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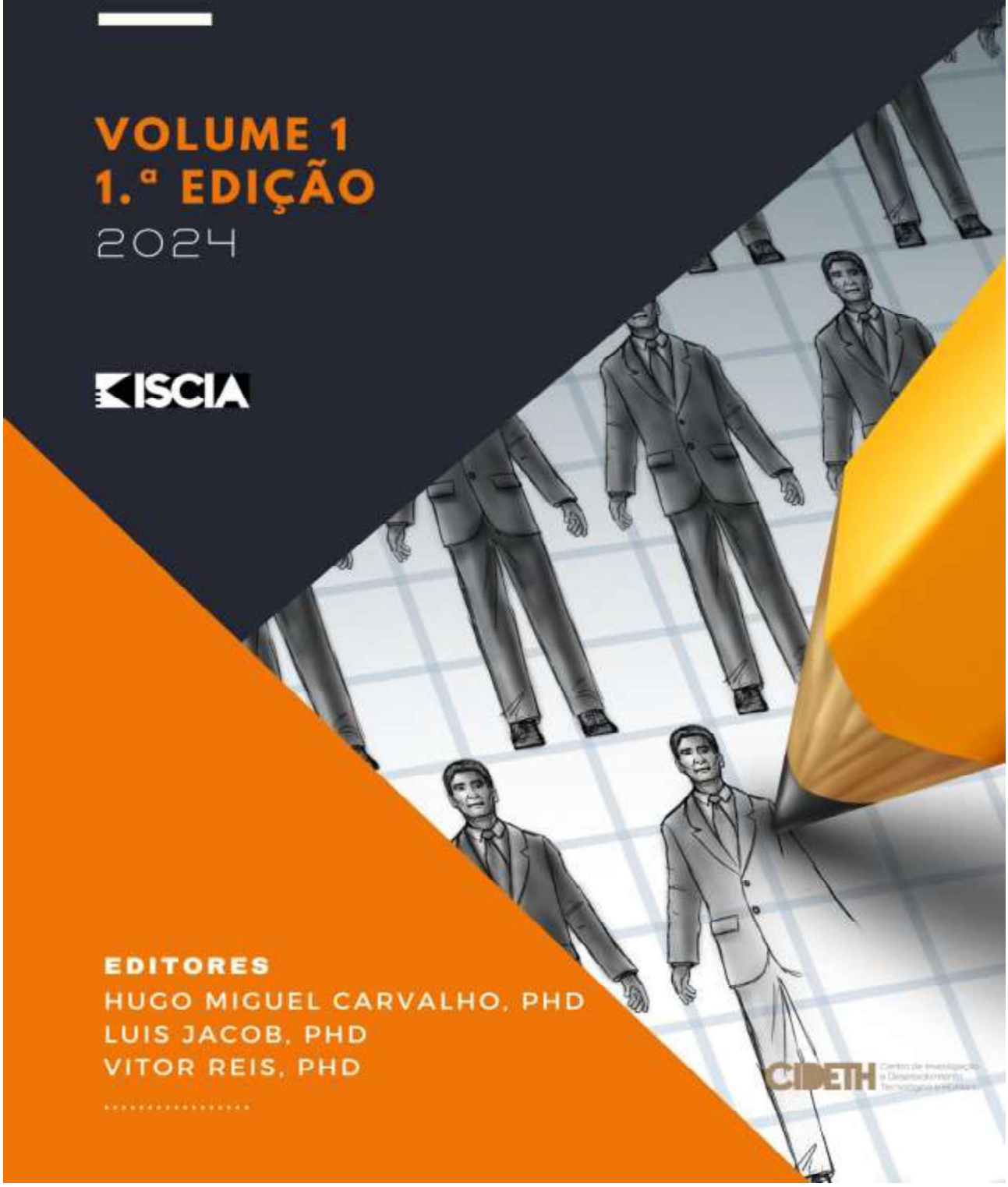

EDITORES
HUGO MIGUEL CARVALHO, PHD
LUIS JACOB, PHD
VITOR REIS, PHD

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5 - Implementing Lean management tools for process improvement - a case study in the manufacturing industry

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Maria Pereira
Mestranda no Instituto Europeu de Estudos Superiores|IEES
lasalete_pereiora@hotmail.com
Laurentino Guimarães
Instituto Europeu de Estudos Superiores|IEES
laurentino.guimaraes@iees.pt | ORCID: 0000-0002-8015-9980
Margarida Rodrigues
Instituto Europeu de Estudos Superiores|IEES
CEFAGE-University of Beira Interior, Portugal.
mmmrodrigues@sapo.pt | ORCID: 0000-0002-0997-9716
Cidália Oliveira
Instituto Europeu de Estudos Superiores|IEES
University of Minho, Braga, Portugal.
REMIT – University Portucalense, Porto, Portugal.
cidalia.o@hotmail.com | ORCID: 0000-0002-3512-6151
Nayra Martins
Polytechnic Institute of Coimbra, Technology and Management
School of Oliveira do Hospital
NECE-Research Center in Business Sciences
University of Beira Interior
nayralmartins@hotmail.com | ORCID: 0000-0001-7177-3375

Resumo: Tendo em conta o papel fundamental da melhoria contínua no contexto organizacional, é necessária uma grande atenção por parte dos gestores para que as medidas de melhoria implementadas estejam de acordo com as expectativas do mercado. Ao longo das últimas décadas, a gestão Lean tem demonstrado a sua capacidade de identificar, melhorar e reduzir atividades sem valor acrescentado, com base em ferramentas de gestão Lean, como o mapeamento do fluxo de valor, o fluxo de uma peça, o 5-S e várias outras ferramentas. Considerando a constatação de que as organizações que implementaram as ferramentas Lean têm vindo a afirmar-se, em diversas áreas de atividade, esta investigação pretende confirmar as melhorias baseadas nas ferramentas Lean numa organização transformadora portuguesa. Objetivos: Caracterizar o percurso efetuado pelos gestores para identificar as ferramentas lean a implementar, de modo a descrever o processo de implementação. Para além disso, as poupanças obtidas com as implementações podem ser um ponto de referência para outras organizações implementarem ferramentas de gestão lean. Metodologia: Para aprofundar o conhecimento foi selecionado um estudo qualitativo, nomeadamente um Estudo de Caso realizado na organização transformadora portuguesa. Resultados: Com as ferramentas de gestão lean implementadas, foram conseguidas várias melhorias no chão de fábrica, relacionadas com um layout mais eficiente, redução de etapas de manuseamento, bem como ajustes e reduções de inventário. Conclusão: Esta investigação confirma que as ferramentas de gestão lean são replicáveis em indústrias de transformação, independentemente da sua atividade. A principal preocupação está relacionada com a identificação dos processos, movimentos de materiais e etapas de manuseamento que

