7th Bangladesh Conference on Industrial Engineering and Operations Management
December 21-22, 2024
Publisher: IEOM Society International, USA DOI: 10.46254/BA07.20240012
Published: December 21, 2024

Application of Lean Warehousing Strategies in Footwear Trading SMEs: A Case Study on Enhancing Operational Efficiency in Peru

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Abstract

The footwear industry, particularly among SMEs in Peru, faces significant challenges in warehouse management, contributing to inefficiencies that affect overall competitiveness. Current research in Lean Warehousing highlights the potential for these practices to improve operational efficiency, yet the application in SMEs remains underexplored. The primary challenges addressed include excessive travel distances in picking, high cycle times, and low dispatch efficiency, which were critical to resolve for enhanced productivity. This study proposes a Lean Warehousing model tailored to SMEs, integrating Systematic Layout Planning and standardized work practices to optimize warehouse operations. Results indicated a 45% reduction in picking distance, a 26.47% decrease in cycle time, and a 4.17% improvement in office efficiency. These outcomes not only validated the model's effectiveness but also demonstrated its potential to significantly improve the operational efficiency of SMEs in the footwear sector. The findings offer valuable insights for academics and practitioners, emphasizing the need for further exploration of Lean Warehousing in SME contexts to enhance industry competitiveness.

Keywords

Lean Warehousing, Footwear Trading SMEs, Operational Efficiency, Systematic Layout Planning, Process Improvement.

1. Introduction

The small and medium-sized enterprises (SMEs) engaged in the footwear sector play a pivotal role in the global economy, particularly in Latin America and Peru. This sector not only significantly contributes to employment but also serves as a catalyst for innovation and economic development. In Peru, for instance, SMEs in the footwear industry generate approximately 57,000 direct jobs and account for around 1.2% of the industrial Gross Domestic Product (GDP) of the country. Furthermore, the development of footwear clusters, such as Cibaduyut in Indonesia, illustrates the potential of these enterprises to compete in international markets, highlighting the necessity of enhancing their export capabilities. Globalization has created both opportunities and challenges for these businesses, compelling them to adapt to an ever-changing competitive landscape. Therefore, understanding the dynamics of this sector is essential for promoting its growth and sustainability.

However, SMEs in the footwear sector face numerous challenges that hinder their efficiency and competitiveness. One of the primary issues is the low efficiency in storage processes, which results in high levels of unproductive time and elevated rates of reprocessing during the picking and packing stages. These inefficiencies often stem from inadequate distribution of workstations within warehouses, as well as suboptimal picking and packing methods. Additionally, electronic failures in dispatch devices exacerbate these problems, complicating effective inventory management and customer satisfaction. The lack of adequate supply chain management practices is also identified as a critical challenge, as it affects the ability of SMEs to manage their operations effectively (2020). Therefore, addressing these issues is vital for enhancing operational efficiency and competitiveness among SMEs in the footwear sector.

Resolving these challenges is of utmost importance for the SME sector, as efficiency in supply chain management and storage is fundamental to their success. Implementing methodologies that optimize these processes not only improves productivity but also enables companies to better respond to market demands and consumer expectations. The adoption of Lean Warehousing tools, such as standardized work and systematic layout planning, can be particularly beneficial for these enterprises, as they allow for the identification and elimination of waste in operations, thereby enhancing profitability and sustainability. Furthermore, improving the efficiency of storage processes can lead to greater customer satisfaction, which is crucial in an increasingly competitive market.

Despite the relevance of these issues, there exists a notable gap in the literature regarding how SMEs in the footwear sector can effectively implement Lean Warehousing tools to enhance their operational efficiency. Existing research often focuses on isolated aspects of supply chain management, neglecting a comprehensive approach that considers the interrelationship between various processes and methodologies (2023). This research aims to address this gap by developing a production model that integrates Lean Warehousing tools, such as standardized work and systematic layout planning, to optimize storage processes in SMEs within the footwear sector. By doing so, it is anticipated that not only will operational efficiency improve, but a theoretical framework will also be provided that can be utilized by other SMEs in the industry to tackle similar challenges.

In conclusion, the significance of the SME sector engaged in footwear production globally, particularly in Latin America and Peru, is undeniable. However, the challenges related to efficiency in storage processes and supply chain management represent significant obstacles that must be addressed. The implementation of Lean Warehousing tools presents a promising avenue for enhancing the competitiveness and sustainability of these enterprises. Through this research, it is expected to contribute to the existing body of knowledge and provide a practical model that can be adopted by SMEs in the footwear sector.

