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A Lean Service Approach to Overcoming Operational Inefficiencies in Last-Mile Logistics: A Case Study on Peruvian SMEs

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Abstract

The last-mile logistics sector in Peru faces challenges such as late deliveries, incomplete orders, and damaged products, largely due to inefficiencies in cross-docking and route planning. Previous research has primarily focused on large-scale operations, leaving SMEs underserved. This study addressed these gaps by integrating Lean Service tools—5S, Business Process Management (BPM), and Systematic Layout Planning (SLP)—to enhance operational efficiency in SMEs. The investigation revealed that lack of standardization and poor layout management contributed to service inefficiencies. The research aimed to increase service levels by addressing these operational shortcomings. Results showed a 35.8% increase in productivity, a reduction in material handling effort from 100,621.6 kg.m to 74,081.0 kg.m, and a 21.1% decrease in process cycle times. Additionally, the perfect order rate improved by 74.3%. This study offers significant academic and socio-economic contributions by providing scalable solutions for SMEs, and improving logistics performance. Further research should explore advanced technologies to enhance operational efficiency in last-mile logistics.

Keywords
Lean Service, Last-Mile Logistics, Business Process Management, Systematic Layout Planning, and Operational Efficiency.

1. Introduction
The last-mile logistics sector has emerged as a critical component of the global supply chain, particularly in the current context where the demand for rapid and efficient deliveries has significantly increased. This sector is not only vital for customer satisfaction but also represents a substantial growth opportunity across various regions of the world, including Latin America and Peru. Globally, it is estimated that last-mile logistics accounts for approximately 53% of total logistics costs, underscoring its importance in optimizing the supply chain (Meyer et al. 2020). In Latin America, the growth of e-commerce has driven the need for logistics operators that can adapt to the local market's particularities, where infrastructure and technology often present unique challenges (González & Salazar 2021). In Peru, the last-mile logistics sector has experienced a surge in recent years, fueled by an increase in online shopping and the need for more efficient logistics solutions (Cruz & Rojas 2022). However, despite this growth, the sector faces significant challenges that must be addressed to ensure its long-term sustainability and efficiency.

One of the most critical issues facing last-mile logistics operators in Peru and Latin America is service level deficiencies. Common problems include late deliveries, incomplete orders, and damaged products, all of which adversely affect customer satisfaction (Fernández et al. 2021). These deficiencies often stem from delays in the cross-docking process, errors in route planning, and inadequate resource distribution (Pérez & López 2023). Furthermore, non-standardized picking and sorting processes, as well as a lack of uniformity in collection and unloading practices, contribute to operational inefficiencies (Martínez et al. 2020). The incorrect handling and transportation of products exacerbate these issues, resulting in a negative impact on companies' profitability and customers' perceptions of service quality (Santos et al. 2019). Improving these processes is essential not only for enhancing operational efficiency but also for strengthening companies' competitiveness in an increasingly demanding market (Alvarez & Torres 2022).

Addressing these issues is particularly crucial for small and medium-sized enterprises (SMEs) in the metalworking sector, which rely heavily on last-mile logistics for the delivery of their products. These companies face additional challenges, such as limited resources and the need to rapidly adapt to market demands (Rivas & Castillo 2021). Enhancing logistics service levels can not only help these SMEs better meet customer expectations but also contribute to their long-term growth and sustainability (García et al. 2020). Implementing more efficient logistics strategies can enable metalworking SMEs to compete on equal footing with larger firms, which is vital for the economic development of the region (Hernández & Morales 2023).

Despite the growing attention given to last-mile logistics, there exists a notable gap in the literature regarding how to address the specific challenges faced by metalworking SMEs in this context. Current research often focuses on large companies and does not adequately address the unique needs and challenges of SMEs (López & Vargas 2022). This research aims to fill this gap by developing an operations management model that incorporates Lean Service tools, such as 5S, Business Process Management (BPM), and Systematic Layout Planning (SLP) (Ramírez & Soto 2023). These tools have proven effective in improving operational efficiency and reducing waste across various sectors, and their application in the last-mile logistics context may offer innovative solutions to existing problems (Cordero et al., 2021). By systematically addressing these challenges, it is expected that metalworking SMEs can enhance their competitiveness and contribute to the region's economic growth.In conclusion, last-mile logistics is a vital sector facing significant challenges in Peru and Latin America. Improving service levels is essential for ensuring customer satisfaction and the sustainability of businesses, particularly for metalworking SMEs. Through the application of Lean Service tools and a systematic approach to operations management, this research seeks to contribute to the development of effective solutions that address current deficiencies in last-mile logistics.