não criam valor. Após a identificação destas atividades de valor acrescentado, o processo de implementação deve ser orientado e monitorizado. As ferramentas de gestão Leam são competentes para criar valor independentemente do sector de atividade.

Palavras-chave: ferramentas Lean management; 5-S; atividades de valor acrescentado; redução de desperdícios; melhoria contínua.

Abstract: Bearing in mind the key role of continuous improvement in organisational context, a very tight focus beside managers is afforded to enable the implemented improvement steps in accordance to market's expectations. Lean management has, along the last decades proven its ability to identify, improve and reduce non-value-added activities, based on lean management tools, like value stream mapping, one piece flow, 5-S and several other tools. Considering the insight that organisations which implemented lean tools have stated, in several activity areas, this research aims to confirm the improvements based on lean tools in a Portuguese transformation organisation. Objectives: Characterize the performed path by managers to identify the lean tools to implement, so as, to describe the process of implementation. Furthermore, the savings based on the implementations might be a highlight for other organisations to implement lean management tools. Methodology: In order to provide deeper knowledge a qualitative study was selected, namely a Case Study performed in the Portuguese transformation organisation. Results: On hand of the implemented lean management tools several improvement have been accomplished in the shop floor, related to a more proficient layout, reduction of handling steps, so as inventory adjustments and reductions. **Conclusion:** This research confirms that lean management tools are replicable on transformation industries, independently of its activity. The mayor concern is related to identify the processes, material movements and handling steps that do not create value. Subsequently to having identified these on value added activities, the implementation process needs to be guided and monitored. Leam management tools are proficient to create value independently of the activity sector.

Keywords: Lean mangement tools; 5-S; value-added activities; waste reduction; continuous improvement.

1. Introduction

The transformation reached a high point at the beginning of the 20th century with the creation of Henry Ford's automobile factory, which spearheaded the large-scale production movement. The paradigm shift brought about by this industrial change allowed Ford to overcome numerous challenges, reducing manufacturing costs while increasing product quality. The shift from the traditional mass method to the "Lean" approach was largely motivated by the exorbitant expense and limited adaptability of industrial machinery (Womack, Jones & Roos, 1990). On the other hand, Taiichi Ohno did not adapt to the mass production system (realizing that it did not correspond to the Japanese reality) and conceived the model recognized at the time as the Toyota Production System (TPS) (Ohno, 2019). The aim of the method was to maximize productivity and eliminate wasteful practices, a determining and driving factor at the time. By identifying and resolving inefficiencies in the work routine, improving the quality of the end product and training employees, the methodology gained widespread acceptance in various industries (Liker, 2004). This research focused on the Lean methodology, specifically the Lean Manufacturing philosophy, with the aim of reducing waste and improving operations and workstations. In detail, the 5S tool was worked on and applied, highlighting the objectives of improving the organizational environment and employee culture, while increasing the company's productivity.

With the increasingly competitive environment in organizations, it becomes more and more imperative to achieve excellence not only in results, but particularly in processes, and this is the discipline that needs to be optimized through a series of sustainable resources that allow the company to reduce costs, increase productivity and improve customer service.

What's more, after initial contact with the company, the tool in question proved to be a good fit, since the findings at the time of the visit focused essentially on "organization", "cleanliness" and "self-discipline", some of the ideals of the 5S philosophy.

Using the Lean methodology, specifically the 5S tool, all the relevant criteria relating to general warehouse logistics and specifically to the organization's production process will be observed so that they are duly recorded, evaluated and identified as useful or indispensable to the normal and healthy running of the company.

Given the problems described, the following research question was considered:

How can the 5S tools add value to the organization's performance?

To this end, the following research objectives were considered:

- Thorough knowledge of the entire process inherent in the production line in order to identify possible problems (particular interest in the handling of white paraffin);
- Creating proposals for improvement and documentary support for the work routine, using the Lean philosophy, particularly the 5S tool;
- Understand the importance of implementing improvement activities through the management tool.

2. Lean Thinking and Lean Manufacturing

Cusumano and Nobeoka (1992) highlight the ability to minimize costs, shorten production cycles and optimize customer satisfaction has resulted in companies all over the world adopting the concept in order to remain competitive in the business environment.

Intrinsically linked to Lean Thinking, the name Lean Manufacturing, according to Womack et al. (1990), arose from Toyota Production System (TPS) and was also labeled in this way due to the smaller number of elements incorporated, compared to mass production. At the same time, it is less physically demanding for the employee and requires less space, time and investment. The Lean Manufacturing concept focuses on rationalizing production standards and maximizing efficiency by minimizing waste (Womack et al., 1990). According to Liker (2004) the approach emphasizes the need for continuous analysis and refinement of processes in order to eliminate waste and improve effectiveness. The same author also argues that one of the most significant benefits of Lean Manufacturing is the focus on employee training. By involving the team, as well as gaining knowledge, the company creates a culture of learning and continuous improvement, with a positive impact on employee engagement. In the same vein, De Vin et al. (2017) consider that in order to succeed in implementing Lean Manufacturing, the organization must commit to constant training and mutual support, providing resources for this purpose, as well as promoting a culture of collaboration and open communication.

Lean thinking is not about imitating Toyota's manufacturing processes, but rather about including the principles in the company's culture so that they are developed and practiced with the customer in mind, adding value to the final product/service. Womack et al. (1990) states that Lean principles can be applied to the whole industry (Liker, 2004).

