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Improved Performance in Retail Distribution Process Through A Lean Manufacturing Approach: A Case Study

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Abstract:

Purpose: This research aims to implement Lean Manufacturing (LM) techniques and tools (T&T) in a retail distribution center located in Mariano Roque Alonso, Paraguay, targeting waste reduction and efficiency improvements in fresh and frozen product (FFP) handling to reduce long lead times.

Design/methodology/approach: This study was conducted in two phases. First, a literature review revealed the key gaps to be addressed, the most commonly faced problems, and the LM tools applicable to solving these issues. Second, a case study was conducted in which LM T&T were applied to reduce the long lead time and propose solutions to address difficulties in the FFP process. Five problem-detection tools (flowchart, brainstorming, Ishikawa diagram, Pareto, and value stream mapping) and three improvement tools (kaizen, 5S, and Plan-Do-Check-Act) were applied to streamline FFP process from order generation to store reception.

Findings: The analysis revealed significant inefficiencies: four were workforce-related, ten related to work methods, six environmental, and three product-related. Addressing these issues could substantially reduce operational bottlenecks and improve process throughput.

Practical implications: The application of LM techniques significantly minimized waste, enhancing time management and human resource utilization, which led to a 96% improvement in FFP processing efficiency. These changes are expected to shorten lead times, bolster competitive advantage, and increase customer satisfaction.

Originality/value: This study underscores the versatility of LM techniques, adapting them from manufacturing to retail distribution. The innovative combination of kaizen with 5S and PDCA offers a robust framework for ongoing improvements, promising for broader adoption in the retail sector.

Keywords: lean manufacturing, lean techniques and tools, retail distribution center, process improvement, value stream mapping

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1. Introduction

Lean Manufacturing (LM) is a production philosophy that originated in Japan with the Toyota production system (Manotas & Rivera, 2007). LM tools help to identify, eliminate or combine waste (*muda*), improve quality, and reduce production time and cost (González-Correa, 2007). Ohno (1988) identified seven types of waste: overproduction, waiting, transportation, overprocessing, inventories, movements, and rework. Nowadays, an eighth type of waste is also mentioned: human talent.

After implementing LM tools (individually or combined), it is expected to observe a reduction in cycle time, elimination of non-value activities, and a clean, tidy, and hygienic workplace (Palange & Dhatrak, 2021). Nevertheless, lean culture is difficult to apply in logistics and distribution sectors given the volatility of demand and a high degree of human participation (Alvim & Ottomar, 2020). Problems such as stock failures, off-spec orders, inefficient inventory control, and poor storage methods are common in this sector, which can lead to economic losses and customer dissatisfaction (Bedoya-Vargas & Del-Carpio-Lagones, 2024).

LM improvements could have a positive impact on commercial retailers, which are facing challenges that range from inventory management to demand planning in a highly competitive global environment (Bedoya-Vargas & Del-Carpio-Lagones, 2024). Thus, Lean concept adoption leads to improved on-shelf availability, minimized wastes, optimized inventory management and better space utilization, increased customer service and satisfaction, increased productivity, sales margins, and profitability in the retail industry (Čiarnienė & Mančas, 2024). The principles of LM support all industrial operations, covering the entire company (Maldonado-Villalva, 2008). Yet, it is imperative to consider supply chain management as a system and not to apply lean practices only to isolated parts of the chain (Alvim & Ottomar, 2020). In the next 10 years businesses in the retail sector will face important challenges through disruptive changes in their business models and growth strategies and will adopt Lean thinking as their way to adapt in this new scenario (Jimenez, Cuadros & Aranibar, 2021).

The most commonly Lean techniques and tools (T&T) used and the ones that have proven successful in retail are 5S, Value stream map (VSM), Visual management, and Kanban (Čiarnienė & Mančas, 2024). However, there are still a limited number of studies focused on exploring the relationship between Lean Supply Chain Management and competitive advantage (Khawka, Abd-Rahman, Sidek, Ahmed, Al-Hadeethi & Al-Dabbagh, 2024).

Nowadays, competition and complexity in the retail or supermarket industry are increasing internationally and nationally. Characteristics of the retail market are: strong competition, shorter product life cycle, longer product development time and high sensitivity of demand. Retailers operate strategically oriented to lower prices and gain exemption from holding unnecessary stocks (Lukic, 2012). Customers are seeking a defect-free product or one with special attributes and a pleasant purchasing experience in which they receive the product quickly. In this sense, for a product to reach a supermarket shelf, there is a lot of logistical effort involved, from contact with suppliers through the supply or commercial area to preparing and moving the products and finally transporting and distributing them to the stores. These operations are often carried out at strategically located distribution centers (DC), which distribute products from multiple suppliers to the stores.

Globalization has pushed fierce competition in the global market (Shakoor, Qureshi, Jadayil & Jaber, 2017). The retail growth rate in developed economies is constantly increasing, as indicated by the ATKearney Consumer Index's 2030 market foresight report, which notes that emerging markets' share of global retail sales jumped from 32% in 2000 to 51% in 2015 (Boojihawon, Richeri, Liu & Chicksand, 2021). Many companies are looking at value addition in each area of manufacturing or services where LM tools and concepts can be applied to decrease waste to differentiate themselves from competitors and remain at the forefront of their sector (Shakoor et al., 2017).

Many retailers have adopted operational programs based on Lean principles to enhance the effectiveness and productivity of their in-store, online and/or supply chain operations, methods and tools to improve performance, productivity and customer satisfaction (Marques, Jorge & Reis, 2022). Since multinational retailers are facing challenges in expanding into emerging markets in Latin America, this study intends to overcome the existing gap within the retail industry by specifically addressing the challenges of implementing LM in emerging markets such as Paraguay. This country has one of the fastest growing economies and yet faces several obstacles such as underdeveloped logistics and real-estate infrastructures, shortage of local talent, complexity of fragmented local consumer behavior and culture, and underdeveloped institutions (Boojihawon et al., 2021). In addition, through a case study, this research aims to determine the benefits of applying Lean principles and tools in a retail company that seeks to continuously identify and eliminate waste factors from its value streams or processes, contrasting the findings reviewed in the literature.

2. Related Works

The retail sector faces challenges related to operational efficiency, inventory management, and demand response capacity. The lean approach has proven to be effective in reducing waste and optimizing processes in various industries; however, its implementation in the retail environment still presents opportunities for improvement. The literature review covered applications in different sectors to identify the most commonly used lean tools in these industries, providing a basis for replicating their application in the retail or logistics sector. The following are the findings obtained in studies that applied the lean approach, classified according to their application in the manufacturing, retail, and logistics sectors, mostly in Latin America to contrast their characteristics with the retail industry in Paraguay. The findings discovered at length are presented in Appendix A.

2.1. The Benefits of Implementing LM Tools Across Diverse Sectors

In order to continue contributing to the global economy, small and medium-sized enterprises require strong internal production capabilities that can be achieved through a lean manufacturing process that uses fewer resources and offers greater process improvement (Huang, Lee, Chen & Tang, 2022). Some of the benefits obtained in studies where LM tools were applied in various sectors are mentioned as follows. A case study was conducted on a small-medium-sized metal processing manufacturer in China to reduce lead time, work-in-progress, and inventory while increasing the shipment completion rate and efficiency in various processing stages. To achieve these goals, brainstorming sessions were held and various methodologies such as VSM, SMED, and kanban were implemented. In addition, improvement implementation was based on the Plan-Do-Check-Act (PDCA) cycle (Huang et al., 2022).

Moreover, in a study presented by Singh, Garg, Sharma and Grewal (2010) the objective was to detect different types of waste in the value stream of components manufacturing and to take action to eliminate them. Furthermore, this study introduced the kanban system between the organization and suppliers to achieve schedule and delivery discipline and reduced manpower requirements to track demand and inventory at the organization. VSM was also implemented to reduce lead time in dairy processing (Kumar & Shankar, 2022).

The benefits of LM tools extend to address poor service and low customer satisfaction in the bakery business, where a process improvement approach was applied (Mandujano-Malpartida & Vigil-Farfan, 2021). Kaizen, Kanban, and 5S were used in the jewelry industry to optimize value-added time in product manufacturing (Dasgupta, Jain & Ranka, 2023).

On the other hand, LM tools were used in two studies to improve the workplace, indicating that the application of the 5S tool helped to improve order, cleanliness, and safety of the workplace, thus increasing the productivity of the processes (Herrera-Condor & Idiaquez-Poma, 2018; Molina-Barrón, 2016). However, both applications emphasize that the main objective is to reduce costs and increase productivity. Similarly, two studies (Bueno-Rueda, 2020; Paredes-Ortiz, 2017) applied 5S to decrease processing time.

Facing a lack of innovation, LM principles were successfully applied in the food and beverage industry to demonstrate effective implementation (Borges-Lopes, Freitas & Sousa, 2015). Employing tools such as brainstorming, 5S, SMED, and spaghetti diagrams, the industry witnessed heightened productivity, enhanced production flexibility, greater employee engagement, the fostering of a culture of continuous improvement, and reduced lead times. The study revealed that the kaizen tool enhances its effectiveness when used with other tools like 5S or PDCA. In this sense, combining kaizen and 5S tools is key to achieving waste reduction within the processes (Angeles-Méndez, 2018; Mallqui-Ramirez, 2018; Natera-Iglesias, 2007). In addition, studies have emphasized that this is the path toward developing continuous improvement. There was a significant nexus between the cleanliness level and the number of process failures, which could indicate a company's attitude toward improvement actions related to essential management aspects (Iglesias-Reyes, 2006). Furthermore, LM tools application influences worker performance and morale (Dávila-Rodriguez, 2018; Iglesias-Reyes, 2006). On the other hand, many companies in economic sectors fail to implement LM practices because of the inability to measure performance over the medium and long term (Panigrahi, Al-Ghafri, Al-Alyani, Ali-Khan, Al-Madhagy & Khan, 2023). This indicates that it is important for companies to be aware of management responsibility when using LM strategies (Panigrahi et al., 2023).

2.2. The Benefits of Implementing LM Tools in the Retail Sector

Retail companies play a vital economic role by providing goods directly to consumers. They serve as crucial intermediaries between suppliers and consumers, offering a wide range of products while adapting to changing consumer preferences and market trends. Retailers continually innovate their strategies to enhance the customer experience and remain competitive in a dynamic marketplace. A literature review was conducted to identify the strategies used to address distribution challenges in retail companies and select the most effective ones based on the company's specific features. Due to the lack of recent studies on the implementation of LM tools in Paraguayan retail distribution companies, the search was mainly focused on studies conducted in Latin America to identify similarities and obstacles observed in the retail and logistics sector.

The adoption of lean culture has been little documented in distribution centres. However, this method is difficult to implement in companies from the distribution sector due to the volatility of customer demand, the high degree of human participation and the demanding mechanical and repetitive activities in retail and storage activities (Jaca, Santos, Errasti & Viles, 2012).

Retail companies perceive the need to reduce food waste regarding perishable food products. To address this concern, a Colombian study sought improvement through the use of quality tools and techniques to reduce food waste in the perishable sections of a large-scale warehouse (Martínez-Guzmán, 2021). They resalted that the main causes of the problem are associated with labor, machinery and, methods, including non-performance of quality parameters, errors in order planning and, inadequate refrigeration equipment related to lack of preventive maintenance. According to their research, 5S, SMED, total productive maintenance (TPM), and kaizen tools are the most appropriate to eliminate the potential causes identified.