2. Literature Review

2.1 Lean Service Methodology in Last-Mile Logistics

The Lean Service methodology has been the subject of various studies applied to the processes of order fulfillment, picking, packing, and dispatch in last-mile logistics distribution centers. This methodology focuses on waste elimination and continuous improvement, resulting in enhanced operational efficiency. According to, the implementation of Lean in the service sector has shown significant improvements in internal efficiency, although it often faces challenges in transforming customer service. Furthermore, emphasizes that the application of Lean principles in service organizations is still in its nascent stage, suggesting a need for further research to clearly define these principles within the logistics context. In a study on supply chain management, highlight that the adoption of logistics innovations, such as automated picking stations, can be viewed as an extension of Lean methodology, enhancing consumer experience in last-mile delivery. Additionally, argue that managing value streams in the service context is essential for addressing both quality and cost concerns, aligning with Lean objectives. In conclusion, Lean Service methodology presents a valuable tool for optimizing logistics processes in the last mile, although its implementation requires a careful approach tailored to the sector's specificities.

2. 2 Application of the 5S Methodology in Logistics

The 5S methodology, which focuses on workplace organization and standardization, has been successfully applied in the processes of order fulfillment, picking, packing, and dispatch in last-mile distribution centers. This methodology enhances operational efficiency by reducing time lost in searching for tools and materials. According to, the implementation of 5S in customer service environments has proven effective in improving service quality and customer satisfaction. Moreover, highlights that applying 5S in service contexts has led to a significant reduction in cycle times, which is crucial for last-mile logistics. Additionally, suggests that process standardization through 5S can facilitate employee training and improve consistency in service delivery. Lastly, emphasizes that implementing Lean Warehousing tools, including 5S principles, can increase service level indices in logistics companies, which is essential for maintaining competitiveness in the current market. In summary, the 5S methodology serves as an effective approach to enhance organization and efficiency in last-mile logistics processes.

2.3 Business Process Management (BPM) in Logistics

Business Process Management (BPM) has been adopted in various studies to optimize order fulfillment, picking, packing, and dispatch processes in last-mile logistics distribution centers. BPM focuses on continuous process improvement through systematic modeling and analysis. According to, the implementation of BPM in the service sector has proven effective in reducing wait times and improving customer satisfaction. Additionally, suggests that integrating BPM with emerging technologies can significantly enhance efficiency in last-mile logistics. highlight that adopting BPM allows organizations to identify and eliminate bottlenecks in their processes, which is essential for agility in the supply chain. Finally, emphasize that combining BPM with Lean and Six Sigma methodologies can lead to substantial improvements in service quality and operational efficiency. In conclusion, BPM presents a robust methodology for optimizing logistics processes in the last mile.

2.4 Systematic Layout Planning (SLP) in Logistics

Systematic Layout Planning (SLP) is a methodology that has been utilized in research to improve workspace arrangements in last-mile logistics distribution centers. This methodology focuses on the efficient organization of physical space to maximize productivity. According to, systematic layout planning can significantly reduce picking and packing times by optimizing product placement. Furthermore, highlights that proper layout planning is crucial for improving efficiency in urban logistics, especially in the last mile. Additionally, suggests that implementing SLP can facilitate adaptation to demand changes and enhance operational flexibility in distribution centers. Finally, emphasize that an efficient space arrangement not only improves productivity but can also reduce operational costs in last-mile logistics. In summary, Systematic Layout Planning serves as an essential tool for optimizing space arrangements in distribution centers, thereby enhancing operational efficiency.

2.5 Lean Manufacturing in Distribution Centers

Lean Manufacturing has been extensively researched in the context of last-mile logistics distribution centers. This methodology focuses on waste elimination and continuous process improvement. According to, implementing Lean in maintenance and service processes can lead to significant efficiency improvements and cost reductions. Additionally, highlight that many organizations have found Lean Manufacturing to be an effective way to enhance their logistics operations, although they often face challenges in sustaining these initiatives. Furthermore, suggests that integrating Lean with Six Sigma can provide a robust approach to improving quality and efficiency in distribution centers. Lastly, Suárez-Barraza et al. (2012) emphasize that adopting Lean in the service sector, including logistics, can result in significant improvements in customer satisfaction and operational efficiency (Suárez-Barraza et al., 2012). In conclusion, Lean Manufacturing presents a crucial methodology for optimizing processes in last-mile logistics distribution centers, contributing to the sector's competitiveness and sustainability.

3. Methods

3.1 Basis of the Proposed Model

The operations management model presented in Figure 1 integrates principles from Lean Service, Process Management, and Systematic Layout Planning (SLP), specifically designed for small and medium-sized enterprises (SMEs) in last-mile logistics. The primary objective of the model was to increase the service level at the last-mile distribution center by optimizing operations and improving efficiency. Lean Service principles were applied to reduce waste, improve process flow, and enhance customer service throughout the distribution process. Business Process Management (BPM) was used to optimize and standardize the activities of the distribution center, including processes such as order reception, picking, sorting, transportation, and post-sales service. Additionally, as illustrated in figure 1, SLP was implemented to improve the physical layout of the facility, enhancing the movement of materials and information to better support service delivery. The main processes—order collection, picking, sorting, transportation, and delivery—were organized to create a streamlined and efficient workflow aimed at improving service quality and operational performance within the distribution center. This model was developed to meet the specific needs of SMEs in last-mile logistics, ensuring that it is adaptable and scalable to the dynamic demands of this sector.