2. Literature Review

2.1 Lean Warehousing in Footwear SMEs: A Path to Efficiency

The Lean Warehousing methodology has proven to be an effective tool for improving storage processes in small and medium-sized enterprises (SMEs) within the footwear sector. According to, the implementation of lean principles in warehousing operations can significantly reduce waste and enhance operational efficiency. This approach focuses on eliminating non-value-adding activities, which is crucial in a sector where competition is fierce, and profit margins are tight. Furthermore, supports this assertion, demonstrating that the adoption of Lean Warehousing can lead to a decrease in inventory losses, particularly relevant in the footwear industry, where inventory management is critical. Additionally, highlight how the transformation towards a lean warehouse can be assessed through analytical methods, allowing footwear SMEs to measure their progress and adjust their strategies accordingly. Finally, the study by emphasizes that lean warehousing not only enhances efficiency but also contributes to improved customer satisfaction by ensuring timely deliveries and reducing lead times.

2.2 Standardized Work: Standardization for Operational Excellence

The Standardized Work methodology has emerged as an essential component for footwear SMEs seeking to optimize their storage processes. assert that standardizing processes not only improves efficiency but also facilitates the training of new employees, which is vital in a sector characterized by high employee turnover. Moreover, indicates that the implementation of standardized work practices can reduce variability in processes, resulting in higher product quality. In a similar context, demonstrates that standardization enables companies to identify and eliminate inefficiencies, leading to continuous improvement. Finally, emphasize that standardization is a critical success factor for the effective

implementation of Lean Six Sigma in SMEs, suggesting that footwear companies could greatly benefit from adopting this methodology to enhance their operational performance.

2.3 Systematic Layout Planning: Efficient Warehouse Design

Systematic Layout Planning (SLP) is another methodology that has been applied in footwear SMEs to improve the efficiency of their storage processes. According to, a well-planned warehouse layout can significantly reduce travel times and enhance productivity. This approach allows companies to organize their spaces in a manner that minimizes the distances traveled by workers and materials. Additionally, suggest that an efficient layout not only improves operational efficiency but also contributes to better inventory management, which is crucial in the footwear industry. On the other hand, highlight the importance of involving employees in the layout design process, as their experience can provide valuable insights into how to improve efficiency. Finally, Dora et al. (2014) indicate that an optimized warehouse design can be a determining factor for the success of lean practices in SMEs, suggesting that footwear companies should seriously consider this methodology to enhance their operational capabilities.

2.4 Value Stream Mapping: Visualizing Efficiency

The Value Stream Mapping (VSM) methodology has been utilized in various studies to identify and eliminate waste in the storage processes of footwear SMEs. According to, VSM allows companies to visualize their processes and detect areas for improvement, which is essential for implementing lean practices. Furthermore, emphasize that using VSM can facilitate communication between different departments within a company, resulting in better collaboration and efficiency. Additionally, highlight that value stream mapping is a powerful tool for SMEs seeking to improve their operational performance, which is particularly relevant in the competitive footwear industry. Finally, the research by indicates that VSM can help SMEs identify bottlenecks in their processes, enabling them to streamline operations and enhance overall productivity.

2.5 Lean Service: Enhancing Customer Experience

The Lean Service methodology has been applied in the context of footwear SMEs to improve not only operational efficiency but also customer experience. According to, implementing lean practices in service delivery can lead to higher customer satisfaction, which is crucial in a market where customer loyalty is paramount. Additionally, indicate that adopting Lean Service can help companies reduce wait times and improve service quality, resulting in a more positive customer experience. Furthermore, (2012) emphasize that continuous improvement, a central principle of lean, is essential for maintaining competitiveness in the footwear sector, suggesting that companies should adopt a proactive approach to enhancing their services. Finally, the study by highlights that lean methodologies can help SMEs align their service offerings with customer expectations, ultimately leading to increased loyalty and repeat business.

3. Methods

3.1 Basis of the Proposed Model

In Figure 1, the storage management model based on Lean Warehousing philosophy for footwear trading SMEs is presented. This model was designed to address inefficiencies in warehouse operations by applying Lean principles, which focus on eliminating waste, optimizing processes, and improving overall operational efficiency. The model was structured into three main phases: analysis of the current situation, intervention, and evaluation.

In the analysis phase, historical data and process indicators were reviewed to identify areas of low efficiency and other operational challenges. The intervention phase involved systematic layout planning and the implementation of standardized work practices to enhance the organization of the warehouse and streamline workflows. Finally, the evaluation phase was focused on assessing the effectiveness of the interventions, aiming to achieve high efficiency, reduce downtime, and eliminate reprocessing. The objective of this model was to create a more efficient, responsive, and organized warehouse environment, tailored specifically to the needs of footwear trading SMEs, thereby improving their competitiveness and operational sustainability.