As explained by Womack and Jones (1996) the Lean Manufacturing philosophy encompasses five guiding principles (Table 1), which begin by clarifying that: 1) unequivocally determine the value of each item produced, 2) map out the full range of

activities that bring each product to fruition, 3) instill a continuous flow of operations, 4) produce only what is necessary and 5) relentlessly pursue eminence.

Table 1
Lean Manufacturing Principles

Principle	Description
Value	Recognizing that value is not determined by the company but by the end customer is extremely important. It's about what the customer is willing to pay, and inherent waste must be reduced or eliminated.
Value stream	The value chain includes a series of actions necessary to take a product or service from the conceptualization phase to launch, and also includes customer satisfaction. It is essential to understand which stages do and do not add value to the product/service and to discard the unnecessary ones.
Flow	Optimizing processes such as product design, order processing and storage time, as well as enabling the production flow to be continuous, helps to eliminate waste.
Pull system	The aim is to produce only what is necessary (*Just-In-Time* concept), according to the orders received, thus once again avoiding waste.
Perfection	The final value of the product/service is formed with a total absence of waste, which is why only operations that increase legitimacy should be present. Perfection is sought, linked to continuous improvement and the elimination of waste from the previous principles.

Source: Adapted from Womack and Jones (1996).

While the first principle is more customer-oriented, the next four refer to the production and delivery of the product to the customer, always with a view to eliminating waste (Cunningham & Jones, 2007).

the application of the above principles concerns the manufacture of products, however, it also extends to the development of services (Andrés-López, González-Requena & Sanz-Lobera, 2015). Lean tools essentially focus on identifying and eradicating the seven wastes, since these do not add any value to the organization or customer (Tyagi et al., 2011).

Singh and Kumar (2020) consider that despite the particular impact and applicability of the different Lean tools, there is a commonality in the production of certain effects, among them:

- System optimization through collaboration and learning;
- Continuous change and the search for perfection;
- Transmission of esteem by the client;
- Encouraging continuous flow, eliminating aspects that don't add value;
- Introduction of the pull concept, i.e. starting to produce only what is actually ordered.

Therefore, the advantages of Lean tools pointed out by Gupta and Jain (2013) refer to the following points:

- Improved quality and safety: the tools used improve the quality of production and increase safety in the workplace. The possibility of small errors is eliminated;
- Reducing time when searching: using certain tools (e.g. 5S), the organization of materials and raw materials is clearly visible, making it easier to visually check items;
- Change in organizational culture: communication with employees increases, as does their involvement and responsibility in the company;
- Reduction in fatigue: once work movements have been reconsidered and adapted, the reduction in employee fatigue becomes obvious.

Machado and Leitner (2010) mention that the implementation of the Lean philosophy in the quality management of companies requires the adoption of a series of practices and tools known as Lean tools. From this point of view, Toyota developed a method that preserves a clean, organized and efficient working environment, the 5S (John et al., 2008). As one of the most notable philosophies, the 5S, which focuses on visual issues and the organization of spaces, contains five stages, namely use, organization, cleanliness, standardization and self-discipline (Machado & Leitner, 2010). The description of each stage (Table 2) is associated with the senses, as explained by the authors Hirano (1995), quoted by Liker (2004) e Buesa (2009).

According to Liker (2004) senses contribute to the elimination of errors, defects and work accidents.

Table 2
Senses of the 5S Tool

Sense	Description
Seiri (sense of use)	• Separation of necessary and unnecessary items in the work process and in the organization. By removing any dispensable elements, the work environment can be simplified and the organization can operate more efficiently (Hirano, 1995, cited by Liker, 2004). • Separating what is not needed for the work area and disposing of it. (Buesa, 2009).
Seiton (sense of organization)	• Everything deemed necessary must be organized in such a way as to allow easy access. This means assigning a specific place to each item, so that anyone working in the company can quickly find what they need (Hirano, 1995, cited by Liker, 2004). • Arrange the necessary elements of the process in an accessible and arranged manner (Buesa, 2009).
Seiso (sense of cleanliness)	• Regular cleaning of the work area. This creates an environment conducive to efficiency and productivity (Hirano, 1995, cited by Liker, 2004). • The aim is to keep the working environment clean, excluding dirt and increasing staff motivation (Buesa, 2009).

Sense	Description
Seiketsu (sense of normalization)	• To maintain usefulness, organization and cleanliness, the company must develop effective practices and documents that can be easily monitored. This involves standardizing processes to ensure consistent operations (Hirano, 1995, cited by Liker, 2004). • Create *standard* routines that support and enable the three initial senses to be put into practice (Buesa, 2009).
Shitsuke (sense of self-discipline)	• The progress achieved through 5S is instilled through discipline in the workforce. It is crucial that procedures are maintained and that the effort is repeated daily (Hirano, 1995, cited by Liker, 2004). • Discipline that helps control *standard* practices (Buesa, 2009).

Source: Adapted from Hirano (1995), quoted by Liker (2004), e Buesa (2009).

The 5S methodology has been widely adopted in various industries as a way of improving operational efficiency. By complying with the five senses, companies are able to create an organized, clean and profitable work routine, which also leads to greater employee satisfaction and a consequent increase in profitability (Sobek & Smalley, 2008). Al Aomar (2011) explains that 5S is an easy tool to implement and in many cases provides a starting point for companies to integrate other Lean methods into the organizational culture. This philosophy maintains transparency, providing an efficient flow of activities.

2.1 Waste Reduction

Lean Thinking is based on reducing waste (called Mudas by the Japanese) and activities that absorb resources and time and do not add any value to the production process (Womack & Jones, 1996). Williams and Duray (2013, p. 59) in turn, highlight the idea that Lean Thinking is characterized as a commitment to "improving value, optimizing flow and eliminating waste". Examples of two important waste reduction and continuous improvement tools highlighted by Toyota are Just-in-Time and Jidoka. While the first pillar produces goods in the quantity required and according to customer orders, the second automates the production flow so that it is interrupted if quality problems are detected (Mazzocato et al., 2010).

