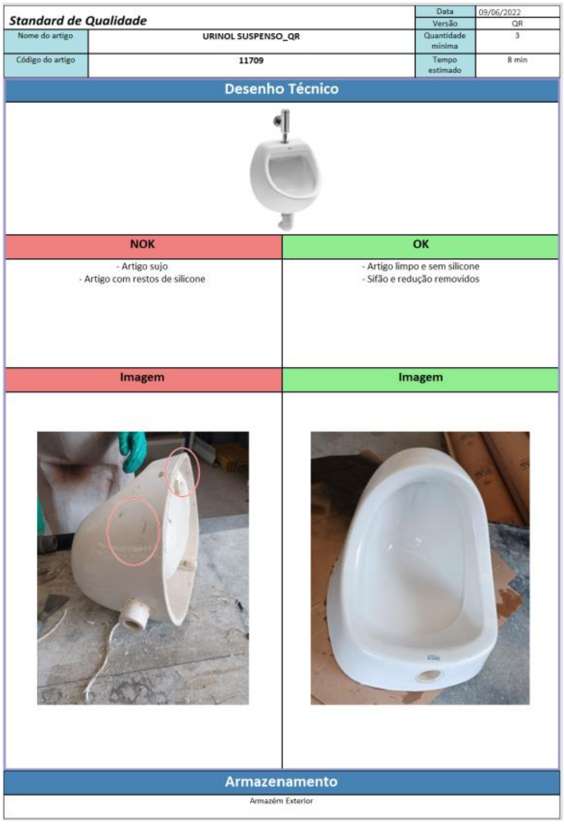
Appendix 2.7. Triage QS (left) and Final QS (right) for component 33268



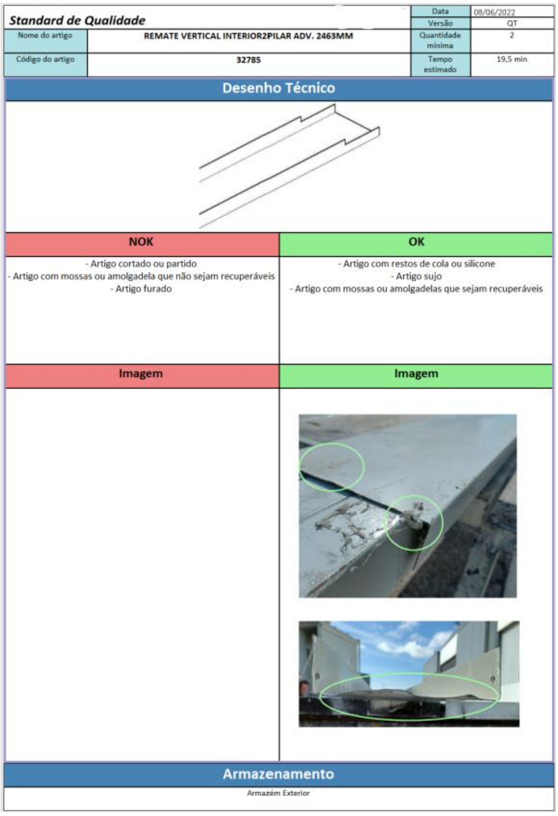


Appendix 2.8. Triage QS (left) and Final QS (right) for component 11709





Appendix 2.9. Triage QS (left) and Final QS (right) for component 32785



Standard de Qualidade		Data	08/06/2022
		Versão	QT
Nome do artigo	REMATE VERTICAL INTERIOR2PILAR ADV. 2463MM	Quantidade mínima	2
Código do artigo	32785	Tempo estimado	19,5 min

Desenho Técnico

NOK	OK
- Artigo cortado ou partido - Artigo com mossas ou amolgadela que não sejam recuperáveis - Artigo furado	- Artigo com restos de cola ou silicone - Artigo sujo - Artigo com mossas ou amolgadelas que sejam recuperáveis
Imagem	Imagem

Armazenamento

Armazém Exterior

Standard de Qualidade		Data	08/06/2022
		Versão	QR
Nome do artigo	REMATE VERTICAL INTERIOR2PILAR ADV. 2463MM	Quantidade mínima	2
Código do artigo	32785	Tempo estimado	19,5 min