Different factors influence delays in the logistics process, such as delays in merchandise reception, availability of resources and supplies to prepare orders (pallets, stretch film, tools), and machines to move the merchandise (Farfan & Silva, 2019). In addition, in the work presented by Farfan and Silva (2019) the main causes of rejected orders in a retail company were related to products arriving in bad condition, incorrect orders (products not ordered), and orders that did not meet customers' specifications. VSM, Ishikawa, Pareto diagrams, flowcharts, 5S, and SMED were implemented to decrease operation time by 14,5%.

On the other hand, a research study stated that the online retail market has become very competitive (Qin & Liu, 2022). Considering this, they applied VSM and the 5-why method to identify potential waste in the supply chain of an e-commerce retailer on Amazon. As a result, lead time was reduced and customer satisfaction increased (Qin & Liu, 2022). Furthermore, the implementation of robotic process automation within logistics companies frees up the workforce for value-creating activities in value-added services (Lam, Tang & Wong, 2024). Concurrently, the significance of smart supply chains and technologies in attaining operational excellence was highlighted in a research study that suggested that a smart supply chain could address issues related to delivering the correct quantity of products to customers promptly, under appropriate conditions, and at reduced costs (Lee, Wong, Alzoubi, Al-Kurdi, Alshurideh & El-Khatib, 2023).

In the logistic area of a Peruvian distribution center, 5S, SMED, and VSM combined through kaizen methodology permitted a 14% decrease in error numbers, leading to reduced costs and efficiency improvement (Puchoc-Barzola & Trejo-Pantoja, 2020). Kaizen methodology was also used in a work presented by Angeles-Méndez (2018) to increase productivity by 20% in a retail company.

Baby and Jebadurai (2018) analyzed the implementation of VSM in an Indian sales warehouse to improve operations and reduce lead time. Because of its capacity to identify bottlenecks and issues in a warehouse, VSM made it easier to recognize inefficient space utilization, long order picking times, improper storage, and delays in vehicle loading. Similarly, logistics were improved and distribution productivity was enhanced by 30% by carrying out VSM, as well as other LM techniques and tools like kanban, flowcharts, Pareto and Ishikawa diagrams (Alfaro-Rodriguez, 2017). In the study conducted by López-Morales (2013), it was proposed to reduce lead time by previously implementing a flowchart, Ishikawa diagram, and VSM in a wood and hardware warehouse.

Whereas in an auto repair company's warehouse delivery time violations were reduced by 19.94% by applying 5S, standardized work, and Pareto diagram (Quiroz-Flores, Posada-Pineda, Anis & Nallusamy, 2023). In order to improve production management in an interior design warehouse (Dotoli, Epicoco, Falagario & Costantino, 2013), oil and gas company logistics (Reis, Stender & Maruyama, 2017) and, machinery parts warehouse (Chavez-Vargas, 2019), Gemba Shikumi was applied.

Implementation of Ishikawa and Pareto diagrams is critical to identify problems linked to logistics costs and propose solutions to these problems (Alayo-Alvarez & Siccha-Camacho, 2021; Dita-Triana, 2021). These tools permitted the identification of nine root causes that generate high processing costs in a mill, poultry, and cattle feed in an industry in Peru, where a kanban system was proposed to avoid shortages of fast-moving items in inventory (Alayo-Alvarez & Siccha-Camacho, 2021). Storage capacity in an advertising and marketing company was increased by 31% using LM tools with high inventory costs (Rosas-Condor, 2021).

Logistics cost was reduced by 50% in a distribution center through lean logistics methodology with VSM, 5S and flowchart (Hernández-Zelada, 2020). Ishikawa diagram was used in a study to point out logistics problems in a drugstore company (Layme-Castillo, 2020). VSM, just in time (JIT), 9S, Andon, kanban, poka-yoke, and total quality management (TQM) were suggested as logistics improvement techniques (Layme-Castillo, 2020).

The construction sector has also witnessed improvements, as highlighted in the research conducted by Molina and Mora (2019). The study focused on reducing inventory costs in a construction materials warehouse through flowcharts, Ishikawa, Pareto diagrams and VSM. As a result of the study an improvement plan was proposed, inventory management was enhanced, and consequently, the inventory costs decreased.

The effectiveness of applying LM tools was demonstrated in a fruit distribution center in Portugal (Proença, Gaspar & Lima, 2022). This implementation reduced cycle time and lead time across the entire process, particularly crucial when dealing with perishable products. The study indicated that it is possible to reduce or eliminate waste throughout the process, including unnecessary activities, seeking to adapt the layout and maximize the workspace in a constant improvement perspective (Proença et al., 2022).

Although some studies have explored the use of lean tools in manufacturing, their application in commercial logistics is still a developing field. In this context, this study aims to analyze and apply lean tools in a retail sector company to improve its operational performance and contribute to the existing knowledge on the adoption of these methodologies in this type of company.

Since this case study was developed in a retail company in Paraguay, a literature review was conducted, mainly focusing on Latin America, with a majority representation of studies from Peru. The objective of this review was to identify the most commonly used tools in both the retail and logistics sectors, as well as in other relevant industries in the region, by analyzing the specific problems addressed by LM T&T and the results commonly obtained in the Latin American context. This geographical orientation is further justified by the relevance that Bedoya-Vargas and Del-Carpio-Lagones (2024) give to small and medium-sized retail companies in the global economy, with special emphasis on Latin America and Peru.

Moreover, the choice of Paraguay as the location for the case study is based on its particular economic context and the significant opportunities and challenges it presents for the implementation of methodologies such as lean in the retail sector. Despite having one of the fastest-growing economies, Paraguay faces obstacles related to operations management and efficiency in the retail sector, including underdeveloped logistics, shortage of local talent, and developing institutions (Boojihawon et al., 2021). The combination of dynamic economic growth with specific operational challenges makes Paraguay a relevant scenario for assessing the impact and adaptability of lean practices in a Latin American context with unique characteristics.

More specifically, this case study focuses on identifying the challenges and activities that do not add value to the FFP (Fresh Food Products) process within the Paraguayan company. The purpose of this identification is to support the proposal of potential solutions that could result in time optimization and a more efficient process flow. In addition, the optimal flow process for FFP through the Distribution Center (DC) is defined to eliminate existing inefficiencies in the current operation.

3. Methodology

The methodology of this study was structured into two phases. The first phase consisted of an exhaustive review of the existing literature, with the main objective of identifying the Lean Manufacturing (LM) techniques and tools most commonly used in the retail or logistics sector, as well as in other relevant industries in the region. Given the applied nature of the second phase, which was developed as a case study of a retail company located in Paraguay, the literature review focused mainly on the Latin American context. Secondly, we sought to understand the specific problems addressed by these techniques and tools (T&T) and the results commonly obtained in the context analyzed.

The direct connection between both phases lies in the fact that the findings of the literature review (identification of effective tools and common problems in Latin America) provided a theoretical and practical basis for the selection and subsequent application of lean tools in the specific case study of the FFP process within the Paraguayan company. Specifically, this case study focused on identifying the activities that do not add value to the FFP process, the purpose of which is to support the proposal of possible solutions that can optimize times and generate a more efficient process flow and reduce long lead time.

3.1. Phase 1: Literature Review

In the first phase, a comprehensive review of the available literature was conducted between 2005 and 2023 to identify the most widely used LM T&Ts in the retail sector worldwide. This period was selected to cover the recent trends and evolution of LM applications in this sector. Additionally, studies applying LM T&T to industries other than the retail sector were included in the selection. This strategic inclusion allowed us to analyze the benefits and difficulties of implementing lean in various settings and operational contexts, offering a broader and more robust perspective to understand its potential and the specific challenges that could be presented in the industries.

The following databases were used for the literature search: EBSCO, Scopus, Web of Science, and Google Scholar, which are recognized for their broad coverage of academic and scientific publications at the international level. Google Scholar was used to complement the search by covering non-peer-reviewed studies, unpublished sources and other potentially relevant sources.

Initially, the keywords "Lean Manufacturing in distribution centers," "Lean Manufacturing in logistics," "Lean Manufacturing in perishable processes," and "Lean Logistics in distribution warehouses" were defined and used in both Spanish and English, which allowed finding studies and thesis carried out in Latin America, in Spanish and English. The term "Lean Manufacturing" was considered more specific and appropriate to capture those studies that analyze the implementation of Lean in logistics, inventory management, in-store process optimization, and other key retail operational areas. Thus, this strategy made it possible to identify studies that might not have used the specific terms distribution or logistics in the title, abstract, or keywords but that applied LM principles and tools relevant to the retail sector.

Given the large amount of information obtained, the first selection stage was carried out based on a revision of the title, abstract, and keywords of published articles and studies. Those works in which the defined keywords or terms related to LM and its application in the supply chain or operational processes of the retail sector were not mentioned were discarded. This initial screening stage was crucial for focusing the review on the most relevant and adaptable literature in the context of the case study.

The initial search yielded 921 publications, including articles and studies in Spanish and English. This volume underscores existing interest and research in the field of LM and related areas. Subsequently, the preliminary results were analyzed in greater detail by examining the full texts and references of the pre-selected publications.

In the second stage of selection, the search was restricted to journal articles and studies where LM T&T were implemented specifically in logistics or production processes. The search included studies that applied LM T&T to the logistics and production processes of materials and products other than fresh and perishable products, such as electrical materials, drugstores, wood products and hardware, and construction materials. The inclusion of studies from other sectors is justified by the transferable nature of LM principles and tools, which can often provide valuable insights into the optimization of logistics and production processes in different industries.

After discarding repeated works and studies without a clear implementation of LM T&T in the context of logistics or production, 33 publications were considered relevant to the scope of study and were reviewed in depth to identify the T&T applied. The flowchart in Figure 1 depicts sequentially the different stages of the literature review process, from the definition of keywords to the final selection of relevant studies.