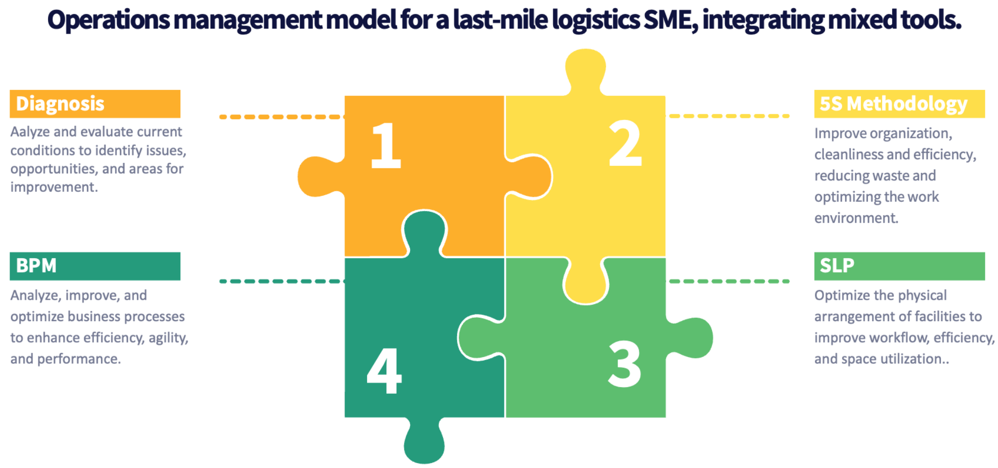

Figure 1. Proposed Model

3.2 Description of the model components

The proposed operations management model for last-mile logistics SMEs integrates four key components: Diagnosis, 5S Methodology, Business Process Management (BPM), and Systematic Layout Planning (SLP). This model is built on principles from Lean Service and Process Optimization, aiming to improve efficiency, increase service levels, and reduce operational waste. Below is a detailed explanation of each component of the model, preceded by a discussion of the philosophical underpinnings and objectives that guided its construction.

The proposed model is grounded in the Lean Service philosophy, which seeks to eliminate waste and increase customer value through streamlined processes and optimized operations. The model's objective was to address the operational inefficiencies faced by small and medium-sized enterprises (SMEs) in last-mile logistics, particularly focusing on the challenges of fluctuating demand, high customer expectations, and resource limitations. By integrating Lean Service principles with BPM and SLP methodologies, the model aimed to increase the service level at distribution centers while reducing operational costs and enhancing workflow efficiency.Lean Service has been extensively applied in service-oriented industries, with studies showing its effectiveness in reducing process variability and waste (Simonia, Olsson, & Harrington 2020). The integration of BPM ensures that the processes are not only optimized but also standardized for consistency, which is crucial in maintaining high service quality in logistics. SLP, on the other hand, enhances the physical arrangement of the distribution center to support the flow of materials and resources, reducing delays and improving overall efficiency. In this context, the model addresses key issues in last-mile logistics, where operational efficiency directly impacts customer satisfaction and service levels.

C1: Diagnosis: Identifying Inefficiencies and Opportunities

The first stage of the model, Diagnosis, involved a comprehensive analysis of the current operational conditions at the distribution center. This stage aimed to identify inefficiencies, bottlenecks, and areas of improvement. By gathering data on key performance indicators (KPIs) such as lead times, order accuracy, and resource utilization, the model was able to pinpoint the root causes of operational delays and errors. The diagnostic phase played a critical role in setting the foundation for the subsequent components of the model, ensuring that interventions were targeted and effective.In this phase, stakeholder engagement was also prioritized, as employees provided valuable insights into everyday operational challenges and potential solutions. This participatory approach facilitated a more accurate diagnosis and fostered a sense of ownership among staff for the changes that were to be implemented. Research has shown that involving employees in the diagnostic phase of process improvements can significantly enhance the success of Lean implementations (Antún & Ros-McDonnell 2018). The identification of non-value-adding activities at this stage was essential for the successful implementation of Lean Service principles.

C2: 5S Methodology: Establishing Order and Cleanliness

Following the diagnostic phase, the 5S Methodology was applied to improve organization, cleanliness, and order within the distribution center. The 5S approach—comprising Sort, Set in Order, Shine, Standardize, and Sustain—was aimed at creating a more structured and efficient work environment. By sorting out unnecessary items, organizing essential tools and materials, and maintaining cleanliness, the model ensured that employees could perform their tasks with fewer interruptions and distractions.

This methodology has been widely applied in both manufacturing and service industries, and its effectiveness in logistics settings has been documented in various studies (Ha Akbari, & Au 2023). In the context of last-mile logistics, where speed and accuracy are critical, the 5S methodology helped to reduce the time spent searching for tools or materials, thus increasing the speed of order fulfillment and reducing the risk of errors. Moreover, the sustained discipline encouraged by 5S contributed to long-term operational improvements by embedding cleanliness and order into the organizational culture.