Desenho Técnico

NOK	OK
- Pintura branca não uniforme - Artigo apenas com pintura primária - Artigo com mossas ou deformações	- Pintura a branco, uniforme em todo o artigo - Artigo sem deformações ou amolgadelas - Artigo sem restos de silicone
Imagem	Imagem

Armazenamento

F06

Appendix 2.10. Triage QS (left) and Final QS (right) for component 19938

Standard de Qualidade		Data	09/06/2022
		Versão	QT
Nome do artigo	CHAPAS GALV. P/ACOPLAMENTO SEM VINILÍCO_QT	Quantidade mínima	3
Código do artigo	19938	Tempo estimado	88 min

NOK	OK
- Artigo cortado com menos de 90 cm - Artigo cortado, partido ou furado em zonas que não sejam cobertas pelo vinílico	- Artigo furado em zonas passíveis de serem cobertas pelo vinílico - Artigo com vinílico estragado - Artigo com ferrugem ou pintura estragada - Artigo com mossas ou amolgadelas
Imagem	Imagem

Armazenamento

Armazém Exterior

Standard de Qualidade		Data	09/06/2022
		Versão	QR
Nome do artigo	CHAPAS GALV. P/ACOPLAMENTO SEM VINILÍCO_QR	Quantidade mínima	3
Código do artigo	19938	Tempo estimado	1,5 horas

Desenho Técnico

NOK	OK
- Vinílico rasgado ou furado - Artigo por pintar -Artigo com deformações ou amolgadelas	- Vinílico sem marcas - Artigo pintado, com pintura uniforme - Artigo sem deformações
Imagem	Imagem

Armazenamento

F07

Appendix 2.11. Triage QS (left) and Final QS (right) for component 19906

Standard de Qualidade

Nome do artigo	PEÇA ACOP.EXT.C/L C/ABA P/3015 0,8X2200X10X1890 MM	Data	08/06/2022
		Versão	QT
		Quantidade mínima	3
Código do artigo	19906	Tempo estimado	10,5 min

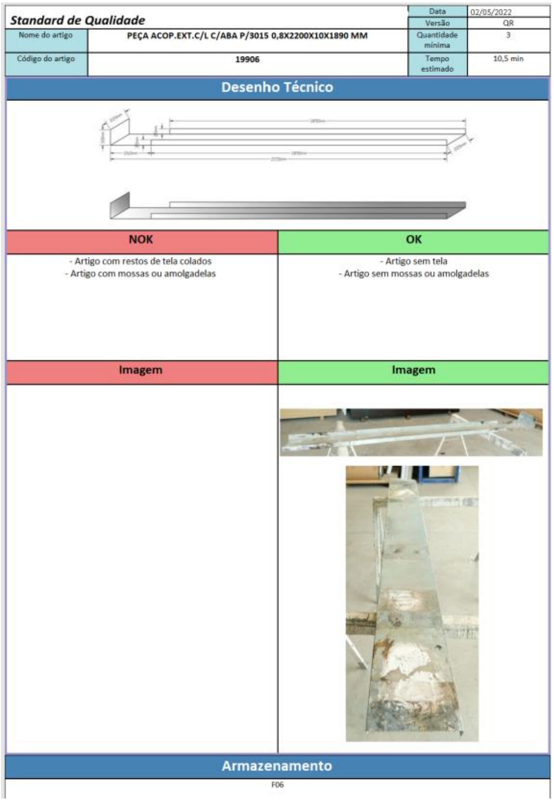
Desenho Técnico

NOK	OK
- Artigo cortado - Artigo com demasiados furos	- Artigo com tela - Artigo com poucos furos - Artigo deformado ou com amolgadelas

Imagem	Imagem

Armazenamento

Armazém Exterior



Standard de Qualidade

Nome do artigo	PEÇA ACOP.EXT.C/L C/ABA P/3015 0,8X2200X10X1890 MM	Data	02/05/2022
		Versão	QR
		Quantidade mínima	3
Código do artigo	19906	Tempo estimado	10,5 min