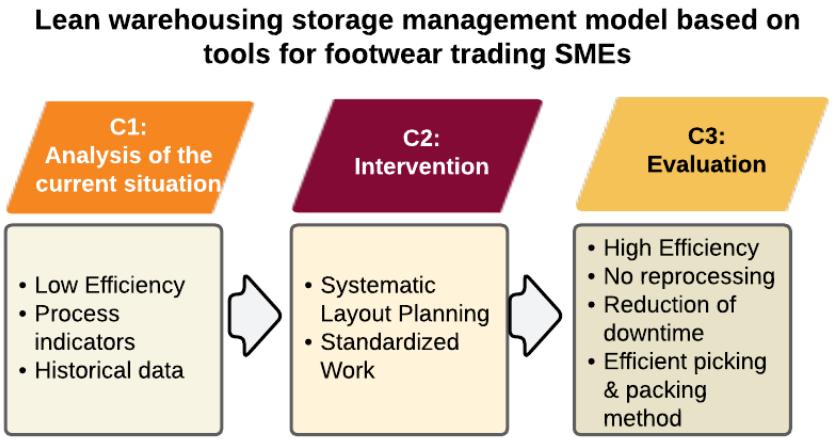

Figure 1. Proposed Model

3.2 Description of the model components

In the proposed storage management model based on Lean Warehousing for footwear trading SMEs, it is crucial to first acknowledge the theoretical underpinnings and contributions that this model brings to the existing literature. Lean Warehousing, derived from Lean Manufacturing principles, focuses on waste reduction, streamlining processes, and improving overall operational efficiency. The integration of these principles into warehouse management has gained significant attention in recent years, particularly for SMEs that often struggle with resource constraints and operational inefficiencies. This model, as outlined in Figure 1, represents a structured approach to enhancing the efficiency of warehouse operations in footwear trading SMEs, which are critical components of the retail supply chain. The model's design is rooted in the fundamental Lean principles of continuous improvement and waste elimination, making it a significant contribution to the body of knowledge on Lean applications in warehouse management. The model is divided into three main phases: Analysis of the Current Situation, Intervention, and Evaluation. Each phase plays a pivotal role in transforming warehouse operations, leading to enhanced efficiency, reduced costs, and improved service levels.

C1: Analysis of the Current Situation

The first phase of the model focuses on analyzing the current warehouse operations to identify inefficiencies and areas for improvement. This phase is critical as it sets the foundation for the entire Lean Warehousing initiative. The analysis begins with the collection of historical data, including process indicators such as lead times, inventory accuracy, and space utilization. These metrics are essential for understanding the baseline performance of the warehouse and identifying specific areas where improvements are needed. The analysis also includes a thorough examination of the existing warehouse layout, material handling processes, and storage practices. This step is informed by the Lean principle of "value stream mapping," which involves mapping out all the activities involved in the warehouse operations to identify value-added and non-value-added activities. The primary goal of this phase is to establish a clear understanding of the current state of the warehouse operations and to identify the root causes of inefficiencies, such as excessive travel times, poor space utilization, and delays in order fulfillment. By focusing on these critical areas, the model ensures that subsequent interventions are targeted and effective, leading to significant improvements in warehouse performance.

C2: Systematic Intervention for Process Optimization

Once the analysis phase is complete, the next step involves implementing targeted interventions aimed at optimizing warehouse processes. This phase is driven by the Lean principles of "kaizen" (continuous improvement) and "standardized work," which emphasize the importance of consistent and incremental improvements in operational processes. The intervention phase begins with a systematic layout planning process, which involves redesigning the warehouse layout to optimize space utilization and reduce travel times for picking and packing activities. This step is crucial in addressing one of the most common sources of inefficiency in warehouse operations: the poor organization

of storage spaces and material flow. By reorganizing the layout based on the frequency of item retrieval (informed by the ABC analysis), the model reduces the distance traveled by warehouse workers, thereby improving picking efficiency and reducing cycle times.

In addition to layout optimization, the intervention phase also involves the implementation of standardized work practices. This includes developing standard operating procedures (SOPs) for key warehouse activities such as receiving, storage, picking, packing, and dispatching. Standardization is a core aspect of Lean Warehousing, as it ensures consistency in operations, reduces variability, and minimizes errors. The implementation of SOPs is accompanied by staff training programs aimed at ensuring that all employees are familiar with the new procedures and understand the importance of adhering to them. The model also emphasizes the importance of continuous monitoring and feedback during this phase, as it allows for the identification of any issues that may arise during the implementation process and ensures that corrective actions are taken promptly.