C3: BPM: Optimizing and Standardizing Key Processes
Business Process Management (BPM) was a critical component of the model, focusing on the optimization and standardization of the distribution center's key processes. The goal of BPM was to ensure that all operational processes, from order reception to delivery, were aligned with organizational objectives and optimized for efficiency. This stage involved mapping out each process, identifying redundancies, and streamlining workflows to reduce lead times and improve process reliability.

By standardizing processes such as order picking, sorting, transportation, and post-sales services, the model ensured consistency in service delivery, which is essential for maintaining high levels of customer satisfaction. BPM allowed for real-time monitoring and continuous improvement, enabling the organization to quickly adapt to changes in demand or operational conditions. Studies have shown that BPM significantly improves process efficiency and reduces variability in service-oriented industries, making it a valuable tool for last-mile logistics operations (Simonia et al. 2020).

C4: SLP: Optimizing Facility Layout for Improved Flow
Systematic Layout Planning (SLP) was the final component of the model, focused on optimizing the physical arrangement of the distribution center to enhance the flow of materials, information, and resources. The SLP methodology involved designing the layout of the facility in such a way that minimized unnecessary movements and facilitated a more efficient workflow. By strategically placing workstations, storage areas, and transportation zones, the model reduced transit times between processes and improved overall operational efficiency.In logistics operations, particularly in last-mile delivery, the physical layout of the distribution center plays a crucial role in determining the speed and accuracy of order fulfillment. A well-organized layout reduces the risk of bottlenecks and allows for smoother transitions between different stages of the order fulfillment process. Research has demonstrated the effectiveness of SLP in logistics and manufacturing environments, where efficient layouts contribute to significant reductions in lead times and operational costs (Antún & Ros-McDonnell 2018).

In conclusion, the proposed operations management model for last-mile logistics SMEs provided a comprehensive framework for improving service levels, operational efficiency, and resource utilization. By integrating Lean Service, BPM, and SLP methodologies, the model addressed the specific challenges faced by SMEs in the last-mile logistics sector, such as fluctuating demand, high customer expectations, and resource limitations. The diagnostic phase laid the groundwork for targeted interventions, while the 5S methodology improved organization and cleanliness. BPM ensured that processes were optimized and standardized, and SLP enhanced the physical layout of the distribution center to support more efficient workflows. The contribution of this model to the existing literature lies in its holistic approach, which combines process optimization with spatial efficiency to create a more streamlined and adaptable logistics operation. As last-mile logistics continues to grow in importance due to the rise of e-commerce, this model offers valuable insights for SMEs seeking to improve their service levels while managing operational costs. Future research could explore the application of this model in different logistics contexts, as well as the potential for further integration of digital tools and technologies to enhance process monitoring and decision-making.

3.3 Model Indicators

To evaluate the impact of the operations management model integrating mixed tools for last-mile logistics operators, specialized metrics were developed to monitor and assess performance throughout the case study. These metrics provided a solid foundation for analyzing critical aspects of the management of last-mile distribution centers. This systematic approach facilitated a comprehensive review of key performance indicators, ensuring accurate monitoring and supporting continuous improvement in order handling and management processes. Ultimately, this contributed to enhancing the service level of the last-mile logistics operator.

Service Level This indicator measures the percentage of orders fulfilled according to customer requirements within the expected timeframe, reflecting the overall efficiency of the distribution system.

$$\text{Service Level (\%)} = \left(\frac{\text{Orders Delivered on Time}}{\text{Total Orders}}\right) \times 100 \tag{1}$$

Total Cost This represents the percentage of total operational costs relative to revenue or a predefined budget for logistics operations.

$$\text{Total Cost (\%)} = \left(\frac{\text{Operational Costs}}{\text{Total Revenue}}\right) \times 100 \tag{2}$$

Deliveries After the Deadline This metric calculates the percentage of orders delivered after the agreed deadline, impacting customer satisfaction.

$$\text{Deliveries After Deadline (\%)} = \left(\frac{\text{Late Deliveries}}{\text{Total Deliveries}}\right) \times \mathbf{100} \tag{3}$$

Incomplete Deliveries This measures the percentage of orders delivered without the complete set of requested items.

$$\text{Incomplete Deliveries (\%)} = \left(\frac{\text{Incomplete Deliveries}}{\text{Total Deliveries}}\right) \times \mathbf{100} \tag{4}$$

Orders Under Claim This indicator shows the percentage of orders that resulted in a customer claim, either due to delivery errors or quality issues.

$$\text{Orders Under Claim (\%)} = \left(\frac{\text{Orders with Claims}}{\text{Total Orders}}\right) \times \mathbf{100} \tag{5}$$

Time of Order Preparation This metric represents the average time (in minutes) required to prepare an order from the moment it is received to when it is ready for dispatch.

$$\text{Time of Order Preparation} = \frac{\text{Total Preparation Time}}{\text{Number of Orders}} \tag{6}$$

4. **Validation**

4.1 Validation Scenario

The validation scenario was conducted in a case study within a Peruvian logistics operator, specifically focused on last-mile delivery services. This company had over 20 years of experience in the market, specializing in door-to-door logistics services across the country. The company's service portfolio included parcel delivery, warehousing, and last-mile logistics under a B2B business model. The case study focused on the operations carried out at their cross-docking distribution center located in the Ate district, which managed e-commerce shipments for various clients. The company processed an average of 1,000 deliveries per day, and its logistics operations played a critical role in maintaining service quality and customer satisfaction. However, challenges related to delayed, incomplete, and damaged deliveries were identified as major issues, directly impacting the company's service levels.