Desenho Técnico

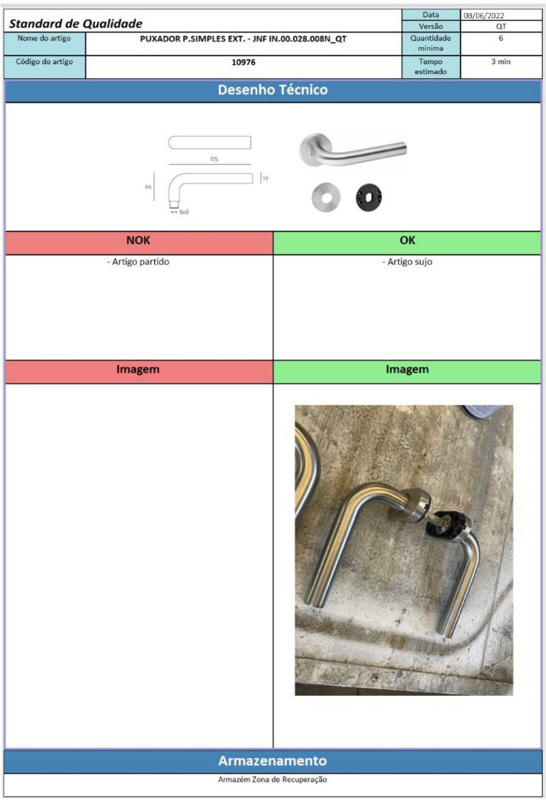
NOK	OK
- Artigo com restos de tela colados - Artigo com mossas ou amolgadelas	- Artigo sem tela - Artigo sem mossas ou amolgadelas

Imagem	Imagem

Armazenamento

F06

Appendix 2.12. Triage QS (left) and Final QS (right) for component 10976



Standard de Qualidade

Nome do artigo	PUXADOR P.SIMPLES EXT. - JNF IN.00.028.008N_QT	Data	08/06/2022
		Versão	QT
		Quantidade mínima	6
Código do artigo	10976	Tempo estimado	3 min

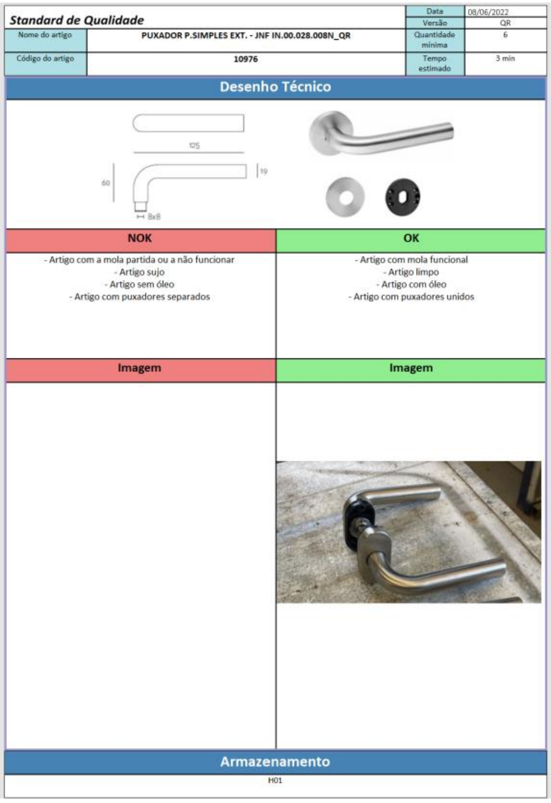
Desenho Técnico

NOK	OK
- Artigo partido	- Artigo sujo

Imagem	Imagem

Armazenamento

Armazém Zona de Recuperação



Standard de Qualidade

Nome do artigo	PUXADOR P.SIMPLES EXT. - JNF IN.00.028.008N_QR	Data	08/06/2022
		Versão	QR
		Quantidade mínima	6
Código do artigo	10976	Tempo estimado	3 min

Desenho Técnico

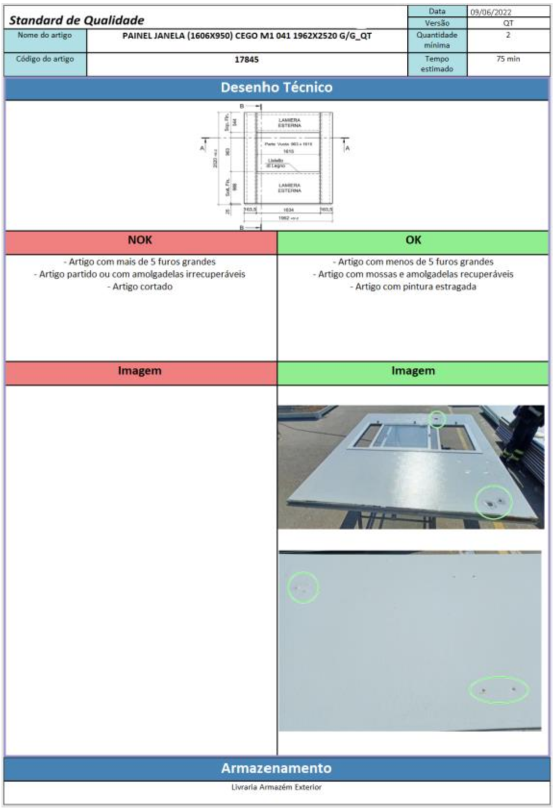
NOK	OK
- Artigo com a mola partida ou a não funcionar - Artigo sujo - Artigo sem óleo - Artigo com puxadores separados	- Artigo com mola funcional - Artigo limpo - Artigo com óleo - Artigo com puxadores unidos