In the work carried out by Ohno (1988) identified seven wastes associated with the work environment and how these can be effectively eliminated, thereby achieving significant improvements in efficiency and productivity. The seven wastes identified by the research include overproduction, waiting times, transportation, inadequate processes, unnecessary movements, stock and defects (Table 3).

Table 3
Seven Lean Thinking Wastes

Waste	Description
Overproduction	Production exceeds demand, generating unnecessary *stocks.* Use of resources without financial return.

Waste	Description
Waiting times	Delays in carrying out activities in the production process. These include periods of employee or machine inactivity.
Transportation	Transportation of raw materials or end products that are not needed in the production process.
Inadequate processes	Deficiencies in the workflow that occur incorrectly and therefore need to be repeated. Irregularities caused by incorrect use of equipment or tools.
Unnecessary movements	Unnecessary movement of people or equipment, for example due to poor workplace organization. Meyers and Stewart (2002) add poor ergonomic conditions and aspects such as the location and position of tools/materials.
Stock	Non-processing of raw materials, products in manufacture and/or end products compared to the quantity disposed of.
Defects	Non-conforming products. They carry with them implications such as repairs, inspections, increased production quantities, among others.

Source: Adapted from Ohno (1988).

Just like Ohno (1988), Brunt and Butterworth (1998) point out that the overuse of employee potential can form the eighth waste. This, according to Ohno (1988), underuses the team's mental, creative and physical skills, due to causes such as inefficient workflow, organizational culture, unsuitable practices and training, and high employee turnover.

2.2 Barriers to Lean Manufacturing implementation

Considering the observations of Kilpatrick (2003) successful implementations in companies can, in many cases, be difficult and/or inaccessible to the expected benefits. To this detriment, the author highlights a few points:

- The improvement indicators are not associated with the financial statements; in other words, the company reports the percentage of improvement, but does not convert it into monetary terms. This communication is necessary for Lean implementation to continue to be supported;
- The sequence of measures applied is not correct. Improvements must be implemented logically and sequentially, so that the workflow is optimized from the first moment to the last step;
- The first contact with the Lean methodology must be successful or generate sufficient return, so that support for the measures remains in the future;
- Certain areas, such as administrative areas, are not targeted for implementation because they have little impact there;

- Too much time is spent on training and less on introducing the concepts, or on the other hand, starting at the wrong stage;
- Suppliers must be involved in improvement efforts, but failure is common when it comes to expanding them. The need for Just-in-Time delivery and stock minimization requires the commitment of suppliers, and if it is not possible to deliver on time and in precise quantities, the benefits of Lean will be diminished;
- The Lean methodology affects each employee individually and notoriously the organizational culture. The magnitude of these changes can cause discomfort and companies don't always have the capacity to deal with it;
- Understanding and implementing the Lean concept throughout a large company can be a lengthy process, more so than the occasional cycle of management turnover;
- The traditional view and the Lean view approach certain definitions differently (Table 4).

Table 4
Definitions according to traditional and Lean organizations

Concept	Traditional organization	*Lean* Organization
Inventory	An asset, as defined by accounting.	A waste. It ties up capital and increases processing time.
Quantity and lot size	Handling large batch sizes to compensate for process downtime.	A continuous effort is made to reduce downtime to zero.
Use of employees	Everyone must be busy all the time.	Since the work is done on the basis of customer demand, employees may not be busy.
Using processes	Processes are carried out quickly and at all times.	Processes just need to be designed to keep up with demand.
Work planning	Creation of products according to the forecast.	Creating products according to demand.
Labor costs	Variables.	Fixed.
Working groups	Traditional departments.	Multifunctional teams.
Quality	Inspection of the work at the end of the process to check for errors.	Processes and products are designed to eliminate errors.

Source: Adapted from Kilpatrick (2003).

To be added, Achanga et al. (2006) indicate that the lack of financial resources in small industries and inadequate top management are obstacles to implementing the methodology. For their part, Abdul-Nour, Lambert and Drolet (1998) identify the lack of

qualified personnel as an impediment to the application of Lean practices and Chong (2007) states that the time factor is also a barrier to the process.

3. Methodology

This research was carried out using qualitative research and action research methodology. The qualitative approach is, according to Padgett (2008) e Watkins (2012) is preponderant in applied research, as it provides in-depth information on human experience. For Strauss and Corbin (1990) a research model in which the results cannot be obtained through statistical methods or other quantification tools. Instead, the results are derived from the data collected with the aid of interpretative processes involving non-mathematical analysis. In turn, Yin (2003) e Bonoma (1985) argue that qualitative research presents an intimate version, allowing the researcher to cooperate with the organization's stakeholders, collecting data and personal experiences.

As far as it is concerned, action research methodology works in defense of plans whose objectives are to simultaneously create new knowledge and improve practice. The same research can continually increase the professional's ability to solve problems encountered in the field (Vallenga et al., 2009). For Checkland and Holwell (2003) the researcher is involved in a real situation and aspires to improve it while acquiring knowledge. Assuming three aspects of action research, accepted by Grundy and Kemmis (1982) it is assumed that it is the object of a social practice subject to improvement actions, that it comprises the sequence of planning, acting, observing and reflecting, and that, finally, all stages of the activity include those responsible for the practice. Advantageous for creating change and new knowledge (Waterman et al., 2001).

A qualitative research approach was used in this investigation, where the starting point comes from familiarizing ourselves with the situation or event, as well as describing and analyzing it. Through the tools used to collect data, namely observation and conversation (Latorre, 2003), photographs and field notes (descriptive and reflective) (Coutinho, 2023) the requirement to use "words" and their consequent contrast, comparison and analysis can be seen.

The action-research methodology was therefore applied, since (Elliot, 1993) the aim is to improve the quality of an action within a given situation. In the same vein, Lomax (1990) defines the concept as an intervention aimed at improving professional practice. In addition, Dick (1999) points out that action research can include change and understanding, in other words, action and research respectively. According to Simões (1990, p. 43) for this methodological perspective "(...) the result of research will always have a triple objective: to produce knowledge, to modify reality and to transform the actors".