C3: Evaluation of the Intervention Outcomes

The final phase of the model focuses on evaluating the outcomes of the interventions to determine their effectiveness and to identify areas for further improvement. This phase is guided by the Lean principle of "genchi genbutsu," which means "go and see for yourself." It emphasizes the importance of direct observation and data-driven analysis in assessing the impact of the interventions. The evaluation process begins with the collection of post-intervention data on key performance indicators such as efficiency rates, cycle times, and order accuracy. These metrics are compared to the baseline data collected during the analysis phase to quantify the improvements achieved through the Lean Warehousing initiatives.

The evaluation phase also involves conducting regular audits of the warehouse operations to ensure that the improvements are sustained over time. This includes periodic reviews of the warehouse layout, inventory levels, and SOPs to identify any deviations from the standardized processes. The results of these audits are used to make necessary adjustments to the warehouse operations and to reinforce the importance of adherence to Lean principles among the staff. The model also encourages the use of customer feedback as part of the evaluation process, as it provides valuable insights into the impact of the interventions on service levels and customer satisfaction.In addition to assessing the operational improvements achieved through the interventions, the evaluation phase also focuses on identifying opportunities for further enhancement. This includes exploring the potential for integrating advanced technologies such as warehouse management systems (WMS) and automated material handling equipment to further improve efficiency and accuracy in warehouse operations. The model's emphasis on continuous improvement ensures that the warehouse operations remain agile and responsive to changes in demand, ultimately contributing to the long-term success of the footwear trading SMEs.

The Lean Warehousing storage management model for footwear trading SMEs makes a significant contribution to the field of warehouse management by providing a structured approach to improving operational efficiency. By integrating Lean principles with practical interventions such as layout optimization and standardized work, the model offers a comprehensive framework for transforming warehouse operations. The model's focus on continuous improvement and data-driven decision-making ensures that the improvements achieved are sustainable and scalable, making it a valuable tool for SMEs looking to enhance their competitiveness in the market.However, further research is needed to explore the scalability of this model across different industries and regions. While the model has proven effective in the context of footwear trading SMEs, its applicability to other sectors with different operational challenges remains to be tested. Future studies should also investigate the long-term impact of Lean Warehousing on organizational culture and employee engagement, as these factors play a critical role in the successful implementation of Lean initiatives. Additionally, research on the integration of advanced technologies such as WMS and automation into the Lean Warehousing model could provide valuable insights into how SMEs can leverage these tools to achieve even greater efficiency and accuracy in their warehouse operations.

3.3 Model Indicators

To evaluate the impact of the warehouse management model based on Lean Warehousing and WMS for footwear trading SMEs, specialized metrics were developed. These metrics were designed to monitor and assess performance throughout the case study, providing a solid foundation for analyzing critical aspects of warehouse management within an SME environment. This systematic approach facilitated an in-depth examination of key performance indicators, including the distance traveled in picking, cycle time, and efficiency of the dispatch. This comprehensive assessment

ensured effective monitoring and supported the continuous improvement of storage processes, ultimately contributing to enhanced operational efficiency and effectiveness within the SME.

Distance Travelled in Picking: Measures the total distance that warehouse staff travel to pick items for orders, indicating the efficiency of the layout and picking process.

$$\text{Distance Travelled in Picking (meters)} = \sum_{i=1}^{n} \text{Distance}_i \quad (1)$$

Cycle Time: Represents the total time taken to complete one cycle of a process, reflecting the speed and efficiency of operations.

$$\text{Cycle Time (seconds)} = \text{End Time} - \text{Start Time} \quad (2)$$

Efficiency of the dispatch: Indicates the percentage of tasks completed correctly and on time at dispatch, reflecting operational efficiency.

$$\text{Efficiency of the Office}(\%) = \left(\frac{\text{Tasks Completed on Time}}{\text{Total Tasks}}\right) \times \mathbf{100} \quad (3)$$

4. Validation

4.1 Initial Diagnosis

In Figure 2, the problem tree summarizes the diagnostic analysis conducted in the case study to identify the causes and root causes contributing to the research problem. The main issue identified was the low efficiency of the shoe warehouse logistics process, with an efficiency rate of 91.3%, which is below the industry standard of 95%. This inefficiency resulted in a significant economic impact, estimated at 178,010 USD per year, representing 9.2% of the company's annual revenue. The diagnostic process revealed that 51.45% of the inefficiency was due to a high reprocessing rate, while 40.89% was attributed to high unproductive times. The root causes of these inefficiencies were further analyzed, with inadequate distribution of storage workstations contributing 36.89%, poor picking methods 29.61%, and poor packing methods 14.66%. Additionally, untimely shutdowns of the coding reader system accounted for 3.91%, and reprocessing caused by product search issues due to closed locations within the warehouse contributed 7.18%. This systematic analysis provided a comprehensive understanding of the underlying issues, guiding the development of targeted interventions to improve the efficiency of the logistics process within the shoe warehouse.