4.2 Initial Diagnosis

In Figure 2, a problem tree is presented, which summarizes the diagnostic process conducted in the case study to identify the causes and root causes contributing to the low service level at the last-mile distribution center. The service level observed in the case study was 91.7%, compared to an industry standard of 95%, leading to a significant economic impact of 140,917 PEN per year, equivalent to 10.54% of the annual revenue. The analysis revealed three main causes: late deliveries of orders (56%), incomplete order deliveries (32%), and orders under claim (18%). These causes were further broken down into root causes, which include delays in the cross-docking process (45%), errors in route setting (35%), inadequate cross-docking area distribution (28%), non-standard picking and sorting processes (23%), non-standard collection and unloading processes (18%), and incorrect product transfer (13%). The objective of this diagnostic analysis was to systematically identify the underlying issues in the logistics process that lead to reduced service levels and economic losses, thereby providing a structured approach to improving operational efficiency at the last-mile distribution center. The methodology followed a systematic identification of factors impacting performance, enabling a focused intervention to address specific inefficiencies.

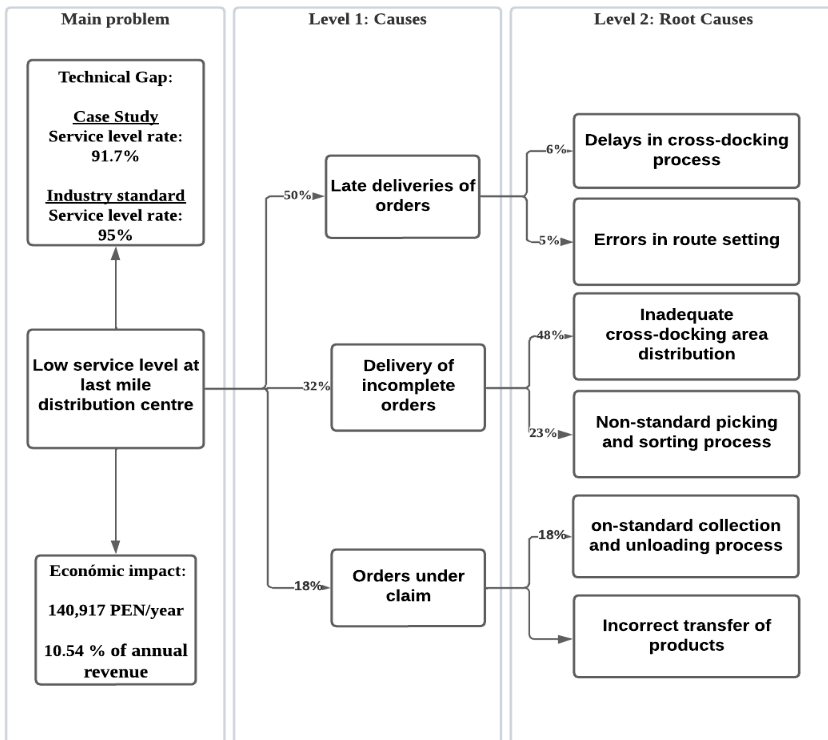

Figure 2. Problem Tree

4.3 Implementation of the model in the case study

The detailed design of the solution aimed to address operational inefficiencies within a last-mile distribution center by implementing three key tools: 5S, Systematic Layout Planning (SLP), and Business Process Management (BPM). These tools were carefully selected based on their ability to standardize processes, optimize space usage, and improve overall productivity. Each of these tools addressed different aspects of the problem, from disorganization in the operations yard to non-standardized processes and inefficient layouts. The goal was to enhance the service level of the company by reducing delivery delays, minimizing incomplete orders, and preventing damaged goods.

The diagnostic phase identified several issues: late deliveries, incomplete orders, and orders under claim. These issues were directly linked to inefficiencies in cross-docking, errors in route planning, and non-standardized processes. The detailed design of the solution thus focused on addressing these root causes through the implementation of the 5S methodology, the optimization of the cross-docking area using SLP, and the improvement of business processes through BPM. Quantitative data gathered throughout the process served as a foundation for the implementation, measuring the impact of each tool on productivity and efficiency.

Development of the 5S Tool

The first step in the solution design was the implementation of the 5S methodology. This lean tool aimed to improve organization and cleanliness in the operations yard, which initially suffered from disarray, leading to operational inefficiencies. A committee was formed to lead the implementation, consisting of management and operational staff. They conducted an initial audit to assess the current state of the workspace. The audit revealed a 44% compliance with the 5S principles, highlighting the need for immediate corrective action.