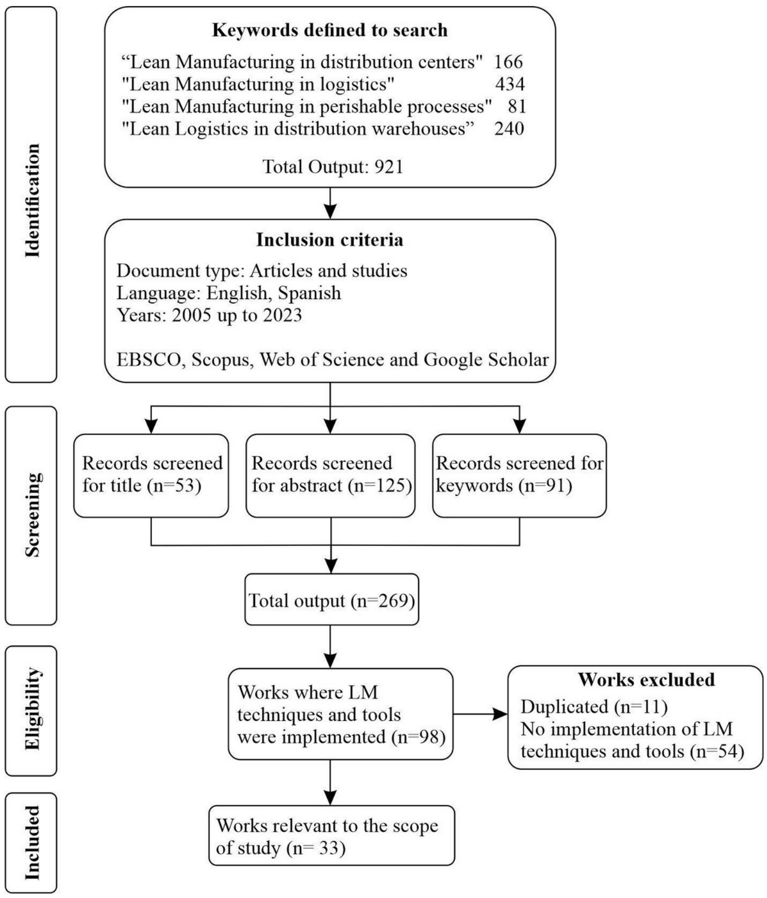

Figure 1. Literature review process

3.2. Phase 2: Case Study

A case study is presented on one of the largest retail companies in Paraguay with more than 80 points of sale nationwide, including two stores in Luque and Mariano Roque Alonso. The analyzed distribution center (DC) plays a crucial role in the logistics of this extensive retail network, handling a wide variety of products, ranging from groceries and bazaar items to textiles, cleaning products, fragrances, and fresh or frozen foods. The choice of this case is justified by the representativeness of the company within the Paraguayan retail sector, where its volume of operations and the diversity of products handled make it a key player. Analyzing the particularities of its logistics, especially in the handling of fresh and frozen products, offers valuable insight into the challenges and opportunities present in large-scale retail distribution in the country.

A distinctive and challenging aspect of this DC is the delicate logistics required for the handling and storage of fresh and frozen products, which account for 79% of purchases in this sector (of which only 40% are weighable products), demanding the maintenance of specific cold temperatures throughout the transportation process. This study focuses on the analysis of the retail transportation of perishable products (meat, poultry, fruits, and vegetables) from DC to stores. The fresh and frozen process has been identified as having significant difficulties in recording input, output, and movement information. This is partly due to the need for transparent and standardized processes for weighable products, where the actual quantity delivered by suppliers often varies from the quantity ordered. These discrepancies generate distortions in the system information and flow of products, causing inconsistencies throughout the process and the need for multiple reprocesses when recording information. This situation makes time a critical factor in DC operation.

The identification of LM T&T through the literature review phase was a crucial step in addressing problems related to the long lead time in the analyzed process. The literature allowed the identification of LM T&T that contribute to the detection and solution of problems, schematization, and standardization of the FFP process. The selection of these tools was based on the need for a clear visualization of the process and better interpretation and detection of any difficulties encountered. The scope for applying LM T&T extends from the placement of the order by the purchasing and perishables supply department to the physical and theoretical receipt of merchandise in stores. Figure 2 illustrates the stages in which this process was divided, along with the sub-processes that comprise each stage.

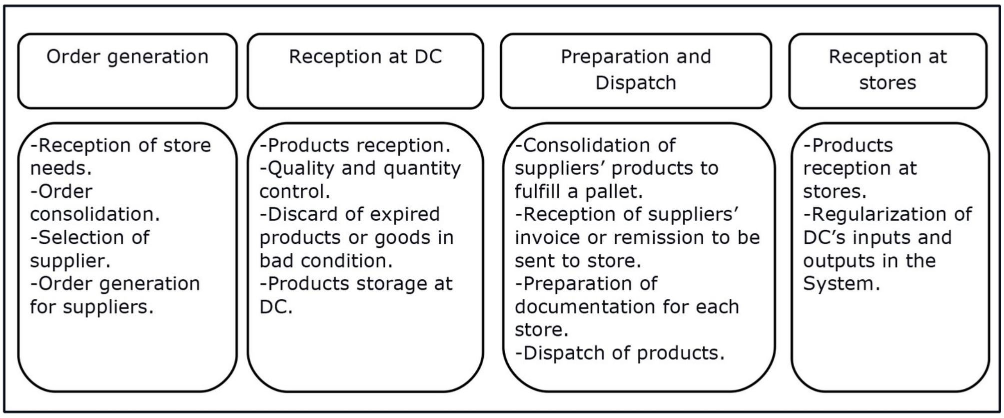

Figure 2. Process of fresh and frozen products

Each of the mentioned stages is described as follows:

- Order generation: The process starts with the reception of the store's requirements. A purchase request is then generated, followed by the consolidation of all the orders by the purchase and supply analyst. The analyst's crucial role is to select the supplier that provides the best price and can assure timely delivery. An order is created for each supplier, who is responsible for delivering the products according to the DC order. Nowadays, distribution from the DC to the stores occurs once a week.
- Reception at DC: During this stage, the quantity and quality of products are thoroughly inspected to identify expired items or products in bad condition. If any expired or bad products are found, they are discarded. In case of any discrepancies in the quantity of products received or if any products in bad condition are discarded, the supplier will be required to modify the invoice to reflect the actual quantity of

products in good condition. Depending on the day the supplier arrives at the DC, the merchandise can either be stored at the DC or loaded directly onto the truck for delivery to the stores. This entire process takes approximately 26 minutes.

- Preparation and Dispatch: To ensure efficient delivery of products, suppliers' items are consolidated into pallets by the store. Once this is done, the supplier invoice or remission for the destination store is received by DC. At the DC, operators prepare all necessary documentation for each store and dispatch the products, which takes approximately 23 minutes per truck. The trucks are prepared in a way that allows them to be distributed to multiple stores along the way.
- Reception at stores: This process is performed when the products are physically received at the stores. In some cases, with imported products, the inputs and outputs of the distribution centers must be regulated in the system to allow the store to theoretically receive the products. This sub-process is usually completed days or even weeks after the products have been received at the stores, and it takes an average of 226.5 minutes. The physical reception of the products at the stores takes place before the theoretical reception through the system.

Although the study explores various stages of the process, from order generation to reception in stores, it is observed that the reception of products in stores takes considerable time, with an average of 226.5 minutes for theoretical reception through the system, which can even be completed days or weeks after physical reception. This long lead time, particularly evident in the final stage of the process, underscores one of the central issues in fresh and frozen logistics for this major retail chain. The implementation of lean tools, such as process flow, brainstorming, and Ishikawa diagrams, seeks to facilitate a better understanding of the process and identification of areas for improvement, with the ultimate goal of optimizing efficiency and reducing lead times in the different stages. This case study focuses on one of the largest retail chains in the country and addresses the specific challenges of the logistics of perishable products, allowing us to obtain relevant and potentially applicable findings to other similar contexts within the sector.

Optimizing the logistics process for fresh and frozen products in this important retail chain in Paraguay presents a significant opportunity for substantial benefits. The reduction in the long lead time, especially at the receiving stage in stores, could translate into greater operational efficiency and a reduction in costs associated with reprocessing and inconsistencies in information. By implementing more transparent and standardized processes, as intended through visualization and problem-solving tools, more precise inventory management and better distribution planning can be achieved, which could reduce losses due to product deterioration. Ultimately, improving efficiency in this critical area, which accounts for a significant portion of customer purchases, has the potential to strengthen the company's competitiveness and improve customer satisfaction.

4. Results and Discussions

Through the examination of logistics procedures at the distribution center, employing the validation and implementation of T&T, a nuanced insight into the intricate challenges and potential enhancements within the operational framework is revealed. This section presents the findings and discussion for both Phase 1 and Phase 2.

4.1. Phase 1: Literature Review

Of the literature reviewed, 66.7% (22 studies) originated in Latin America (see Figure 3), with a notable concentration of research coming from Peru and Colombia. This preponderance of Latin American studies in the literature review, with a particular emphasis on Peru, is because the fundamental purpose of this review was to recognize the lean tools most frequently used in the manufacturing, retail, and logistics sectors within the Latin American context. This included the analysis of the specific problems that LM T&T have addressed and the results commonly obtained in this geographical environment. Notably, the database search did not yield any studies on LM implementation in Paraguayan companies, which could be explained by the lack of publications related to logistics in Paraguay.

Figure 4 shows the growth of LM research and applications over the years. In this sense, more work has been carried out in the last five years due to the increased interest in productivity improvement.

The number of times that each LM tool was used among the 33 works reviewed was counted and displayed as a percentage in Figure 5. It was found that the most applied LM T&T were VSM, 5S, Ishikawa and Pareto diagrams, flowcharts, kaizen and, kanban. Other less used LM tools included brainstorming, SMED, standardized work, spaghetti map, gemba shikumi, the 5-why method, PDCA and, poka-yoke.

The literature review played a key role in identifying recurring problems and effective solutions applied in the retail, logistics, and manufacturing sectors, particularly in the Latin American context. This initial exploration provided a solid basis for orienting the selection of tools towards those most likely useful for the specific challenges identified in the Paraguay DC, especially those related to long lead times. 45% of the studies shown in Appendix A focused on reducing long lead times, which are commonly caused by inefficient management of processes, warehousing, or logistics. Among these studies, the most implemented LM T&T were VSM and 5S. These helped in achieving lead times, production time, cost reduction, increased customer satisfaction, and improvement in warehouse and processing stages. Considering the problems to be reduced or eliminated in the reviewed studies, 42.4% incorporated kaizen, kanban, or both as a part of continuous process improvement.