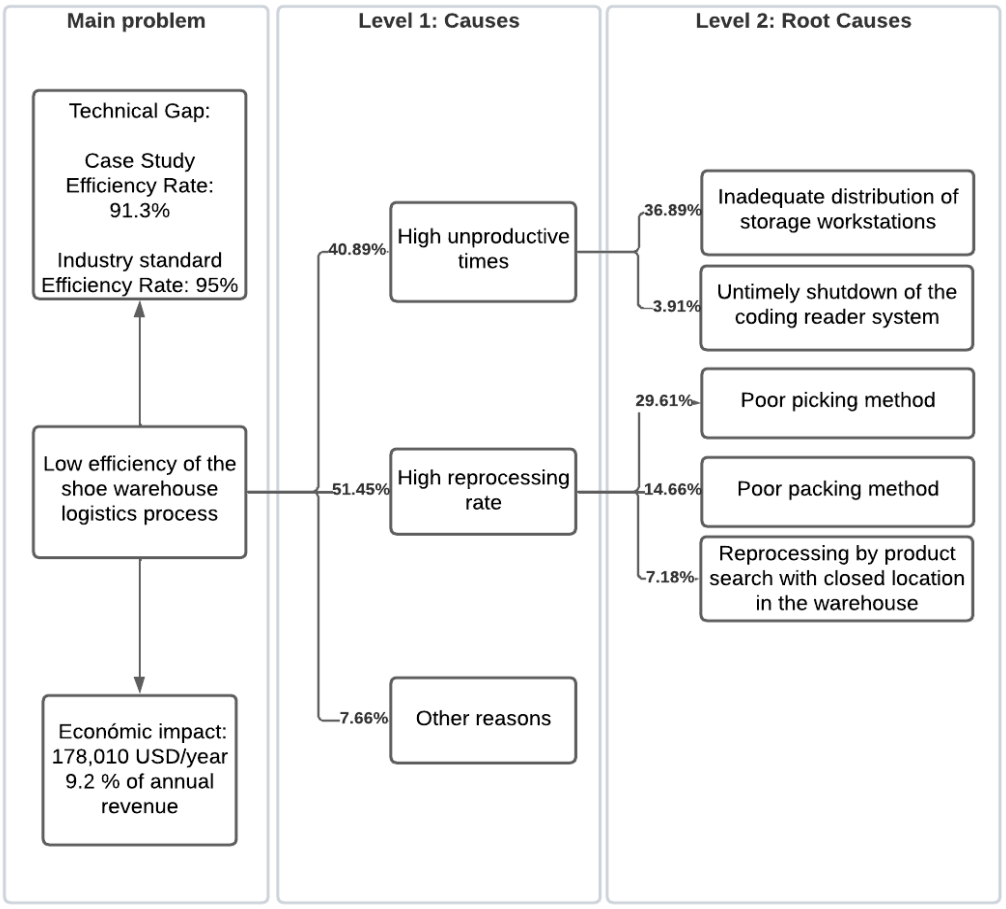

Figure 2. Problem Tree

4.2 Implementation of the model in the case study

Comprehensive Planning Phase

The detailed solution design began with a comprehensive planning phase aimed at allocating resources and setting clear objectives for the implementation of Lean Warehousing tools in a footwear trading SME. The initial assessment identified key inefficiencies in warehouse operations, including excessive travel distances for picking, high cycle times, and low dispatch efficiency. Resources such as manpower, technology, and time were allocated to address these issues, with a focus on ensuring that each step of the Lean Warehousing implementation could be executed effectively. The planning phase also involved the creation of a detailed project timeline, outlining milestones and deliverables that would guide the execution process.

Execution of Systematic Layout Planning (SLP)

The next phase involved the execution of the Systematic Layout Planning (SLP) technique. This phase was critical in optimizing the physical layout of the warehouse to reduce unnecessary movements and streamline workflow. The SLP process included the creation of a relational diagram of spaces and routes, which highlighted inefficiencies in the existing layout. The redesign of the layout led to a significant reduction in the total distance traveled by warehouse staff, from 579.8 meters to 346.2 meters. This reduction in travel distance directly contributed to an increase in picking efficiency, which is crucial for meeting the high demand in the footwear trading sector. Additionally, the SLP implementation was supported by quantitative data, showing a reduction in time spent on non-value-added activities, thereby freeing up resources for more productive tasks.