Imagem	Imagem

Armazenamento

H01

Appendix 2.13. Triage QS (left) and Final QS (right) for component 17845



Standard de Qualidade

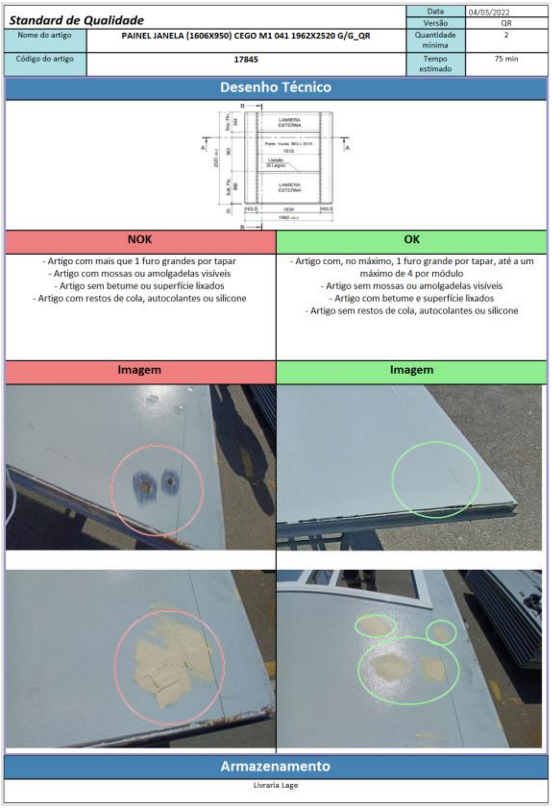
		Data	09/06/2022
		Versão	QT
Nome do artigo	PAINEL JANELA (1606X950) CEGO M1 041 1962X2520 G/G_QT	Quantidade mínima	2
Código do artigo	17845	Tempo estimado	75 min

Desenho Técnico

NOK	OK
- Artigo com mais de 5 furos grandes - Artigo partido ou com amolgadelas irrecuperáveis - Artigo cortado	- Artigo com menos de 5 furos grandes - Artigo com mossas e amolgadelas recuperáveis - Artigo com pintura estragada
Imagem	Imagem

Armazenamento

Livraria Armazém Exterior



Standard de Qualidade

		Data	04/05/2022
		Versão	QR
Nome do artigo	PAINEL JANELA (1606X950) CEGO M1 041 1962X2520 G/G_QR	Quantidade mínima	2
Código do artigo	17845	Tempo estimado	75 min