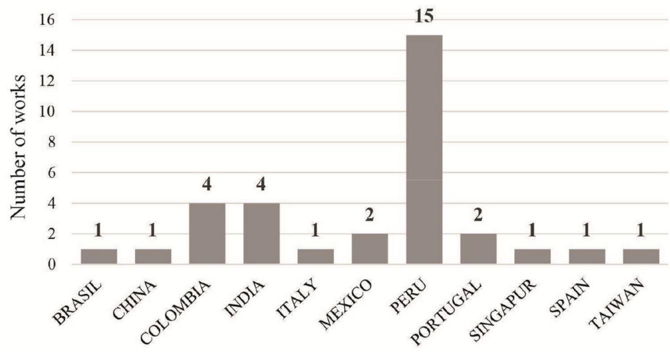

Figure 3. Number of works by country

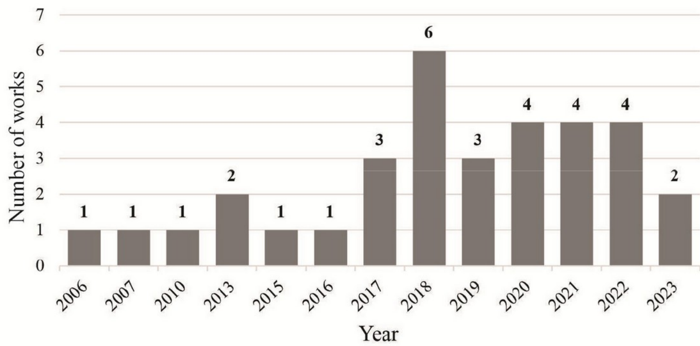

Figure 4. Number of works by year

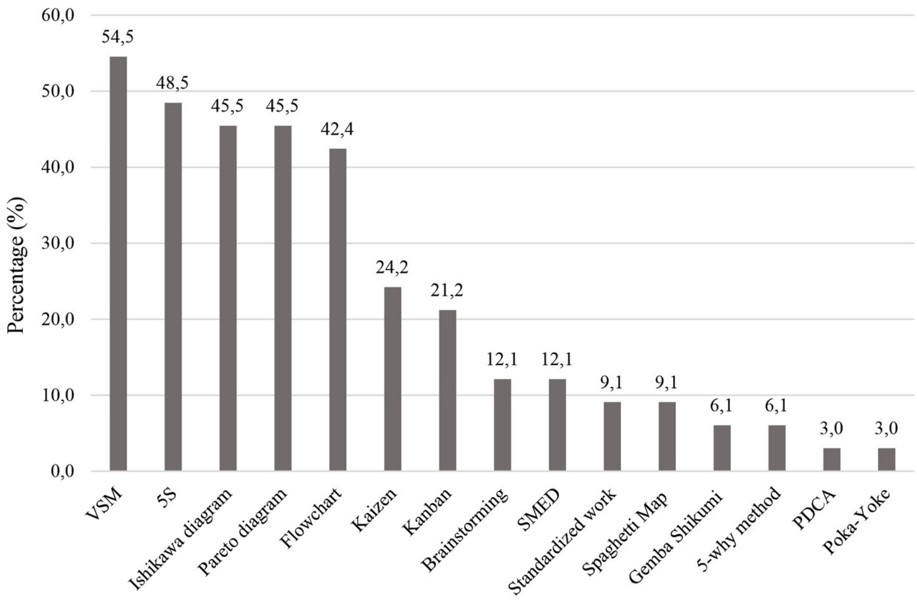

Figure 5. Percentage of use of each LM tool

As mentioned above, the FFP process had difficulties related to the recording of input, output, and movement information, especially due to the variability in the quantities delivered of weighable products, which generated distortions in the information and the need for multiple reprocesses, consuming valuable time. In this context, the flowchart made it possible to identify the points where inefficiencies and possible bottlenecks that contributed to the long lead time occurred. The brainstorming facilitated the identification of the various causes in the process that impacted delivery times, and in turn, served as a complement to the Ishikawa diagram, which allowed structuring and visualizing with greater precision the causes that contributed to the long lead time, allowing a deeper analysis of its roots. On the other hand, the Pareto diagram helped prioritize the most significant causes that generated most of the delays in the process, allowing us to focus improvement efforts on the areas of greatest impact. Finally, Value Stream Mapping (VSM) facilitated the identification of value-adding and non-value-adding activities by highlighting opportunities to reduce cycle times and eliminate waste that contributes to the main problem. Singh et al. (2010) stated that VSM is a powerful tool to implement in practically any business activity and allows the identification of gap areas in the production industry.

These tools were selected based on the research objective of improving the efficiency of the FFP process and the knowledge of how these lean methodology tools can address the specific issues of process visualization, difficulty detection, schematization, problem-solving, and process standardization identified in the DC, which ultimately affected the overall delivery time.

4.2. Phase 2: Case Study

The implementation and validation stages played a crucial role in ensuring that the selected T&T was suitable and effective for the unique characteristics of the DC. This detailed process involved a thorough evaluation of the proposed tools' applicability and adaptability to the specific logistics operations. Factors such as demand variation, product diversity, and physical attributes of the storage space were considered.

A flowchart of the process was created to define and schematize the sub-processes within the FFP distribution process according to the defined scope. The process consists of four main steps when it comes to local suppliers, as illustrated in Figure 6. However, in the case of import suppliers, an additional stage is required, referred to as the regularization of inputs and outputs in the DC system, making it a five-stage process.

Because it was discovered that the main problem of the DC is a long lead time, brainstorming sessions were conducted to identify challenges that do not add value to the FFP process and to make changes that could result in time savings and a smoother process flow. First, a brainstorming session was conducted based on direct observation of the operational flow according to the previously defined stages. The compilation of notes was performed through exhaustive note-taking by a researcher of the present study for 10 days. Subsequently, these observations provided the basis for a comparison of the process perceptions among operators and managers to reinforce brainstorming and gain other perspectives. Validation was conducted through a three-hour meeting with four operators, a manager, and the researcher who collected the data and led the session. Individual verification with the operators responsible for each stage allowed the initial observations to be compared with their direct experience. Additionally, validation by the manager provided a higher-level perspective on the process and its strategic objectives. This participant triangulation approach sought to ensure a comprehensive and robust understanding of the process, thus minimizing the biases inherent in a single perspective.

The identified challenges were separated into four main process stages: order generation, reception at the DC, preparation and dispatch, and reception at the store. A total of 14 problems/difficulties were identified, as shown in Figure 7.

The brainstorming session unveiled several key challenges in the supply chain, highlighting the need for a thorough review to enhance efficiency and reduce errors. In the present analysis, several needs of the FFP process were identified, which could be addressed through the implementation of technological solutions. However, it is important to note that concrete solution proposals will be presented later. At that stage, the synergy between the application of technological solutions and the implementation of Lean Manufacturing principles and tools will be explored. This strategic combination aims to comprehensively address the problems detected through brainstorming in the DC.

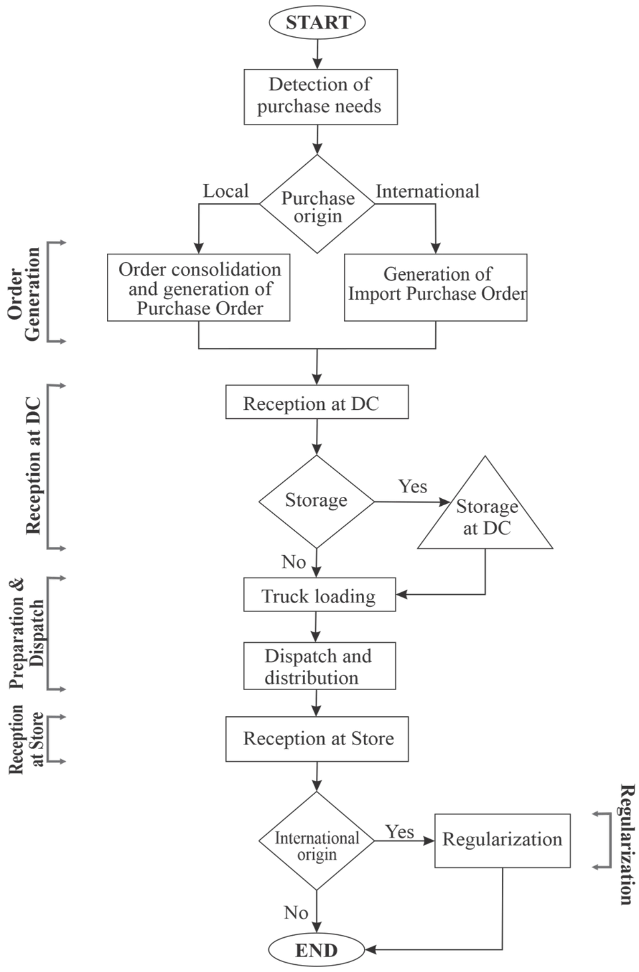

Figure 6. Flowchart of retail supply process

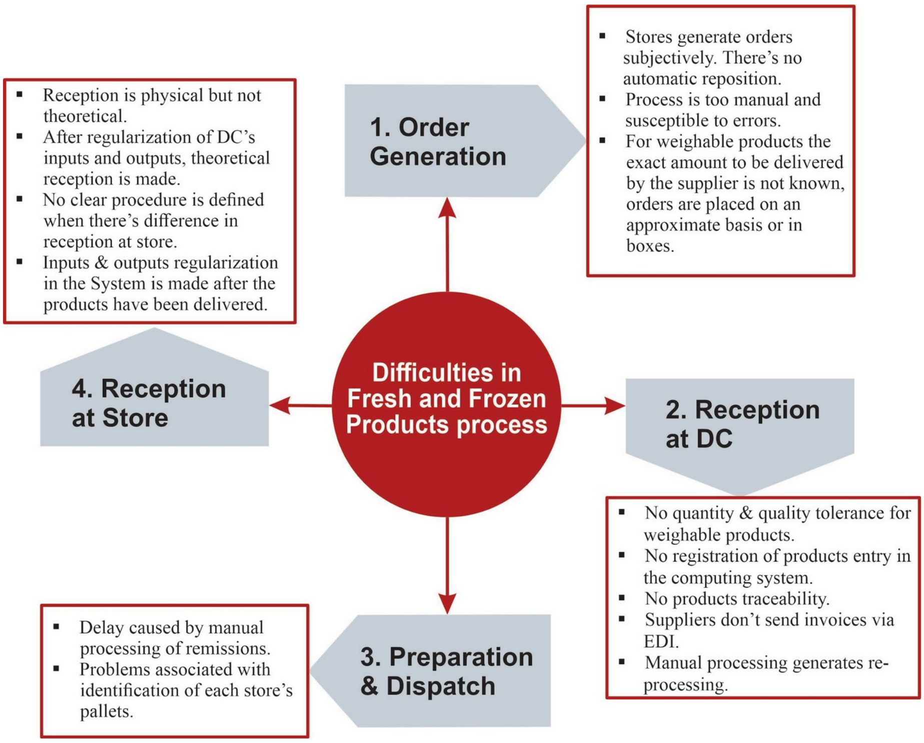

Figure 7. Brainstorming difficulties in the FFP process

During the analysis, it was discovered that the process of generating orders was subjective and manual, which could result in inaccuracies and lack of precision. Furthermore, the lack of automatic replenishment made the situation even more complex. This finding emphasized the critical need to implement automated systems to streamline the order generation process, thereby minimizing subjectivity and reducing human errors (Tanco, Jurburg & Escuder, 2015; Varma, Wadhwa & Deshmukh, 2006).

It is important to note that during the reception stage at the DC, weighable products must meet the exact quantity and quality specifications because no tolerance is allowed. This represents a problem since the products in bad condition can easily be distributed without any quality assurance, or even the weighable products received from suppliers could not match the specified weight as per the agreed-upon terms. Consequently, products are expected to meet specific weight standards, conditions, and overall quality to maintain customer satisfaction. In addition, it was revealed that there was no real-time recording through the system. The lack of traceability and the non-transmission of invoices via electronic data interchange (EDI) by suppliers are critical areas requiring immediate attention. The EDI system interconnects DCs to suppliers to automate transactional processes such as purchase orders, payments, and invoices. These challenges could be addressed through the implementation of scanning technologies, automatic recording, and electronic document management systems (Alomari, 2021; Khan, Ahmad & Abdollahian, 2013; Manuj & Sahin, 2011).

In the preparation and dispatch stage, delays due to manual preparation of dispatch notes and difficulty in identifying pallets for each location were evident obstacles. These issues indicate the need to adopt technological solutions (Chin, Rao-Tummala, Leung & Tang, 2004), such as labeling systems and automated pallet tracking, to streamline the process and improve accuracy (Rao & Goldsby, 2009; Tanco et al., 2015).