Figure 3 illustrates a relational diagram of routes and activities within a warehouse layout designed to optimize the flow of operations. The diagram displays the strategic placement of storage areas for classified and unclassified

products, temporary storage zones, and the allocation of operational spaces such as the operator room, quality inspection area, and the administrative office. This layout aims to minimize unnecessary movement and streamline the workflow by clearly defining pathways and workstations. The central aisles are organized to facilitate efficient picking, packing, and dispatch processes, reducing the travel distance for workers and enhancing overall productivity. This visual representation is crucial for understanding the physical arrangement of the warehouse, which is fundamental to implementing Lean Warehousing principles and improving operational efficiency.

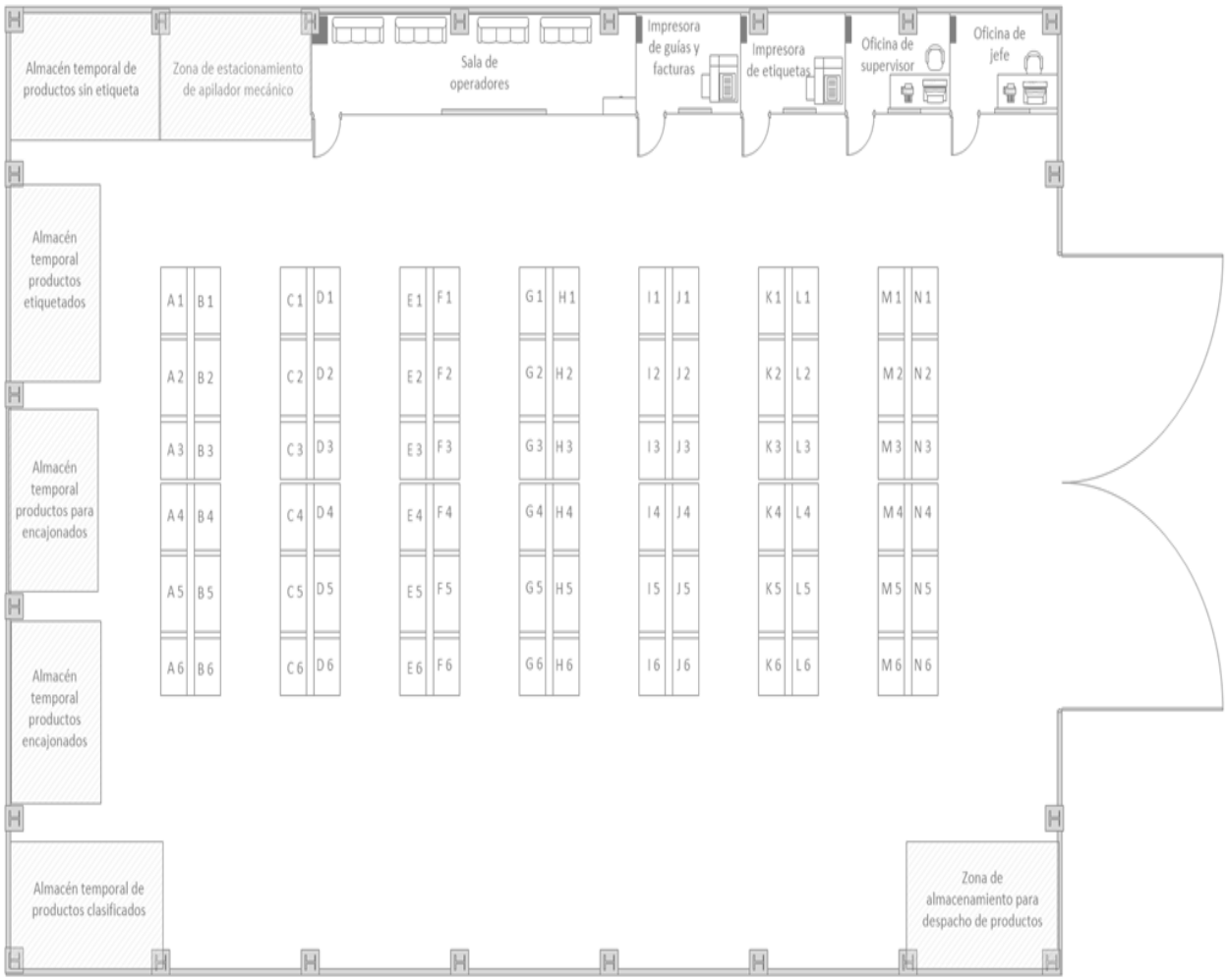

Figure 3. Relational diagram of routes and activities

Figure 4 depicts a Spaghetti Diagram, which visualizes the flow of movements within the warehouse layout. This diagram is used to track the paths taken by workers during various activities such as picking, packing, and dispatching products. The diagram highlights the complexity and potential inefficiencies in the current movement patterns, showing how workers navigate through different zones including temporary storage areas for classified and unclassified products, quality inspection, and the dispatch zone. The Spaghetti Diagram is a crucial tool for identifying excessive travel distances, overlapping routes, and unnecessary movements, which can then be addressed through layout optimization and process improvements. By analyzing this diagram, the company can implement changes to streamline operations, reduce travel time, and enhance overall efficiency in the warehouse.