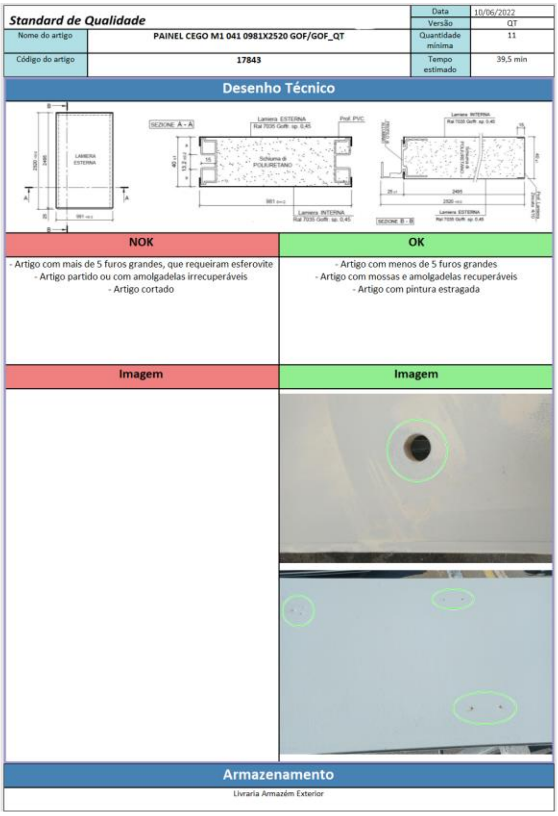
Desenho Técnico

NOK	OK
- Artigo com mais que 1 furo grandes por tapar - Artigo com mossas ou amolgadelas visíveis - Artigo sem betume ou superfície lixados - Artigo com restos de cola, autocolantes ou silicone	- Artigo com, no máximo, 1 furo grande por tapar, até a um máximo de 4 por módulo - Artigo sem mossas ou amolgadelas visíveis - Artigo com betume e superfície lixados - Artigo sem restos de cola, autocolantes ou silicone
Imagem	Imagem

Armazenamento

Livraria Lage

Appendix 2.14. Triage QS (left) and Final QS (right) for component 17843



Standard de Qualidade

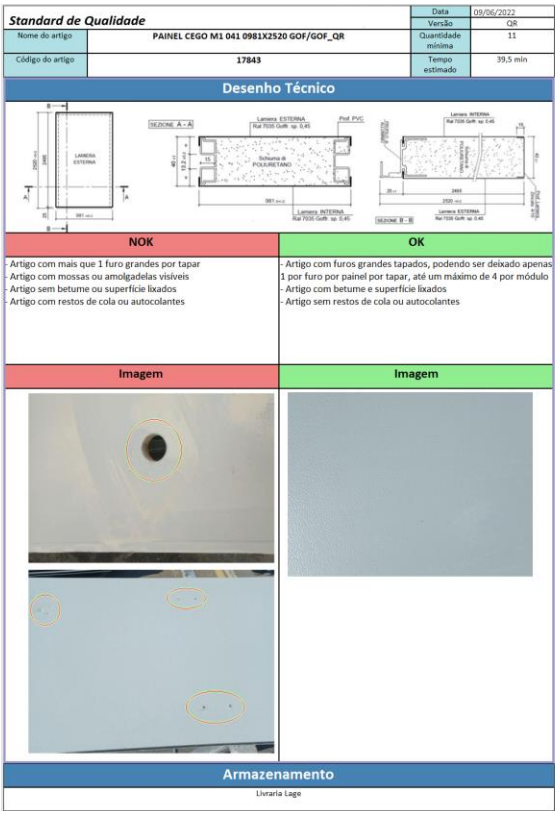
		Data	10/06/2022
		Versão	QT
Nome do artigo	PAINEL CEGO M1 041 0981X2520 GOF/GOF_QT	Quantidade mínima	11
Código do artigo	17843	Tempo estimado	39,5 min

Desenho Técnico

NOK	OK
- Artigo com mais de 5 furos grandes, que requeiram esferovite - Artigo partido ou com amolgadelas irrecuperáveis - Artigo cortado	- Artigo com menos de 5 furos grandes - Artigo com mossas e amolgadelas recuperáveis - Artigo com pintura estragada
Imagem	Imagem

Armazenamento

Livraria Armazém Exterior



Standard de Qualidade

		Data	09/06/2022
		Versão	QR
Nome do artigo	PAINEL CEGO M1 041 0981X2520 GOF/GOF_QR	Quantidade mínima	11
Código do artigo	17843	Tempo estimado	39,5 min