In the reception at the store stage, it was noted that a sub-process that involves checking inputs and outputs in the DC system to verify quantity and the store's invoice is conducted after the products have been delivered. This issue was viewed in the regularization stage shown in the flowchart (Figure 6) which takes place when the FFP process involves import suppliers. At the moment, the DC performs regularization days or even weeks after products have been received at stores, which causes delays in the theoretical reception of products in stores. The lack of a clear procedure for discrepancies identified during physical reception is a crucial point. The subsequent regularization of entries and exits from the DC suggests the possibility of implementing a real-time monitoring system and well-defined protocols to address and rectify discrepancies immediately. This step aims to strengthen consistency and reliability in the logistics process.

Although not all the difficulties in the FFP process are presented in the brainstorming diagram, its application resulted in a visualization of the broader inconveniences that most influence the long lead time matter. Accordingly, patterns, inefficiencies, bottlenecks, and areas of improvement are better visualized through an Ishikawa diagram. For instance, brainstorming was implemented before the Ishikawa diagram to better understand the root causes of the problems observed in a retail bank to reduce account opening rejection. It resulted in the identification of eight potential causes of the problem, categorized into four categories through the Ishikawa diagram (sales, process, services providers, and policy) (Sunder, 2016). However, hidden waste is not generally identified in brainstorming (Sunder, 2016). A study stated that brainstorming could be supported by the Ishikawa diagram for process analysis to structure the different causes that may lead to the undesired effect (Stergiou, 2022).

While brainstorming was carried out considering the different stages of the FFP distribution process, from order generation to reception in the stores, the Ishikawa diagram (Figure 8) adopted an approach based on four critical factors (manpower, method, materials, and environment) that allowed the identification of the possible root causes of the problems detected in the system that affected long lead times. The literature analysis revealed that 45% of the studies focused on lead time reduction, suggesting the prevalence of long lead times as a significant problem in the retail and logistics sector, particularly in Latin America. This information supports the relevance of time as a critical factor in FFP process of the DC in Paraguay, where there are inconveniences in the registration of input, output, and movement information, generating inconsistencies and several time-consuming reprocesses, making it a critical factor. These problems are directly aligned with the causes of long lead-times in the literature review. Thus, the Ishikawa diagram addresses long lead times as the main problem. This method, developed in four phases (identify the problem, work out the major factors involved, identify possible causes, and analyze the diagram) (Liliana, 2016), facilitated a structured examination. A total of 23 problems were identified: four related to labor or manpower, ten related to work method, six related to environmental factors, and three related to the product or merchandise.

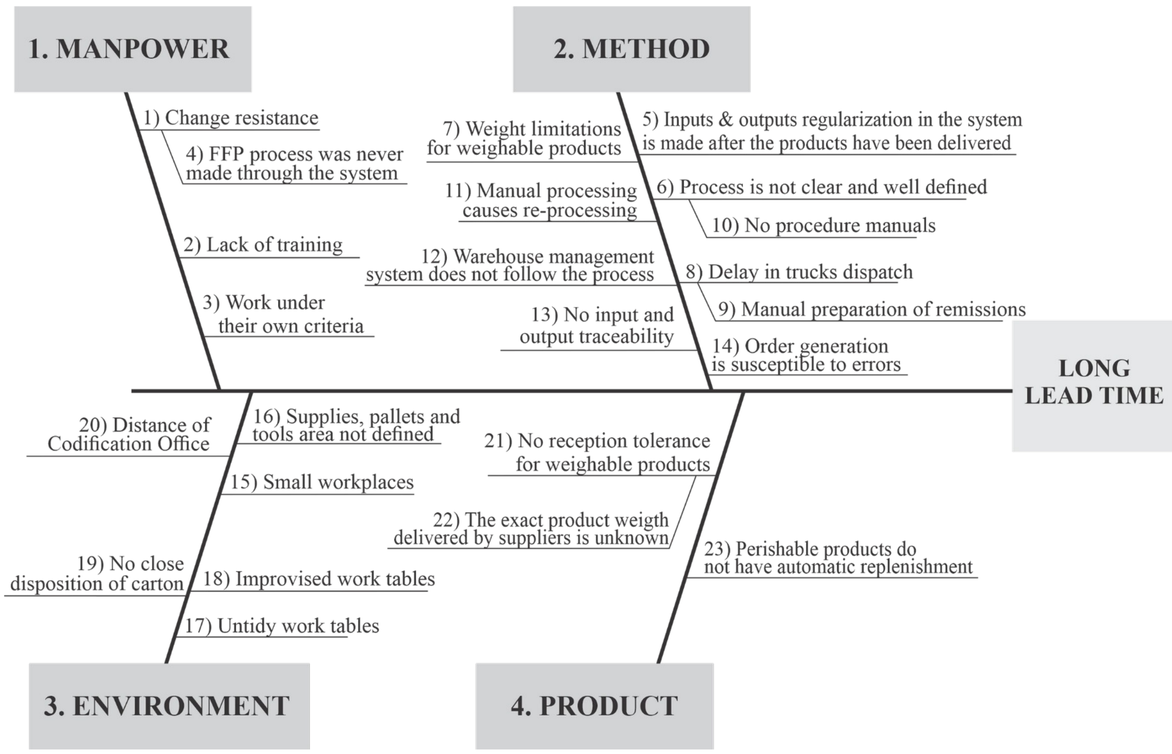

Figure 8. Ishikawa diagram of difficulties/problems in the FFP process

During the development of the case study, some of the problems initially identified during the brainstorming session were subsequently highlighted in the Ishikawa diagram. However, the fundamental difference between the two diagrams lies in the perspective from which the FFP process is analyzed. Thus, although certain problems were common to both representations, the analysis with the Ishikawa diagram provided a more in-depth view of the root causes organized by categories, complementing the sequential perspective obtained through brainstorming by stages of the process. Furthermore, the combination of these tools not only facilitates a deeper understanding of operational challenges but also effectively guides the implementation of strategic solutions aimed at optimizing the efficiency and functionality of the distribution center.

This case study reveals significant challenges within the manpower process, particularly concerning resistance to change, reliance on individual criteria, and inadequate training. Team resistance to change poses a substantial barrier to adopting innovative practices, a common issue echoed in previous research (Antony & Gupta, 2018; Ramadas & Satish, 2018). Inadequate training exacerbates this challenge, necessitating targeted interventions for enhanced training and role clarity for employees in the retail distribution process. This assertion aligns with the findings of Jain and Lyons (2009) who demonstrated that organizations with robust training programs experienced higher levels of employee satisfaction and productivity. Similarly, Khusaini, Ismail and Rashid (2016) highlighted the correlation between clear role expectations and improved team performance, further emphasizing the importance of addressing training deficiencies to optimize workforce effectiveness.

Concerning the method, the FFP process lacks systematic implementation and traceability in product movements, highlighting a technological gap that integrated solutions could rectify. For lean application, there is a need for a systematic implementation framework in accordance with research held by Dora, Kumar and Gellynck (2016). This idea concurs with recent studies that emphasized the importance of leveraging technology to streamline supply chain processes and improve visibility throughout the product journey (Musa, Gunasekaran & Yusuf, 2014). Studies revealed that issues such as weight limitation for weighable products and subsequent regularizations after products have been delivered underscore the need for explicit and efficient protocols (Dora et al., 2016; Reiner, Teller & Kotzab, 2013). This finding aligns with the conclusions drawn by several researchers, as noted in studies conducted by Liu, Prajogo and Oke (2016) and Mohd-Zawawi, Abd-Wahab, Sofian-Yaacob, Al-Samy and Fazal (2016), who emphasized that standardized protocols are essential for mitigating operational risks and ensuring compliance with regulatory requirements.

In our research, we have identified several impediments within the work environment, which align with findings from various authors in the field (Permatasari, Pramandha, Karima & Santoso, 2020; Vinayagasundaram, Ramkumar, Arasu & Anax, 2020). These impediments include the distance from the coding office, undefined spaces for resources, insufficient nearby space for cartons, and small, improvised, and disorganized worktables. Our analysis indicates that these factors significantly contribute to operational delays and errors, corroborating previous studies on workspace inefficiencies. Therefore, our research underscores the critical importance of implementing workspace reorganization and efficiency measures to address these challenges effectively. This aligns with the recommendations put forth by other researchers (Abhishek & Pratap, 2020; Reiner et al., 2013), highlighting the consensus within the literature on the need for proactive strategies to optimize the work environment and enhance operational performance.

The issues identified within the product category are associated with results from various authors in the field (Permatasari et al., 2020; Xu, Lan & Wang, 2010). These issues, including intolerance for receiving weighable products and error-prone order generation, emphasized the necessity for enhanced inventory management and improved supplier communication. Moreover, the absence of automatic replenishment for perishable products underscored the critical importance of implementing systems that facilitate timely stock replenishment. Through adhering to a structured method consistent with the discovered model, we could effectively address these obstacles, resulting in an overall enhancement of the fresh and frozen process. This aligns with recommendations from other researchers, emphasizing the consensus within the literature on the significance of systematic approaches to improving inventory management and supply chain operations (Frankel, 2006).

To evaluate the correlation among difficulties (variables) and to determine the most critical ones, a correlation matrix was built (Table 1) according to numbers assigned in the Ishikawa diagram. First, difficulties were compared to each other by assigning a value of 1 if they were mutually correlated, or 0 if there was no correlation between them. A matrix of 1 and 0 was built and the total score for each one of the 23 difficulties identified was calculated.

The matrix was constructed to identify strongly correlated difficulties to prioritize critical factors that influence the most in long lead time during the FFP process. To subsequently have a priority order to propose solutions and, to identify the few crucial difficulties that contribute to the undesired effect (Sunder, 2016), a Pareto diagram (Figure 9) was constructed according to the total scores calculated in the correlation matrix. As shown in the Pareto diagram, the horizontal axis displays the listed difficulties arranged from the highest to the lowest scores. The left vertical axis indicated the total scoring numbers, while the right vertical axis represented the cumulative percentage.

Despite not adhering strictly to the classic 80-20 rule, the Pareto diagram demonstrates a notable concentration of impact. Approximately 60% of the influence on the FFP processes is attributed to 40% of the identified causes, specifically, nine out of the 23 problems outlined. This observation underscores the significance of a select set of challenges in driving the overall inefficiencies within the processes.