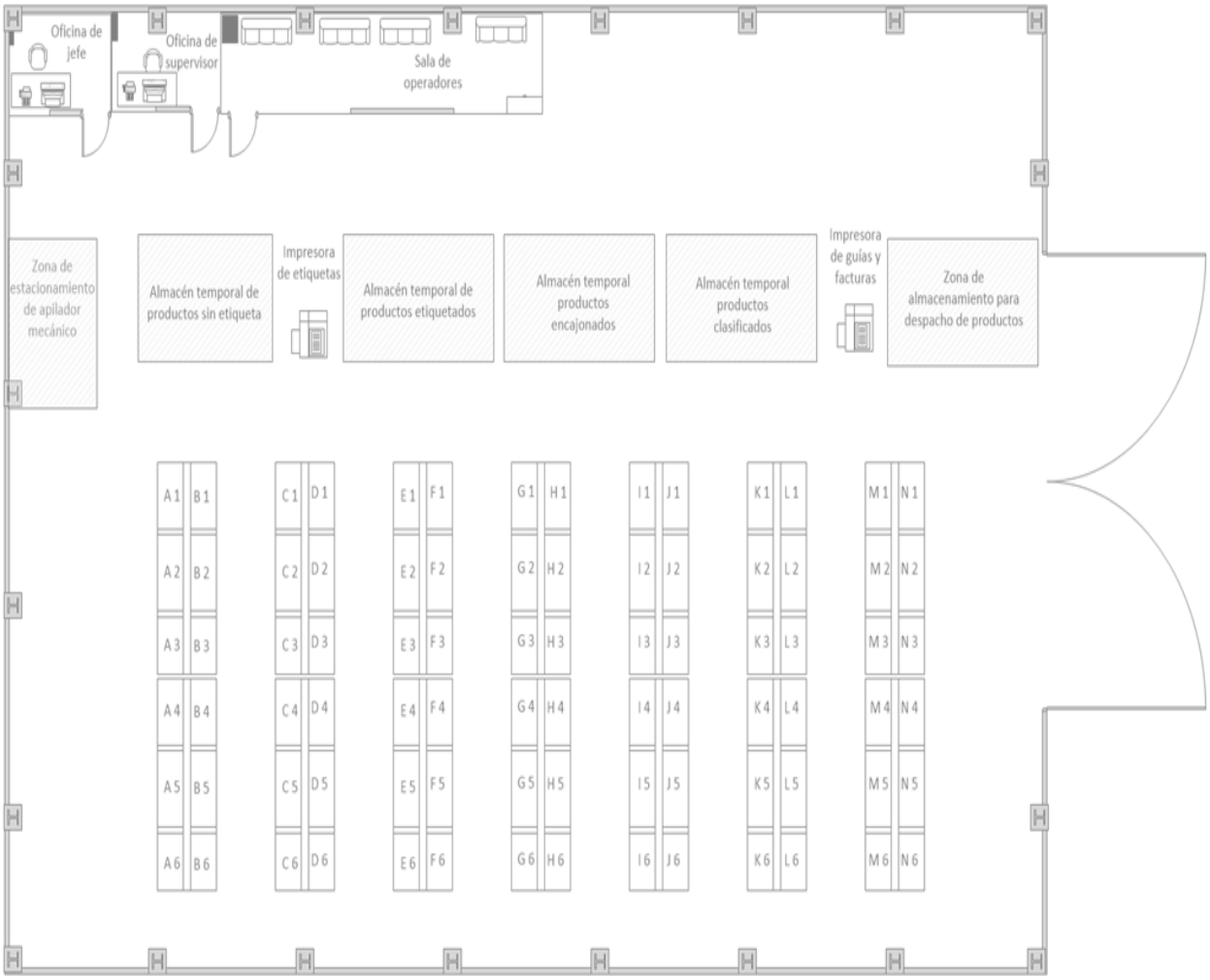

Figure 4. Spaghetti Diagram

Standardization of Picking and Packing Processes

Following the layout optimization, the standardization of picking and packing processes was implemented. This step involved the development and enforcement of standard operating procedures (SOPs) for key warehouse activities. By standardizing these processes, the variability in picking and packing times was reduced, leading to more consistent and predictable operations. The impact of this standardization was evident in the reduction of cycle times by 26.47%, as documented in the control charts presented in the PDF. Furthermore, dispatch efficiency improved by 4.17%, aligning the warehouse's performance with industry standards. The standardization process was also accompanied by staff training programs to ensure that all employees were fully equipped to adhere to the new procedures, thus minimizing the risk of errors and rework.