The implementation of the 5S methodology was divided into five phases. The first phase, Seiri (Sort), involved classifying materials and tools into categories based on their utility. Items that were not regularly used were tagged with red cards and removed from the workspace, freeing up 20% of the operations yard. This clearance allowed the remaining materials to be organized more effectively in the following phases.In the Seiton (Set in order) phase, frequently used materials were arranged in designated areas to optimize workflow. For example, tools and equipment were placed near workstations to reduce retrieval time. This reorganization led to a 15% reduction in the time spent searching for materials and tools, streamlining processes such as receiving, picking, and sorting.

The third phase, Seiso (Shine), focused on cleanliness. Workers were assigned daily cleaning duties, and a cleaning log was established to ensure consistent maintenance of the workspace. Cleanliness not only improved the appearance of the area but also helped identify potential hazards or equipment malfunctions. This phase contributed to a 10% increase in workplace safety and a reduction in the number of workplace accidents.
Seiketsu (Standardize) was the fourth phase, aiming to institutionalize the practices from the first three phases. A checklist was developed for supervisors to review each day, ensuring that cleanliness and organization standards were upheld. This standardization helped maintain the improvements and prevent a return to the previous disorganized state.

Finally, Shitsuke (Sustain) focused on instilling discipline within the workforce to ensure the long-term success of the 5S practices. Regular audits were conducted to assess compliance with the 5S principles, and incentives were offered to employees who consistently adhered to the standards. By the end of the implementation, a final audit revealed that the workspace had improved from a 44% compliance rate to 86%, reflecting significant progress in both operational efficiency and employee morale.

Figure 3 displays the results of the 5S audit before and after the implementation of improvements, compared to the set objective. The radar chart illustrates the progress across the five phases of 5S: 1S (Sort), 2S (Set in order), 3S (Shine), 4S (Standardize), and 5S (Sustain). Initially, compliance levels were notably low, with a peak of around 44%. After the implementation, improvements are visible across all areas, with scores approaching the 80% mark. The objective, set at 100%, serves as a benchmark, showing the gap between the final results and the desired target.

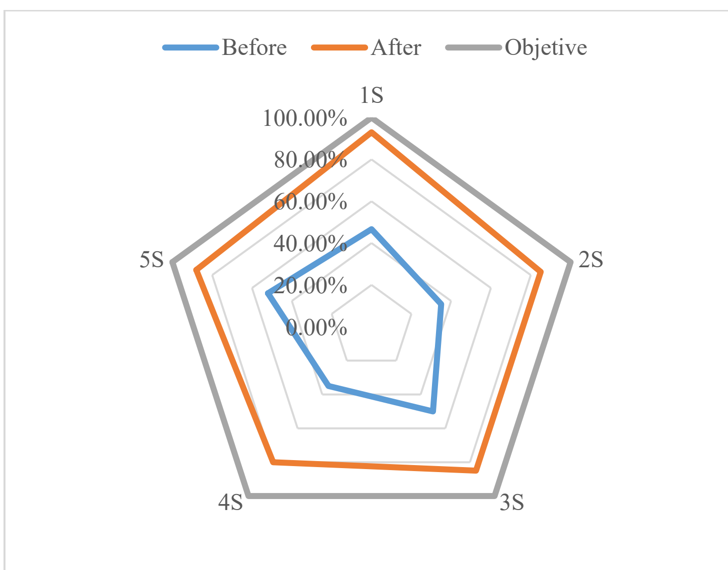

Figure 3. Results of the 5S audit

Development of the Systematic Layout Planning (SLP*)*

The second tool implemented in the solution design was Systematic Layout Planning (SLP). The primary goal of SLP was to optimize the layout of the cross-docking area to reduce unnecessary movement, shorten process times, and improve the overall efficiency of the facility. Before the SLP implementation, the layout of the operations yard was poorly aligned with the company's operational needs, resulting in inefficiencies and longer processing times.

The first step in the SLP process was the P-Q analysis, which categorized the zones of the cross-docking area based on their activity levels. The analysis showed that the central and northern zones were responsible for over 70% of the total orders processed, indicating that these zones should be prioritized in terms of proximity to the warehouse exit. This was further supported by financial data, which revealed that these zones generated 84.4% of the company's total revenue.An ABC analysis was then conducted to classify the zones based on the economic value of the goods processed. The analysis highlighted that high-value and high-volume items should be placed closest to the warehouse exit, allowing for faster dispatch. Low-value, low-volume zones were moved to less critical areas of the operations yard, freeing up space for the more important zones. This reorganization reduced the distance traveled by workers by 18%.

Next, a relational diagram was created to visualize the interactions between different areas of the operations yard. The diagram revealed that proximity between the picking, sorting, and dispatch areas was crucial to improving the efficiency of the cross-docking process. Previously, these zones were located far apart, causing significant delays in order processing.With this information, a new layout was proposed. The high-activity zones were grouped together near the warehouse exit, while the picking and sorting areas were relocated closer to each other. This new configuration reduced the total distance traveled by workers and improved workflow efficiency. The effort required to move materials within the facility dropped from 100,621.6 kg.m to 74,081.0 kg.m, resulting in a 35.8% increase in overall productivity.