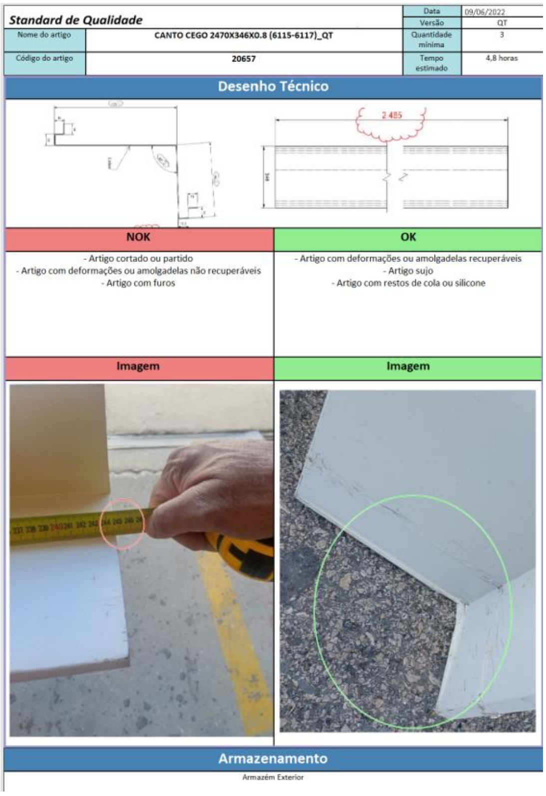
Desenho Técnico

NOK	OK
- Artigo com mais que 1 furo grandes por tapar - Artigo com mossas ou amolgadelas visíveis - Artigo sem betume ou superfície lixados - Artigo com restos de cola ou autocolantes	- Artigo com furos grandes tapados, podendo ser deixado apenas 1 por furo por painel por tapar, até um máximo de 4 por módulo - Artigo com betume e superfície lixados - Artigo sem restos de cola ou autocolantes
Imagem	Imagem

Armazenamento

Livraria Lage

Appendix 2.15. Triage QS (left) and Final QS (right) for component 20657



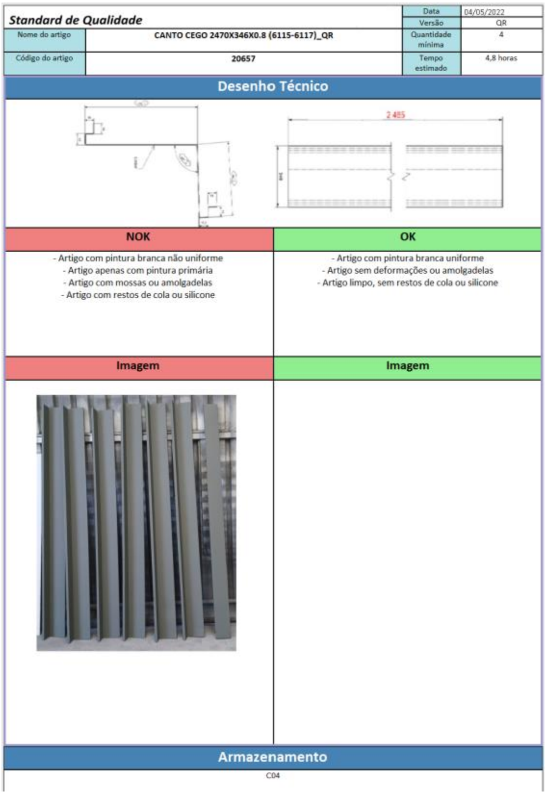
Standard de Qualidade		Data	09/06/2022
		Versão	QT
Nome do artigo	CANTO CEGO 2470X346X0.8 (6115-6117)_QT	Quantidade mínima	3
Código do artigo	20657	Tempo estimado	4,8 horas

Desenho Técnico

NOK	OK
- Artigo cortado ou partido - Artigo com deformações ou amolgadelas não recuperáveis - Artigo com furos	- Artigo com deformações ou amolgadelas recuperáveis - Artigo sujo - Artigo com restos de cola ou silicone
Imagem	Imagem

Armazenamento

Armazém Exterior



Standard de Qualidade		Data	04/05/2022
		Versão	QR
Nome do artigo	CANTO CEGO 2470X346X0.8 (6115-6117)_QR	Quantidade mínima	4
Código do artigo	20657	Tempo estimado	4,8 horas