Evaluation of Operational Impac*t*

The operational impact of the Lean Warehousing implementation was thoroughly evaluated using key performance indicators (KPIs). The evaluation phase involved collecting and analyzing data on efficiency rates, cycle times, and overall productivity. The results showed a substantial improvement in warehouse operations, with the efficiency rate increasing from 91.3% to 95.11%. This improvement was particularly significant given that the industry standard is 95%, indicating that the warehouse was now operating at a level comparable to its peers. Additionally, the reduction in the distance traveled during picking operations, as well as the decrease in cycle times, contributed to a more streamlined and efficient process. The economic impact of these improvements was also notable, with annual savings projected at approximately USD 178,010, representing 9.2% of the company's annual revenue.

Ensuring Sustainability of Improvements

The final phase of the detailed solution design focused on ensuring the sustainability of the improvements achieved through the Lean Warehousing implementation. This phase involved the development of a comprehensive sustainability plan, which included regular audits, continuous staff training, and the integration of advanced warehouse management systems (WMS). The sustainability plan was designed to maintain the gains made during the implementation phase and to ensure that the warehouse operations continued to improve over time. The plan also included provisions for continuous monitoring and feedback, allowing the company to make necessary adjustments and to stay ahead of potential challenges. The integration of WMS was particularly important for automating routine tasks and reducing the reliance on manual processes, thereby further enhancing the efficiency and accuracy of warehouse operations.

5. Results

In Table 1, the key results of validating the Lean Warehousing-based storage management model for footwear trading SMEs are presented, aimed at addressing the identified research problem. The model successfully reduced the distance traveled during picking by 45%, decreased the cycle time by 26.47%, and improved office efficiency by 4.17%. These outcomes highlight the effectiveness of the proposed model in optimizing warehouse operations, leading to more streamlined processes and enhanced overall efficiency. The reduction in cycle time and picking distance also suggests a significant improvement in the productivity of the warehouse staff, while the increase in office efficiency reflects better management practices and process control.

Table 1. Results of the validation of the proposed model

Indicator	Unit	As-Is	To-Be	Results	Variation (%)
Distance traveled in picking	metro	193.1	105	106.2	-45.00%
Cycle Time	seconds	34	23	25	-26.47%
Efficiency of the office	%	91.30%	98%	95.11%	4.17%

6. Conclusions.

The study revealed significant improvements in the operational efficiency of a footwear trading SME through the implementation of a Lean Warehousing model. Key findings include a substantial reduction in the distance traveled during picking operations, which decreased by 45%, alongside a notable reduction in cycle times by 26.47%. These improvements were complemented by a 4.17% increase in office efficiency. The integration of systematic layout planning and standardized work processes played a crucial role in achieving these results, highlighting the effectiveness of Lean Warehousing tools in addressing the inefficiencies identified during the initial diagnostic phase.

The importance of this research lies in its application of Lean principles to the warehousing processes of SMEs within the footwear industry, a sector that is vital to the economy but often plagued by inefficiencies due to resource constraints. The study's findings underscore the critical role that process optimization plays in enhancing the competitive edge of SMEs, particularly in a globalized market where agility and efficiency are paramount. By systematically addressing the root causes of inefficiencies, the research provides a robust framework for improving operational performance in similar contexts.

This research contributes to the broader field of industrial engineering by offering a practical application of Lean Warehousing principles in a real-world setting. The study extends existing literature by demonstrating the scalability of Lean tools in small and medium-sized enterprises, particularly in industries with high variability and operational complexity. The successful application of these tools in the case study provides empirical evidence that Lean methodologies can be adapted to suit the specific needs of SMEs, thereby contributing to the ongoing discourse on the adaptability of Lean practices in diverse industrial contexts.

Final observations suggest that while the Lean Warehousing model proved effective in this case, further research is needed to explore its long-term sustainability and impact on overall business performance. Future studies should consider the integration of advanced technologies, such as warehouse management systems and automation, to further enhance the efficiency gains achieved. Additionally, expanding the scope of research to include other sectors and regions would provide a more comprehensive understanding of the model's applicability and potential benefits.

Continuous improvement and regular audits are recommended to ensure that the gains made are maintained and that the warehouse operations remain responsive to changing market demands..

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Biographies

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