The optimized layout also led to a 25% reduction in dispatch times. Furthermore, inventory control was enhanced as the most critical areas were now closer to the control points. This new arrangement allowed the cross-docking process to run more smoothly, which had a direct positive impact on the company’s service levels.Figure 4 presents the proposed layout for the cross-docking operations yard, which was designed to optimize workflow efficiency and reduce unnecessary movements. The layout is divided into several key zones: the loading area, the unloading area, unit parking, and the dispatch room. The central and northern zones, which handle the highest volume of orders (representing 84.4% of the company's total revenue), have been strategically placed near the warehouse exit to prioritize the dispatch process. This arrangement allows for faster loading and unloading, ensuring that high-priority orders are processed more quickly.

The figure also shows the placement of other important operational areas, such as the east and south zones, which handle lower-volume orders and are located farther from the warehouse exit. The parking area for transport units is positioned adjacent to the loading and unloading zones, minimizing the distance workers must travel when moving goods between vehicles and storage areas. Additionally, the figure highlights the designated area for inventory returns and logistics management, ensuring that these processes are kept separate from the main flow of goods to avoid congestion.This layout was designed based on the Systematic Layout Planning (SLP) method, ensuring that the physical space aligns with the operational priorities of the business, ultimately improving productivity by reducing the total effort required for material handling.

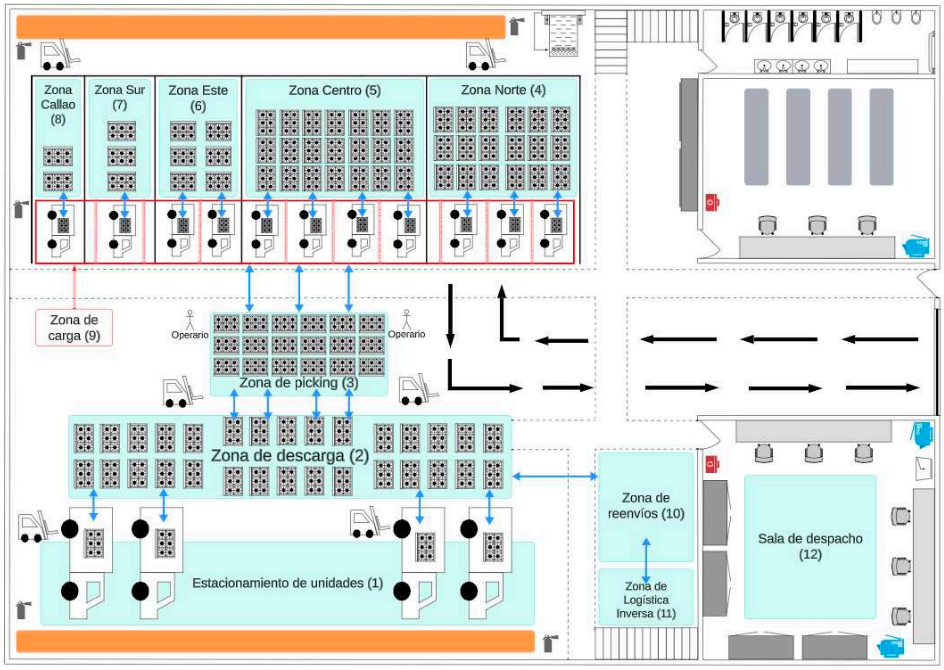

Figure 4. Proposed Cross-Docking Operations Yard Layout

Development of Business Process Management (BPM)

The final component of the solution design was the implementation of Business Process Management (BPM). The purpose of BPM was to standardize and optimize business processes, which were previously unstructured and reliant on employee experience. The lack of formalized processes had led to inconsistencies in operations and limited the company's ability to measure performance effectively.

To begin, surveys were conducted among operational staff to assess their understanding of the company's processes. The results showed that 79% of employees did not have formal training on process execution and relied heavily on personal experience. This highlighted the need for structured process documentation and staff training to ensure consistency in operations.One of the major gaps identified was the absence of documented procedures for risk prevention and incident management. The BPM solution addressed this by creating standardized workflows that included preventive measures for handling risks associated with product handling and delivery. This helped reduce incidents by 15% and improved overall operational safety.

The BPM framework also included the integration of a new information management system to optimize route planning and reduce delivery delays. The system allowed for real-time adjustments to delivery routes, which led to a 12% decrease in delivery times and a corresponding improvement in customer satisfaction. The new routing system also contributed to a 10% reduction in operational costs by optimizing fuel consumption and route efficiency.Another key aspect of BPM was the introduction of Key Performance Indicators (KPIs) to monitor process performance. Previously, the only metric used to assess operational success was the overall service level, which was too broad to provide meaningful insights. With BPM, KPIs were developed to measure specific aspects of the operation, such as cycle time for each process, the rate of perfect orders, and the number of incidents. This allowed for more granular monitoring and control of the company’s operations.