The primary issues identified as major contributors to the operational challenges include the absence of input and output traceability, manual processing causing re-processing, order generation being error susceptible, FFP process not being made through the system, DC's warehouse management system not following the process, operators working under their own criteria, supplies, pallets and tools are not defined, absence of procedure manuals, and the existence of improvised worktables. This aligns with the results of previous studies that have highlighted these factors as critical in FFP processes (Cravener, Roush & Jordan, 1993; Fotopoulos, Kafetzopoulos & Gotzamani, 2011; Pulakanam, 2011; Xu et al., 2010).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
1		1	1	1	0	0	0	0	0	1	0	0	1	1	1	1	1	1	0	0	0	1	0	11
2	1		1	1	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	1	0	1	10
3	1	1		1	0	0	0	1	0	1	1	1	1	1	1	1	0	1	0	0	1	1	1	15
4	1	1	1		0	0	0	1	1	1	1	1	1	1	1	1	0	1	0	0	1	1	1	16
5	0	0	0	0		1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3
6	0	0	0	0	1		0	1	0	1	1	1	1	1	0	0	0	0	0	0	1	0	1	9
7	0	0	0	0	1	0		0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2
8	0	0	1	1	0	1	0		1	1	1	1	0	0	1	1	0	0	1	0	0	0	0	10
9	0	0	0	1	0	0	0	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
10	1	0	1	1	0	1	0	1	0		1	0	1	1	1	1	1	1	0	0	0	1	0	13
11	1	1	1	1	0	1	0	1	0	1		1	1	1	1	1	1	1	0	1	1	1	1	18
12	0	1	1	1	0	1	0	1	0	0	1		1	1	1	1	1	1	0	1	1	1	1	16
13	1	1	1	1	1	1	1	0	0	1	1	1		1	1	1	1	1	1	1	1	1	1	20
14	1	1	1	1	0	1	0	0	0	1	1	1	1		1	1	1	1	1	1	0	1	1	17
15	1	0	1	1	0	0	0	1	0	1	1	1	1	1		0	0	0	1	1	0	0	0	11
16	1	1	1	1	0	0	0	1	0	1	1	1	1	1	0		1	1	1	1	0	1	0	15
17	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1		0	1	1	0	0	0	9
18	1	0	1	1	0	0	0	0	0	1	1	1	1	1	0	1	0		1	1	0	1	0	12
19	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1		1	0	0	0	8
20	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1		0	0	0	9
21	0	1	1	1	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0		1	1	9
22	1	0	1	1	0	0	0	0	0	1	1	1	1	1	0	1	0	1	0	0	1		0	11
23	0	1	1	1	0	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	1	0		9

Table 1. Correlation matrix of difficulties shown in Figure 8

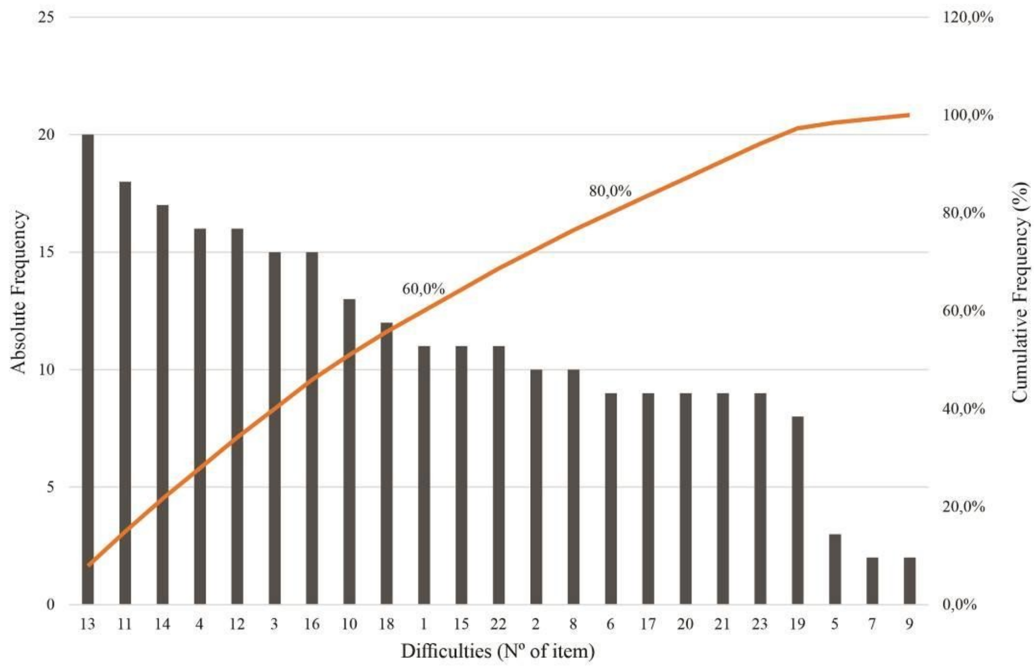

Figure 9. Pareto diagram of FFP process

To address these issues and move toward value stream optimization, the next stage of the case study focused on the Value Stream Mapping (VSM) tool application with time tracking. This strategic choice was based on the ability of VSM to comprehensively visualize the FFP process from receipt to delivery, allowing the identification and quantification of activities that do not add value and therefore represent opportunities for improvement to achieve a more efficient process.

4.2.1. Time Tracking for Value Stream Mapping

Exhaustive tracking of the time taken for each process stage was carried out for the VSM development of the FFP logistics process in the DC in Paraguay. Monitoring for each activity was carried out continuously for 14 days by one of the researchers at the DC in Mariano Roque Alonso. During this period, the start and end times of the different activities and sub-processes involved were observed and recorded, from the generation of the order to the physical and theoretical reception of merchandise in the stores. This time data collection provided an accurate view of the duration of each stage, identified bottlenecks, and quantified the time spent on value- and non-value-adding activities. This tool enabled the visualization of the flow of materials and information, including cycle and waiting times, which facilitated identifying activities that consume time and resources without directly contributing to value. By quantifying the impact of these non-value-added activities through time tracking, the VSM served as an initial strategy to obtain a more efficient process by eliminating or minimizing waste. Thus, this optimized process becomes a solid foundation for the subsequent application of other proposed lean tools, allowing the remaining underlying issues to be addressed in a more efficient and value-focused workflow. Value stream maps of local and import suppliers are presented as follows:

VSM of local suppliers: Ten local supplier arrivals were studied at the reception stage. Figure 10 shows the value stream map of local suppliers in the FFP process. Planning is carried out by a purchase and supply analyst who receives the purchase orders from the stores, consolidates them, and sends them to the supplier.

A total of 420 minutes of reception time was registered while attending to a few suppliers simultaneously. Reception starts at 5 a.m., and currently, 30 suppliers are received weekly, arriving in the DC once or twice.

At the dispatch stage, mobile vehicles responsible for store distribution were studied. Dispatches occur either once or twice a week, depending on volume. On average, each mobile dispatch requires approximately 23 minutes. The entire dispatch process takes 94 minutes.

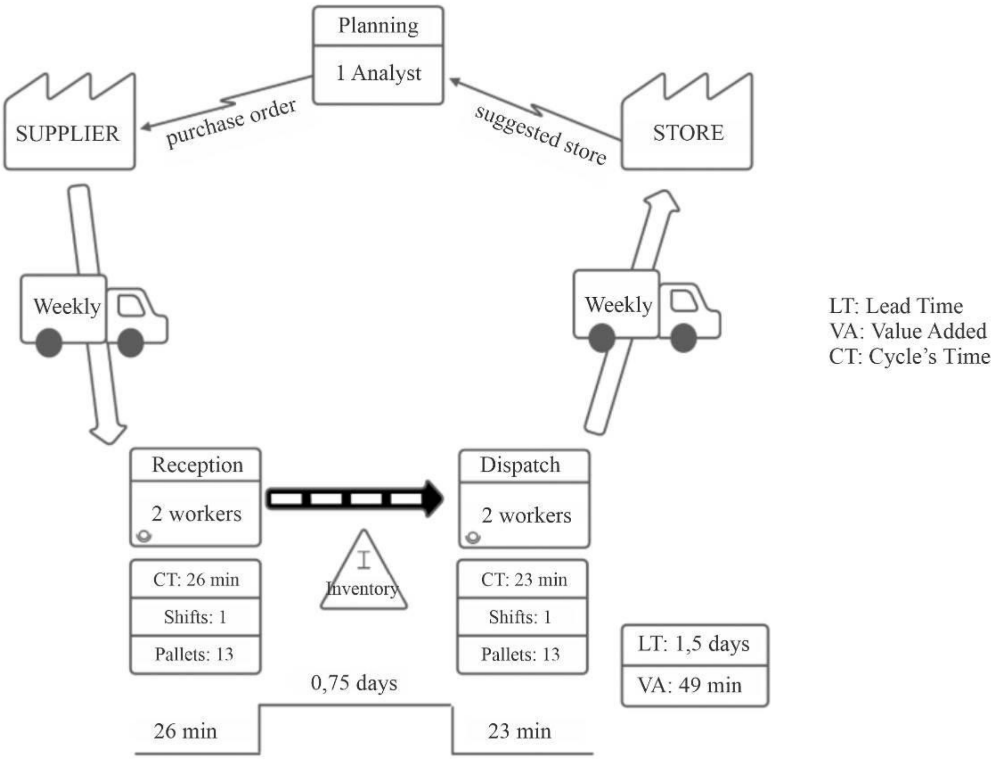

Figure 10. VSM of local suppliers in the FFP process

Furthermore, the process is executed during an 8-hour shift, which is managed by two assigned workers/operators.

Considering that value is defined from the viewpoint of customers and involves the ability to efficiently deliver exactly what the customer needs with minimal time at an appropriate price (Shou, Wang, Wu & Wang, 2020), it was found out that the stages that add value to the process are the reception at DC and Dispatch stages since these activities contribute directly to creating service value. On the contrary, since the objective of VSM is to make the flow of the products, information, and funds efficient (Qin & Liu, 2022), it was found that storage of the products/goods that the supplier delivers the day before distribution does not add value to the process. Reducing non-value-added activities' time could mean value-creating time improvement (Qin & Liu, 2022).

The VSM (Figure 10) shows a lead time of 1.5 days from reception at the DC to reception at the store, where the time that adds value is approximately 49 minutes (reception+dispatch).

VSM of import suppliers: On the other hand, Figure 11 shows the value stream map of import suppliers in the FFP process. Two workers participate in the reception and dispatch stages in a shift of 8 hours. It is also noted that two workers are constantly involved in the input and output regularization stage: the purchase and supply analyst in charge of order generation and the DC assistant in charge of merchandise input and output on the system. The reception time of imported cheese was considered since its distribution is carried out monthly and the reception time is approximately constant during this period. A total of 255 minutes of reception time was registered.

Import shipments typically arrive monthly or quarterly. Also, merchandise distribution is monthly, quarterly, or even when the stores require the products. Occasionally, the merchandise arrives late in the afternoon, is unloaded, and stored and distributed only the following day, meaning half a day it's stored half a day in the warehouses.

Reception and dispatch add value to the service. Goods storage does not, nor does the regularization process. In the regularization process, waste is identified as reprocessing and underutilizing human talent in the case of the DC assistant.