The fieldwork carried out in the organization took shape through the use of tools based on observation, conversation (Latorre, 2003), photography and field notes, the latter descriptive and reflective (Coutinho, 2023).

Coutinho (2023) defines the data collection tool as being direct and face-to-face (observation), and as an interaction in a dialog environment (conversation).

4. Implementation of 5S improvements

According to Arabzad and Shirouyehzad (2012) SWOT analysis is a strategic planning model that encompasses the organization's internal and external environment, in which it is stated whether a certain goal is achievable and what requirements are necessary to achieve that goal. According to Porter (1991) there is a desired alignment of organizational variables, in which listing positive and negative internal and external issues makes it possible to understand how new opportunities can arise from strengths, and how organizational setbacks and increased threats can be associated with weaknesses.

Table 5
SWOT Analysis Organization

	Strengths	Weakness
Internal factors	1. Strategic location; 2. Manufacturing mostly with the aid of equipment; 3. Competitive price and easy to negotiate; 4. Product innovation, despite the restricted theme; 5. Solid and growing client portfolio; 6. No competition in the region.	1. Unsustainable raw materials; 2. Dissemination is practically non-existent outside the religious sector; 3. Low investment in *marketing*; 4. Unattractive *web* page presentation; 5. *Website with* no purchase option.
	Opportunities	**Threats**
External factors	1. Growth of e-commerce; 2. An increasingly high-quality, differentiated offer that needs to be adapted; 3. Manufacture of other products related to the religious environment (*e.g.* flower brightener); 4. Rural areas, where the "word gets around" has considerable power; 5. Partnerships with companies linked to religious culture (*e.g.* florists and funeral directors); 6. Partnership with religious institutions; 7. Participation in trade fairs.	1. Environmental factors; 2. Shortage of inputs for making products (including yellow paraffin); 3. Catholic population (practicing) decreasing; 4. Changing consumer buying habits and "Do Yourself" behavior; 5. Decrease in the purchasing power of consumer.

Source: Own elaboration.

Table 5, the SWOT analysis of the company under study, shows that the number of strengths and opportunities exceeds the number of weaknesses and threats. This scenario could show that the organization is optimistic and expanding.

In short, the organization is generally more likely to prosper, if it chooses to exalt the quadrants on the left, than to regress in the market in which it operates.

4.1 Production System Proposals for Improvement

As an introductory note, it should be noted that there is no order management software, and that contact with management is made by telephone, email or WhatsApp. It should also be noted that the description and analysis of the production process in question refers only to white models, and that the company works with the Just-in-Time system. The infographic of the associated circuit takes into account the following phases:

- Stage 1 - grinding the paraffin;
- Stage 2 - grinding and transportation of the wax;
- Stage 3 - molding the wax into the selected shape;

- Stage 4 - wick distribution;
- Stage 5 - packaging the order.

In order to put into practice the concepts covered in the literature review, recommendations were formalized in this report with the intention of applying the 5S tool (the then Seiri, Seiton, Seiso, Seiketsu and Shitsuke senses). In order to apply the Seiri sense - the sense of use - the content present within the company was collected and subsequently classified and grouped according to its relevance to the performance of duties. In line with the literature review, the necessary is distinguished from the unnecessary and only the tools, parts and precise instructions are kept on site. Table 6 considers these elements and shows how they are grouped according to need and use in relation to the work area. Hirano (1995), quoted by Liker (2004) classifies items as necessary or unnecessary.

Table 6
Classification of Items According to Need and Use

Classification of items				
Needed			Unnecessary	
Constant use	Occasional use	Rarely used	Potentially useful	No potential for use
1. DDS A machine; 2. DDS B machine; 3. DDS C machine; 4. Forklift; 5. Pallet trucks; 6. Forklift charger; 7. Support bench (Phase 5); 8. Support table for main equipment; 9. Pallets; 10. *Stock* (cardboard boxes, paraffin, plastic cups, wicks and caps); 11. Raw materials in use and others (paraffin, plastic cups, wicks, lids and cardboard boxes); 12. Sharp object (phase 1); 13. Transparent tape; 14. Brush; 15. Cleaning material (brooms and dustpans).	1. DDS D machine; 2. DDS E machine; 3. DDS F machine; 4. Parts removed from machines (screws and guards); 5. Boxes with wax removed due to faulty machine action; 6. Scissors.	1. Brown tape; 2. Lubricant spray.	1. Compressor; 2. Various tools; 3. Non-compliant product (candles); 4. Electrical extensions.	1. Label machine; 2. Defective raw materials (plastic cups, lids and wicks); 3. Raw materials used in the second warehouse; 4. Recyclable material (food packaging, small containers, soft drink and cooking oil bottles, cardboard boxes, tubes and other plastic).

Source: Own elaboration.

Once the unneeded items have been disposed of, in this case those listed in the "no potential for use" column, it is essential to put the useful ones away and clean up the work

environment. The "potentially useful" items may remain on the company's premises, but separated in a specific location. The analysis and interpretation of Table 6 will lead to the next stage, which aims to organize and maintain the items described there.

As introduced, the sense of organization - Seiton - stresses what needs to be kept in the work environment, depending on its use, ordering and identifying what is previously stipulated as necessary. For its part, the Seiso sense - sense of cleanliness - defines the need to keep the workspace as clean as possible.

Taking into account the field notes and tools based on observation and conversation, while considering the items in the previous sense, a table was created with 20 processes recognized as being subject to improvement. This revealed common errors in all phases of the production process and standards intrinsic to the organization, predominantly linked to the stock of raw materials and associated waste. The organization also saw clear signs of a lack of cleanliness in the machines, both those that are used daily and those that are used occasionally. Likewise, a number of packages were found in the production area that were inconsistent with the location. The company's greatest difficulty was in reorganizing and taking care of the space and the consequent reuse of the areas, resulting in the (essentially) poor organization of the production line. Table 7, in the light of the procedures identified as being developable, presents proposals for solving the main error mentioned above, and in this respect, the suggested interventions of maintenance and cleaning of equipment, intersect with the acquisition of suitable bins for miscellaneous waste. Improvements will also be presented here with ergonomics and general employee well-being in mind.