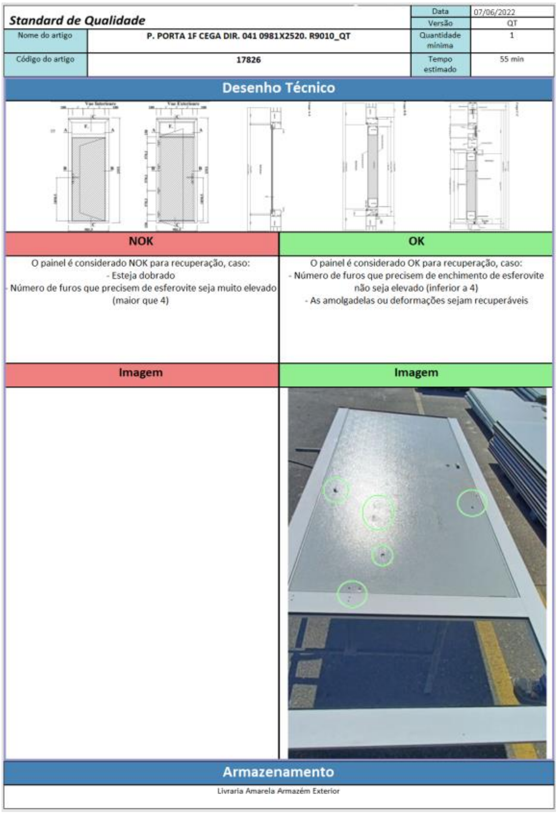
Desenho Técnico

NOK	OK
- Artigo com pintura branca não uniforme - Artigo apenas com pintura primária - Artigo com mossas ou amolgadelas - Artigo com restos de cola ou silicone	- Artigo com pintura branca uniforme - Artigo sem deformações ou amolgadelas - Artigo limpo, sem restos de cola ou silicone
Imagem	Imagem

Armazenamento

C04

Appendix 2.16. Triage QS (left) and Final QS (right) for component 17826



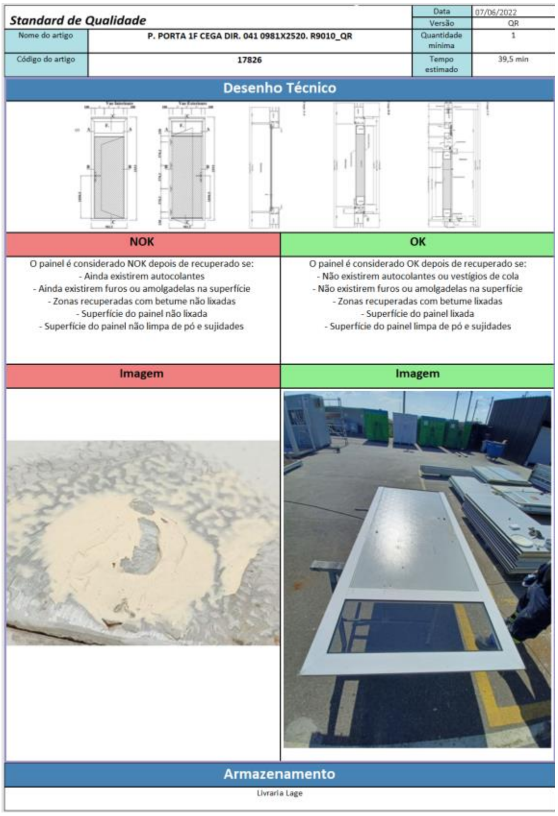
Standard de Qualidade		Data	07/06/2022
		Versão	QT
Nome do artigo	P. PORTA 1F CEGA DIR. 041 0981X2520. R9010_QT	Quantidade mínima	1
Código do artigo	17826	Tempo estimado	55 min

Desenho Técnico

NOK	OK
O painel é considerado NOK para recuperação, caso: - Esteja dobrado - Número de furos que precisem de esferovite seja muito elevado (maior que 4)	O painel é considerado OK para recuperação, caso: - Número de furos que precisem de enchimento de esferovite não seja elevado (inferior a 4) - As amolgadelas ou deformações sejam recuperáveis
Imagem	Imagem

Armazenamento

Livraria Amarela Armazém Exterior



Standard de Qualidade		Data	07/06/2022
		Versão	QR
Nome do artigo	P. PORTA 1F CEGA DIR. 041 0981X2520. R9010_QR	Quantidade mínima	1
Código do artigo	17826	Tempo estimado	39,5 min

Desenho Técnico

NOK	OK
O painel é considerado NOK depois de recuperado se: - Ainda existirem autocolantes - Ainda existirem furos ou amolgadelas na superfície - Zonas recuperadas com betume não lixadas - Superfície do painel não lixada - Superfície do painel não limpa de pó e sujidades	O painel é considerado OK depois de recuperado se: - Não existirem autocolantes ou vestígios de cola - Não existirem furos ou amolgadelas na superfície - Zonas recuperadas com betume lixadas - Superfície do painel lixada - Superfície do painel limpa de pó e sujidades
Imagem	Imagem

Armazenamento

Livraria Lage