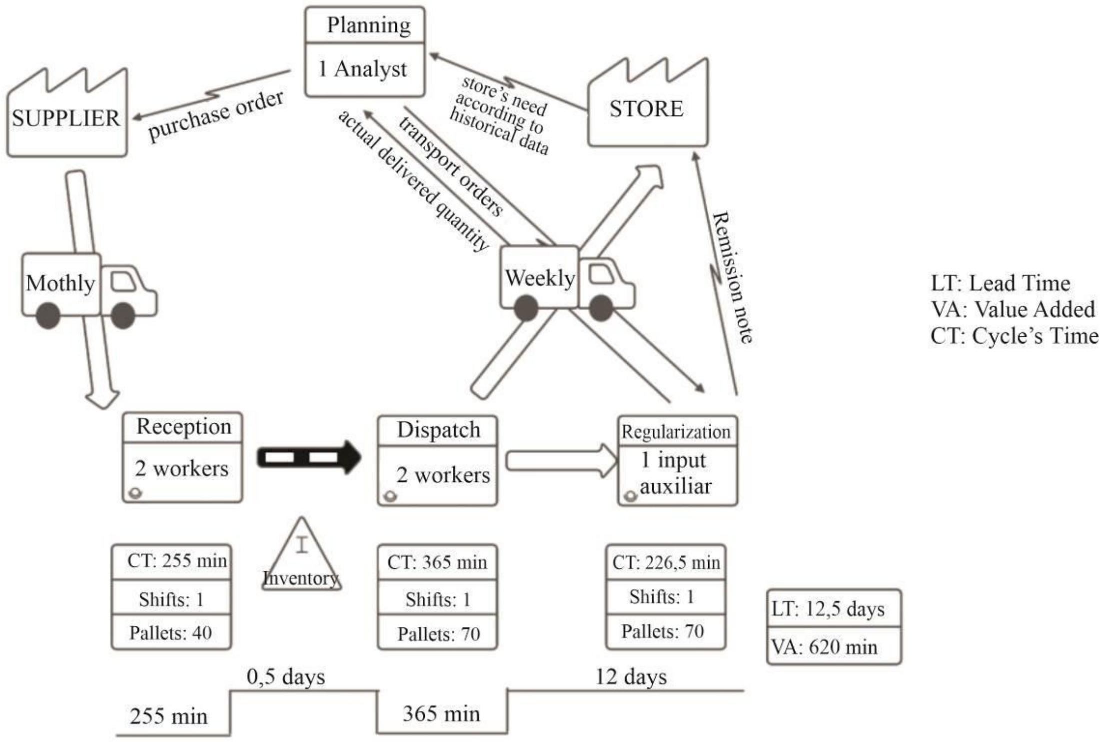

Figure 11. VSM of import suppliers in the FFP process

At the dispatch stage, each mobile dispatch takes an average of 73 minutes.

It is important to note that the duration of loading merchandise to the mobile is approximately 42 minutes, and the generation of manual remission, which is the document that merchandise needs for the trip, is approximately 31 minutes.

Additionally, another primary stage is included in the VSM of import suppliers, which is the regularization of input and output of products/goods that pass through the DC. Time tracking of two regularization processes was carried out, considering data (dates and times) from e-mails and the warehouse management system. Averaging both regularization times, a total of 226.5 minutes was registered.

Similarly, through the VSM of import suppliers, it was found that the stages that add value to the process are the reception and dispatch stages. The storage of products/goods does not add value, nor does the regularization stage, where waste was identified as reprocessing and underutilizing human talent in the case of the DC assistant.

The VSM of import suppliers shows a lead time of 12.5 days from reception at the DC to reception at the store and an added value of 37,200 seconds (equal to 620 minutes) as shown in Figure 11. It was found that 96% of the time that does not add value is because of the regularization stage, which takes an average of 12 days.

Notably, the VSM application constituted a concrete intervention within the FFP process in the DC in Paraguay, as described in Phase 2 of the case study. It is crucial to highlight that through the visualization and analysis of the value stream, a specific stage that could be eliminated was identified, generating a demonstrable improvement percentage in the process (96% reduction in lead-time in the case of international suppliers). This tangible result of the application of VSM represents a significant contribution to this work because it demonstrates the capacity of this tool to identify and eliminate waste, as was sought with the implementation of lean techniques.

The subsequent application of the other lean tools proposed in the next section is a natural and logical continuation of this study. While a detailed quantification of the impact of these additional solutions was not included in this study, the framework provided by the VSM allowed for the identification of specific areas of intervention. The next logical step is the implementation of these solutions and measurement of their effects in terms of waste reduction and efficiency improvement, which is presented as a clear avenue for future research and continuous process improvement.

4.2.2. Problem-Solving and Process Standardization

After the process analysis, following the research objective established at the beginning of this study, seeking to define the best process for the FFP to flow through the DC, the following solutions are proposed according to which LM tool provided the difficulties along the FFP process to reduce long lead time.

1. Based on flowcharts: at the order generation stage for local suppliers the reception of store needs is eliminated. The perishables analyst at DC generates store orders with the help of the system's automatic replenishment. At the preparation and dispatch stage, the operators confirm all the movements (inputs and outputs) they make with a radio frequency device. Original remissions are printed by the system and not manually made. Instead of sending suppliers invoices the system sends remission documents to stores with the merchandise. At the reception at store stage products are received with original remission documents since invoices are uploaded into the system at the DC, not at the store. Consequently, in the import suppliers flowchart regularization stage is eliminated.
2. Based on brainstorming: at the order generation stage the exact amount of weighable products to be delivered is known through the system. At the reception at the DC stage, an encoder process is added to generate reception tasks by the system. The movements are confirmed with a radio frequency device, allowing to have the information in real time at the computing system. Criteria are established for quantity and quality control of weighable products. At the preparation and dispatch stage, instead of sending suppliers invoices, the system sends remission documents to stores with the merchandise. The process for the operator to prepare the documents per location is eliminated. Pallets are identified by handling unit labels according to each store. At the reception at store stage a procedure is established for cases where there are differences between order and receipt of products. In addition, regarding system upgrades and process control and considering the actual process being carried out, the following indicators are proposed to be considered based on brainstorming analysis: number of suppliers the system receives in a shift of 8 hours, time duration of reception of local and import suppliers, lead time for local and import suppliers' deliveries to DC, document printing time.
3. Based on the Ishikawa diagram (Figure 8), solutions are proposed by categories. It is proposed to use the kaizen tool in combination with other LM T&T as in the studied carried out by Angeles-Méndez (2018). The tools applied were kaizen with PDCA and kaizen with 5S, as shown in Table 2.

Category	Proposed solution	Tool
1. Manpower	Training and procedure manuals	Kaizen+PDCA
2. Method	Constant system control from the order generation stage to reception at the store through the EDI system. Integration to a computational system in the *Regularization* stage is proposed in order to control inputs and outputs in real-time. This action will lead to efficient tracking of products and reduce regularization time.	Kaizen+PDCA
3. Environment	Order and cleanliness at the workplace include the following actions: discard unused items, delimitate working areas, define pallet placement, implement label usage, and enhance workers' commitment to workplace cleanliness.	Kaizen+5S
4. Product	Tolerance definition for weighable products to define quality and quantity standards and reduce product rejection.	Kaizen+PDCA

Table 2. A proposed solution for process improvement in each category

4. The implementation of Kaizen and 5S techniques can enhance productivity and quality at the DC. This can be achieved through various methods such as flowchart analysis, brainstorming, value stream map, Ishikawa, and Pareto diagrams analysis. Studies have shown that the application of VSM, 5S, SMED, and

kaizen can decrease the percentage of errors by 14% (Puchoc-Barzola & Trejo-Pantoja, 2020). Similarly, a research work has demonstrated that the use of kaizen, 5S, and kanban can reduce non-value-added time by 50 minutes per worker (Dasgupta et al., 2023).

5. Implementation of PDCA cycle is proposed based on the previous flowchart, VSM, Ishikawa and Pareto diagrams. It was seen in a study that lead time can be reduced through application of VSM, brainstorming, SMED, PDCA, and kanban (Huang et al., 2022). Similarly, inventory costs can decrease with implementation of PDCA, flowchart, Ishikawa and Pareto diagrams and, VSM (Molina & Mora, 2019).

It is worth mentioning that in the retail industry, Lean Six Sigma, a methodology that combines the principles of Lean Manufacturing and Six Sigma, is also being applied to identify pain points and optimize the process by following the steps of DMAIC and applying specific LSS initiatives (Panayiotou & Konstantinos, 2022).

4.2.3. Kaizen + 5S

After data collection, Kaizen + 5S combination diagnosis was made to propose the following improvement opportunities for the process (Figure 12).

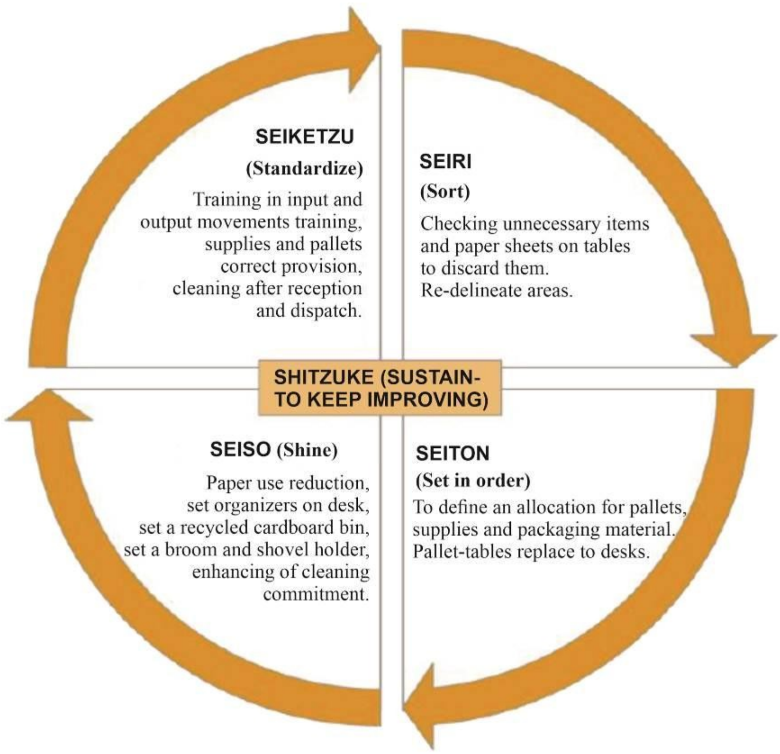

Figure 12. Application of Kaizen + 5S to FFP Process

4.2.4. Kaizen + Plan-Do-Check-Act

For the organization of the implementation of improvements in the system, training, and development of procedure manuals, it is proposed to use the kaizen + PDCA system (Figure 13).

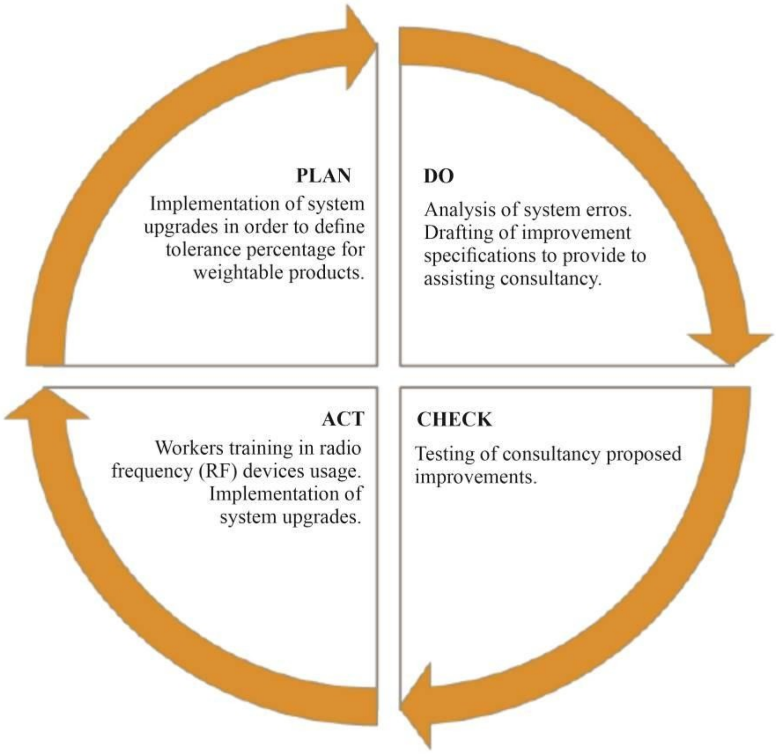

Figure 13. Application of kaizen + PDCA to FFP Process

Under the guidance of a purchasing and supply analyst, weekly merchandise deliveries and distributions are meticulously orchestrated through our planning process. The VSM not only sheds light on valuable processes like reception and dispatch but also emphasizes the non-value-added aspect of goods storage.