Table 7
Improvements Presented to Company Management

Phase	Description	Suggested intervention
1	1. Raw material far from DDS A machine; insufficient circulation space.	Acquisition of a lift table, fixed at an optimum distance from the DDS A machine or determination of an area close to it for unloading raw materials; delimitation of passageways.
1	2. Manual system for placing paraffin blocks in the DDS A machine inappropriate and impractical for the employee; excessive weight and continued poor posture.	Purchase of a lifting table, enabling the pallet to be adjusted according to the employee's preference/height; purchase of an ergonomic belt.
1	3. Empty cardboard boxes with no convenient place to dump them; left for several days, obstructing the employees' passage area.	Acquisition of a container for this purpose, located, if possible, outside the pavilion; agreement with a cardboard collection company (considering the location of the warehouse, Resinorte operates in the perimeter).
4	4. Reduced work tray, with the need to pause the DDS A machine due to the concentration of production.	Purchase of a support bench to free up space on the production tray.

Phase	Description	Suggested intervention
4	5. Lack of auxiliary material with the intention of avoiding daily discomfort for employees, such as back and foot pain.	Purchase of anti-fatigue mats.
5	6. Raw materials of the same category, arranged in different places in the warehouse (*e.g.* cup lids are not all in the same area).	Reorganization of space, delimitation of areas and distribution of raw materials as close as possible to the corresponding phase.
5	7. Support bench shared with the previous phase, making it impossible to arrange storage boxes on the table in question: as a consequence, the periphery was occupied, making it difficult for employees to pass.	Acquisition of an individual workbench. The solution is to clear the way and make it easier to handle materials.
5	8. Once the pallet is complete and packed, there is no identified shipping area; the completed orders are distributed among the empty spaces, mixed in with the *stock of* raw materials or unnecessary material.	Delimiting areas and identifying them. Adopting floor markings (for the activity under study, one of the options will be epoxy paint) throughout the warehouse and placing labels/signs.
General	9. Improperly located factory floor, with a lack of floor markings and identification of sections (*e.g.* "raw material reception", "production", "maintenance" and "dispatch").	Transfer of the production line to near the exit; ground markings using epoxy paint.
General	10. Circulation compromised specifically in the production area corridor, due to insufficient distance between equipment; circulation compromised in general terms.	Reorganization of the shop floor, together with floor markings.
General	11. Non-conforming raw materials permanently in the same space as the production area; no reservoir for storing defective parts.	Identifying a suitable area to place the defective raw material, for later forwarding.
General	12. Forklift and pallet truck without a suitable place to stand.	Reorganization of the space, delimitation of areas with proper identification.
General	13. Wax removed by faulty machinery stored in cardboard boxes.	Since it is possible to put the wax back into the DDS B machine in order to create empty areas and reuse raw materials (and the costs involved), this should be done immediately or by the end of working hours.

Phase	Description	Suggested intervention
General	14. Accumulated wax, the result of cleaning the floor, deposited in cardboard boxes, with no proper place to stay (it remained there for several weeks).	The wax in question is reused in the production of another candle model, in the owners' second factory, so it should be removed and transported frequently, avoiding accumulation and taking up space. Depending on the regularity, a medium-sized storage container could be chosen and, if possible, installed outside the warehouse.
General	15. Various maintenance/safety/cleaning materials randomly distributed not only in the warehouse but also in the production area: machine screws and guards, electrical extensions, various tools, brooms and picks.	Acquisition of a cupboard to store maintenance equipment and tools; individual identification of each item.
General	16. Compressor and label machine unusable, taking up space in the production area.	Verification of the compressor's usefulness for later forwarding; removal of the label machine (as it has no usefulness).
General	17. Disorganized and poorly positioned *stock*, difficult to access.	Reorganization of the warehouse, delimitation of areas through floor markings and establishment of the maximum safety limit for overlapping pallets.
General	18. Miscellaneous waste (soft drink, water and cooking oil bottles, packaging for consumed products, empty containers, tubes, cardboard boxes and plastics) kept mainly in the production area.	Purchase of an ecopoint for inside the warehouse.
General	19. Machines with obvious signs of lack of cleanliness; breakdowns to the detriment of.	Cleaning and maintenance of equipment and work areas. Creating a cleaning plan with the periodicity that best suits (through observation and feedback from employees, the suggestion for rigorous cleaning of each machine is once a week).
General	20. Employees do not have personal protective equipment (PPE).	Purchase of PPE, namely hearing and ergonomic protection and safety footwear.

Source: Own elaboration.

The organization's management was asked to change the current shop floor, since the environment in which the employees work every day is closed, with natural light and insufficient distance between equipment, and the raw materials are arranged at an unfeasible distance. All the equipment was kept, with the sole aim of re-establishing the different zones, with the exception of the recyclable material deposit, which, as we have seen, was proposed to be removed.

Following the alterations, the production line under study and the machines for occasional use were placed close to the exit and with an upper corridor between them - for greater ventilation, passage between machines, natural light and proximity to the outside in case of emergency - creating an upper opening for the organization of raw materials and finished production. This arrangement also favors circulation in the exit area. The area identified as a storage area was eliminated, with the aim of creating a space for this purpose outside the building, thus unobstructing the passage and maneuvering of work, while facilitating the collection of recyclable material. In comparison, from the first to the second layout, the aim was also to manage the existing storage spaces and create more visually attractive places (e.g. placing decorative elements, such as plants in the bathroom). All the aspects described were designed to directly address situations 1, 3, 6, 8, 9, 10, 11, 12, 14, 16 and 17 in Table 7, naturally associated with changes in individual behavior and as a work team.

According to the literature review carried out, the Seiketsu sense - the sense of standardization - involves creating a system for maintaining and monitoring processes, referring to the three previous senses. The aim is to ensure that the workstation functions properly with the help of certain documents, such as procedures and work instructions, technical sheets and maintenance and cleaning plans. Consequently, and due to the lack of the aforementioned documentation, it was drawn up for the interventions checked:

- A Work Instruction (WI) on the production flow of white-tongued tapers;
- An IT for receiving material, specifically cardboard boxes and cups;
- An IT for the treatment of defective raw materials;
- An IT for the treatment of non-conforming products.

In addition, although it is not listed as an object of improvement, as these practices were already maintained before the proposals, it will be added:

- An IT for cleaning the DDS C machine;
- An IT for cleaning the DDS E machine;
- General daily cleaning checklist.

At the same time, signage/awareness-raising boards could be placed around the marked areas. At this stage, it is also suggested that each machine be identified, so that the documents are better understood.

The sense of self-discipline - the Shitsuke sense - makes the whole package of measures developed and applied beforehand sustainable, committing to creating a disciplined culture in which everyone involved takes responsibility for maintaining organizational and cleaning practices and instructions as standard. For this reason, in order for the 5S tool to remain active, evaluation checklists are needed to act as auditors and indicate the real state of implementation. To this end, a document was put in place to check the criteria stipulated in each of the senses. A scale of zero to four was assigned in order to identify nil, bad, fair, good and optimal implementations.

5. Results and Discussion

Through the information observed and duly recorded, it was possible to understand that the team's awareness, including that of the management, has been changing and the great advantage of this is reflected in the work routine. There has been greater interaction between hierarchies, a key point if suggestions are to flow easily and adjustments are to be made jointly. Although a little short of what is needed, in practice there was greater use of the shop floor through reorganization (eliminating items and improving the layout of some stock), an increase in the usefulness attributed to materials, since the hypothesis was raised of creating a second production line using equipment classified as occasional, and a reduction in time spent transporting raw materials in phase 1, as a result of reducing the pallet-machine distance. Considering the wastes pointed out by Ohno (1988) the decrease in unnecessary movement waste was evident, since the poor location and positioning of materials – (Meyers and Stewart, 2002) - was improved, and stock wasted, as the non-processing of raw materials began.

For each step that follows, the implementations applied have been detailed and the next changes scheduled.

Of the items classified in Table 8 as unnecessary, the non-conforming products, auxiliary material, defective raw materials and some of the recyclable waste were removed from the work environment. The remaining items, i.e. unusable machines, miscellaneous tools, the raw material used in the second warehouse and all the recyclable material, have been kept until now, and according to the organization's management, are expected to be evaluated in August, when the company closes for vacations.

Table 8
Unnecessary items in the work routine

Classification of items	
Unnecessary	
Potentially useful	No potential for use
1. Compressor; 2. Various tools; 3. Non-compliant product (candles); 4. Electrical extensions.	1. Label machine; 2. Defective raw materials (plastic cups, lids and wicks); 3. Raw materials used in the second warehouse; 4. Recyclable material (food packaging, small containers, soft drink, water and cooking oil bottles, cardboard boxes, tubes and other plastic).

Source: Own elaboration.

The removal of non-conforming products, defective raw materials and recyclable material from the work area has, in a way, encouraged (certain changes in behavior have stimulated future changes, hence the concern to continue applying suggestions for

improvement when closing for the vacation period) the possibility of creating a second production line, only used for the yellow wax models. As a result, production would be carried out in two independent sequences, one for white candles and the other for yellow candles, and there would be no need to maintain the current system of changing equipment with each order (at the moment, orders that include white paraffin are paused to make way for those that include yellow, as the DDS C machine is used in both processes). Thus, the white wax models would be guaranteed by machines DDS A, DDS B and DDS C, while the yellow wax models, which could form the second line, would be handled by DDS D, DDS E and DDS F, so there would be no need to move equipment, pause production or face maintenance problems.

Following on from this, the apparently unnoticeable elimination of auxiliary material, as indicated in the first paragraph, showed awareness and some interest in what should and shouldn't remain in the work environment, thus creating added value for the company and consequent productivity.

- Description no. 1: the situation listed first refers to the distance from the raw material in use and the fact that the route is partially obstructed. As this is a repeated scenario, it was recommended that ergonomic PPE be purchased or, alternatively, a lifting table be placed in a predefined area (with the added bonus that this would make it possible to lift the pallet, facilitating the employee's process). A suggestion was also made to identify an area close to the DDS A machine, without any extra equipment, solely for boxes of paraffin, in order to reduce the employee's movement.

The problem was detected and the decision was made to keep the raw material as close as possible to the first stage of the production process, reducing the distance from 5.1 to 1.2 meters. The surrounding environment was organized so as not to interfere with the employee's movement. In this way, as well as requiring less time to transport, the weight of the paraffin blocks became more bearable, resulting in an increase in the speed of action.

- Description no. 3: The storage area for the empty paraffin boxes was just a few centimeters from the DDS A machine, obstructing the passage of employees, who repeatedly delayed production in order to clear the area. It was recommended that a container be purchased (due to the considerable quantity of boxes), preferably to be placed outside the premises, and that contact be made with at least one company that collects recyclable material.

The solution that worked best was for employees to place the bins outside the warehouse at the end of the morning and at the end of working hours (no container was purchased for this purpose), thus organizing the internal space and facilitating collection. In the meantime, an external company has agreed to collect the recyclable material on a weekly basis. With this change, employees freed up space, increasing the circulation corridor by around 1.35 meters. The continued elimination of unneeded items will become a favorable and usual practice as the planned layout begins to make sense.