Import shipments add another layer of complexity to operations, with monthly or quarterly arrivals and distributions that must align with store requirements. Any delays that occur can interrupt the smooth flow of operations, resulting in half-day storage in warehouses.

During a single shift, two operators are involved in the reception and dispatch processes, and a purchasing and supply analyst and a DC assistant participate in regularization procedures. All these people play a crucial role in the DC's complex operations, highlighting the importance of human involvement in these processes.

Upon careful examination through VSM, it was discovered that 96% of non-value-added time is concentrated in the regularization process, which takes an average of 12 days. This revelation highlights the focal point for potential improvement. By scrutinizing the process, it becomes possible to identify inefficiencies and areas of waste, such as the underutilization of human talent in the role of DC assistant and unnecessary reprocessing.

Proposed solutions, inspired by the Ishikawa diagram and the kaizen tool, recommend using kaizen with PDCA and kaizen with 5S in a strategic way. These tools should be aligned with the identified problems to create a roadmap for the subsequent phases of improvement. The proposed kaizen + PDCA system adds an organizational layer that emphasizes not only the use of lean tools but also training initiatives, the development of procedure manuals, and the cultivation of a continuous improvement mindset. By integrating these LM techniques and tools, the distribution center can expect significant improvements in its operations (Hoang, 2023; Tiamaz & Souissi, 2019). The value stream map analysis provides a holistic view of the entire process, enabling the identification of bottlenecks, repetitive tasks, and unnecessary activities (Gil-Vilda, Yagüe-Fabra & Sunyer, 2021; Hoang, 2023; Tiamaz & Souissi, 2019).

5. Conclusion

This research focused on the optimization of the fresh and frozen product (FFP) process in a retail distribution center (DC) in Paraguay, using Lean Manufacturing (LM) principles and tools. The initial phase comprised an exhaustive review of the specialized literature on LM that revealed the gap to be addressed in research related to the retail industry in emerging markets, which was fundamental for the identification of the most relevant lean Techniques and Tools (T&T) for the Latin American context. Specifically, the relevance of the flow chart, brainstorming, Ishikawa diagram, Pareto diagram, and VSM in the analysis of the FFP process was determined.

The DC case study allowed an empirical analysis of the FFP flow from reception to dispatch. This analysis revealed four main categories of difficulty, with 56% linked to manpower, method, and environmental factors, which exerted a significant negative impact on process efficiency and delivery time. Additionally, two subprocesses, product storage and regularization, were identified as not adding value to the FFP process. However, the reception and dispatch stages were considered to have a high added value. With the application of VSM, a remarkable finding was obtained: the projection of a 96% improvement in the FFP process by eliminating the regularization sub-process.

To encourage continuous improvement, Kaizen methodologies were proposed, specifically through the application of 5S tools and the PDCA cycle. This emphasizes the adaptability of LM techniques and tools to logistics and distribution processes, with the potential to enhance the FFP process in the DC and minimize waste, along with increasing the company's competitive advantage.

However, it is necessary to highlight certain limitations inherent to this study. The literature review was limited to studies conducted in Latin America, which implies the possibility of omitting relevant research on retail and logistics conducted in other geographic regions. In addition, the geographic focus may have limited the identification of a broader spectrum of techniques and approaches that are potentially applicable to the specific context of the case study in Paraguay. It is recognized that discarding non-peer-reviewed studies could have refined the search for applied LM T&T. Finally, it is recommended that future research evaluate the applicability of the lean tools proposed in this study to the retail industry.

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Appendix A. Works Selected for Revision

Appendix A contains the 33 works considered relevant to the analysis. The spreadsheet was created to organize the collected information, including author(s), year, country, type of company, problems to be solved, LM techniques and tools implemented, and results or improvements.

Author, Year	Country	Type of company	Problem	LM T&T	Results
Iglesia-Reyes (2006)	Colombia	Bakery	Inefficient production process	Flowchart, Pareto, Ishikawa, brainstorming	Proposal of kaizen, JIT, 5S, TPM as process improvement techniques
Natera-Iglesias (2007)	Spain	Electric materials	Long lead time	Flowchart, Pareto, Ishikawa	15% of lead time reduction
Singh et al. (2010)	India	Railways components	Long lead time	VSM, kanban	Lead time reduced by 83.14%, processing time reduced by 12.62%
Dotoli et al. (2013)	Italy	Interior design objects	Inefficient warehouse management	Flowchart, VSM, gemba shikumi	Reengineered warehouse
López-Morales (2013)	Mexico	Wood and hardware	Long lead time	Flowchart, Ishikawa, VSM	Proposal of 5S, identification cards as process improvement technique
Borges-Lopes et al. (2015)	Portugal	Food and beverage industry	Lack of process innovation	Brainstorming, 5S, SMED, spaghetti map	Increased productivity, production flexibility, employee engagement, continuous improvement culture, reduced lead times
Molina-Barrón (2016)	Mexico	Distribution center	Demand is not met	Flowchart, 5S	Increased productivity
Alfaro-Rodriguez (2017)	Peru	Logistics and distribution	Low productivity	VSM, kanban, Pareto, flowchart, Ishikawa	30% of productivity increase with VSM
Reis et al. (2017)	Brazil	Oil and gas company	Inefficient warehouse management	Gemba shikumi	Proposal of improvement action plan for warehouse
Paredes-Ortiz (2017)	Peru	Clothing, jewelry and houseware	Long lead time and low customer satisfaction	5S	Increased customers satisfaction
Ángeles-Méndez (2018)	Peru	Logistics	Low productivity	Flowchart, 5S, kaizen, Ishikawa diagram, VSM	Productivity increased by 20%
Baby & Jebadurai (2018)	India	Sales warehouse	Inefficient warehouse management, long lead time	VSM	Shorter lead time, warehouse operations improved by at least 40%
Dávila-Rodríguez (2018)	Peru	Automotive & industrial oils warehouse	Long lead time	Flowchart, 5S, Ishikawa, Pareto diagram, kanban	Reception and dispatch times increased by 25%

Author, Year	Country	Type of company	Problem	LM T&T	Results
Herrera-Condor & Idiáquez-Poma (2018)	Peru	Food warehouse	Inefficient warehouse management, long lead time	VSM, 5S, kanban, Ishikawa, Pareto, spaghetti map	Increased efficiency by 45.36 %
Kumar, Dhingra & Singh (2018)	India	Automobile parts	Long lead time	VSM, Pareto diagram, kaizen, poka-yoke, 5-why method	Reduction in machine setting time by 65.85%, manpower by 40%, production lead time by 69.47%, and value-added time by 75.25%
Mallqui-Ramirez (2018)	Peru	Construction & hardware	Low productivity	5S, Standardized Work, kaizen	Productivity increased by 0.435
Chavez-Vargas (2019)	Peru	Machinery parts warehouse	Inefficient warehouse management, long lead time	Flowchart, Ishikawa, Pareto diagram, kaizen	Shorter lead time, proposal of improvement action plan for warehouse
Farfan & Silva (2019)	Peru	Retail	Long lead time	VSM, Pareto, flowchart, Ishikawa, 5S, SMED	Operation time decreased by 14.5%
Molina & Mora (2019)	Colombia	Construction materials	High inventory costs	Flowchart, Ishikawa, Pareto diagram, VSM	Inventory costs decreased and an improvement plan was proposed
Bueno-Rueda (2020)	Colombia	Automobile parts	Long processing time	Standardized work, 5S, kaizen	Proposal of an action plan using standarized work
Hernández-Zelada (2020)	Peru	Distribution center	High logistic costs and long lead time	VSM, flowchart, 5S, kaizen, Pareto diagram	Expected costs reduction by 50%, purchase operations time decreased by 73%
Layme-Castillo (2020)	Peru	Drugstore	Inefficient logistics	Ishikawa diagram	Proposal of VSM, JIT, 9S, Andon, kanban, Poka-Yoke, TQM as logistics improvement techniques
Puchoc-Barzola & Trejo-Pantoja (2020)	Peru	Logistic and distribution	High number of errors	5S, SMED, VSM, kaizen	Percentage of errors decreased by 14%
Alayo-Alvarez & Siccha-Camacho (2021)	Peru	Mill, poultry and cattle feed	High processing costs	Ishikawa, Pareto diagram, kanban, 5S	9 root causes that generate high processing costs were identified
Mandujano-Malpartida & Vigil-Farfan (2021)	Peru	Bakery	Low productivity and inefficient service	Pareto diagram, VSM, Ishikawa diagram, flowchart, 5S	Proposal of kaizen, PDCA and kanban as process improvement techniques
Martínez-Guzmán (2021)	Colombia	Retail	High amount of food waste	Ishikawa, Pareto diagram	Proposal of 5S, SMED, TPM, and kaizen as process improvement techniques
Rosas-Condor (2021)	Peru	Advertising and marketing	High inventory costs, inefficient logistics	Flowchart, Pareto diagram, 5S, brainstorming, Ishikawa, VSM	Cycle time decreased from 16.74 to 6.85 days, storage capacity increased by 31%

Author, Year	Country	Type of company	Problem	LM T&T	Results
Qin & Liu (2022)	China	E-commerce retailer	Slow sales growth, long lead time, low customer satisfaction	VSM, 5-why method	Potential waste was identified, lead time was reduced and customer satisfaction increased
Proença et al. (2022)	Portugal	Fruits distribution center	Long lead time, space wasting, inefficient storage management	VSM, spaghetti diagram	A reduction of 35.5% and 10.6% of the cycle time and lead time, space management improvement
Huang et al. (2022)	Taiwan	Metal products	Inefficient production process, long lead time	VSM, brainstorming, SMED, PDCA, kanban	Lead time reduced from 26 days to 19.5 days, efficiency improvement of inventory and various process stages
Kumar & Shankar (2022)	India	Dairy products	Long lead time	VSM	Lead time reduced by approximately 34.79%.
Dasgupta et al. (2023)	Singapore	Jewellery industry	Low time efficiency	Kaizen, kanban, 5S	Reduced overall non-value-added time by 50 min/worker
Quiroz-Flores et al. (2023)	Peru	Auto repair company	High % of not performed maintenance services	5S, standardized work, Pareto (ABC analysis)	Delivery time violations reduced by 19.94%