Table 9
Improvements to be implemented

Phase	Description	Suggested intervention	Scheduling
1	2. Manual system for placing paraffin blocks in the DDS A machine inappropriate and impractical for the employee;	Acquisition of a lifting table, making it possible to adjust the pallet according to the employee's preference/height.	August 2023

Phase	Description	Suggested intervention	Scheduling
	excessive weight and continued poor posture.		
4	4. Reduced work tray, with the need to pause the DDS A machine due to the concentration of production.	Purchase of a support bench to free up space on the production tray.	August 2023
4	5. Lack of auxiliary material with the intention of avoiding daily discomfort for employees, such as back and foot pain.	Purchase of anti-fatigue mats.	August 2023
4	6. Raw materials of the same category, arranged in different places in the warehouse (*e.g.* cup lids are not all in the same area).	Reorganization of space, delimitation of areas and distribution of raw materials as close as possible to the corresponding phase.	August 2023
5	7. Support bench shared with the previous phase, making it impossible to arrange storage boxes on the table in question: as a consequence, the periphery was occupied, making it difficult for employees to pass.	Acquisition of an individual workbench. The solution is to clear the way and make it easier to handle materials.	August 2023
5	8. Once the pallet is complete and packed, there is no identified shipping area; the completed orders are distributed among the empty spaces, mixed in with the *stock of* raw materials or unnecessary material.	Delimiting areas and identifying them. Adopting floor markings (for the activity under study, one of the options will be epoxy paint) throughout the warehouse and placing labels/signs.	August 2023
General	9. Improperly located factory floor, with a lack of floor markings and identification of sections (*e.g.* "raw material reception", "production", "maintenance" and "dispatch").	Transfer of the production line to near the exit; ground markings using epoxy paint.	August 2023
General	10. Circulation compromised specifically in the production area corridor, due to insufficient distance between equipment; circulation compromised in general terms.	Reorganization of the shop floor, together with floor markings.	August 2023

Phase	Description	Suggested intervention	Scheduling
General	12. Forklift and pallet truck without a suitable place to stand.	Reorganization of the space, delimitation of areas with proper identification.	August 2023
General	13. Wax removed by faulty machinery stored in cardboard boxes.	Since it is possible to put the wax back into the DDS B machine in order to create empty areas and reuse raw materials (and the costs involved), this should be done immediately or by the end of working hours.	August 2023
General	14. Accumulated wax, the result of cleaning the floor, deposited in cardboard boxes, with no proper place to stay (it remained there for several weeks).	The wax in question is reused in the production of another candle model, in the owners' second factory, so it should be removed and transported frequently, avoiding accumulation and taking up space. Depending on the regularity, you could opt for a medium-sized storage container and, if possible, install it outside the warehouse.	August 2023
General	15. Various maintenance/safety/cleaning materials randomly distributed not only in the warehouse but also in the production area: machine screws and guards, various tools, brooms and dustpans.	Acquisition of a cupboard to store maintenance equipment and tools; individual identification of each item.	August 2023
General	16. Compressor and label machine unusable, taking up space in the production area.	Verification of the compressor's usefulness for later forwarding; removal of the label machine (as it has no usefulness).	August 2023
General	18. Miscellaneous waste (cooking oil bottles, packaging from consumed products, empty containers, tubes, cardboard boxes and plastics) kept mainly in the production area.	Purchase of an ecopoint for inside the warehouse.	August 2023

Phase	Description	Suggested intervention	Scheduling
General	19. Machines with obvious signs of lack of cleanliness; breakdowns to the detriment of.	Cleaning and maintenance of equipment and work areas. Creating a cleaning plan with the periodicity that best suits (through observation and feedback from employees, the suggestion for rigorous cleaning of each machine is once a week).	August 2023
General	20. Employees do not have personal protective equipment (PPE).	Purchase of PPE, namely hearing and ergonomic protection and safety footwear.	June 2023

Source: Own elaboration.

In order to set the procedures and make them practically in the team, the improvements implemented were formalized (Table 9). At the end of April, the ITs and cleaning checklist became available, subject to the approval of the company manager. In this way, the activities are carried out in the same way, regardless of the employee carrying them out. The documents were both placed in an appropriate place and recognized as useful, and now, at the end of working hours, the checklist is checked step-by-step by the entire team, including the recently hired employee. No signage/awareness-raising signs have been put up, as this action will be accompanied by the rest of the suggestions to be made during the employees' vacation break.

It is extremely important that procedures are maintained and that the effort is repeated daily (Hirano, 1995, cited by Liker, 2004). Continuous evaluation is therefore essential in ensuring commitment and discipline to the 5S philosophy, helping to sustain the results achieved. The 5S implementation checklist showed that the most frequently awarded score was "fair", followed by "excellent". The analysis reflected the employees' commitment to the new concepts and willingness to maintain them and continue with the previous processes (points marked as strong). The absence of a "nil" score indicated that the 5S dynamic is well accepted by the company, even though there are still many aspects that need to be optimized, much of which is focused on organization and not so much on use. Improvements should be made to the arrangement of items, so that the work routine becomes more fluid and less exhausting. In discussion with the head of the organization, it was agreed that audits should be scheduled regularly, monthly if possible.

6. Conclusion

In increasingly non-predictable times, it turns even more relevant to establish internal processes to exceed market’s expectations.

Bearing this demanding environment, lean management based on its tools is capable to identify waste, non-value-added activities, unnecessary material movements, so as to reduce inventory levels.

Further to the shop floor re-organization, to have a continuous flow of materials and steps, also the packaging concept has been improved. With regard to the improvements considered the packaging methodology was reviewed, the minimum order quantities, so as, the inventory levels were leveled. To standardize these improvement practices, support

documents such as work instructions and cleaning plans were formalized, which proved useful as the team recently increased.

Based on the improvements several reductions have been registered, such as the time related to deliver the raw materials to the production flow, which in itself makes the collaborator more productive. The elimination of waiting time in circulation areas, since the passage in many cases hindered the transportation of materials. This rearrangement enabled a more organized, unloading area, so as stock management in the warehouse. At the end, the organization was able to double the production line, based on the savings reached on hand of the lean implementation.

The path to reach these lean management objectives rely on knowing the entire process related to the shop floor and its production line, to be able to identify waste. Furthermore, to provide clear insights, written procedures and work instructions should guide collaborators along their tasks to assure the standardization of the process. The contributions of this research are twofold. The first is that it provides guidance for the researcher, particularly in academic circles, in order to guide the use of the methodology applied in a similar practical situation; the second is that it represents a structured way of applying Lean thinking for senior managers, helping them to find and mitigate the challenges associated with the working environment of any manufacturing company. In the same vein, the study in question could be especially useful for organizations that are in the process of implementing the Lean philosophy, given that a theoretical approach has been carried out with standardized improvements, which could be introduced into other production flows.

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