One of the most significant improvements achieved through BPM was the reduction in cycle times for critical processes. The time required for order collection was reduced by 14.1%, unloading time by 23.1%, picking time by 22.7%, and sorting time by 20%. Overall, the implementation of BPM resulted in a 21.1% reduction in the total cycle time for standardized processes, greatly improving operational efficiency.

In addition to process standardization, BPM also focused on eliminating non-value-added activities, which further contributed to improving the company's operational performance. The perfect order rate, which measures the percentage of orders delivered without errors or delays, improved by 74.3% as a result of BPM.

Figure 5 presents the proposed SIPOC (Suppliers, Inputs, Process, Outputs, Customers) diagram for the case study. It outlines the flow of operations, from the suppliers providing materials and orders to the processes of order reception, sorting, and transport, culminating in deliveries to customers. Key controls include the assignment of zones, operational flow, and cleanliness checks. The diagram also highlights the primary inputs, such as customer orders and necessary materials, as well as the outputs, including on-time deliveries and service quality indicators. The inclusion of operational indicators helps monitor key performance metrics like service level and customer satisfaction.

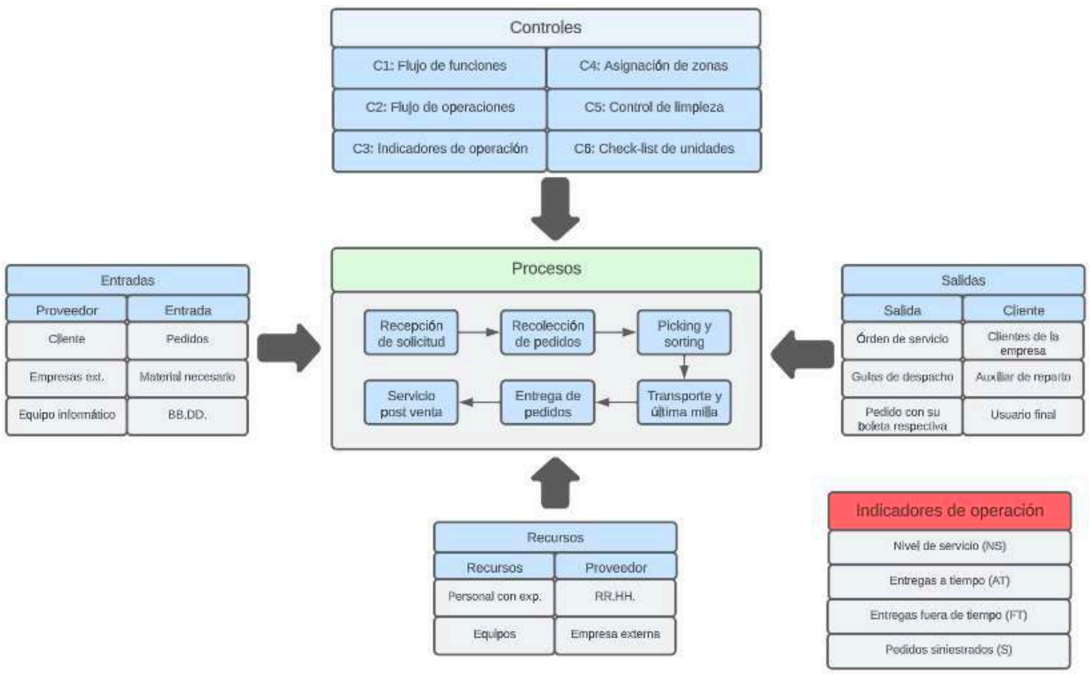

Figure 5. Proposed SIPOC Diagram for the case study

5. Results

In Table 1, the results of the validation of the proposed operations management model for a last-mile logistics operator are presented. The model demonstrated a significant increase in the service level, improving from 91.7% to 96.31%. Furthermore, total costs were reduced by 50.1%, deliveries after the deadline decreased by 54.08%, and incomplete deliveries dropped by 59.43%. Claims and order preparation time also showed notable reductions of 60% and 48.48%, respectively. These outcomes confirm the effectiveness of integrating mixed tools to optimize service quality and operational efficiency.

Table 1. Results of the validation of the proposed model

Indicator	Unit	As-Is	To-Be	Results	Variation (%)
Service Level	%	91.7	95	96.31	**5.03%**
Total Cost	%	10.22	4.5	5.1	**-50.10%**
Deliveries after the deadline	%	4.9	2	2.25	**-54.08%**
Incomplete deliveries	%	3.5	2	1.42	**-59.43%**
Orders under claim	%	0.05	0.01	0.02	**-60.00%**
Time of order preparation	minute	1.32	0.54	0.68	**-48.48%**

6. Conclusions.

The primary findings of the research highlight significant improvements in operational efficiency and service levels within the last-mile logistics sector. The implementation of Lean Service tools, such as 5S, Business Process Management (BPM), and Systematic Layout Planning (SLP), led to measurable improvements, including a 35.8% increase in productivity and a reduction in material handling effort from 100,621.6 kg.m to 74,081.0 kg.m. Additionally, there was a 21.1% decrease in cycle time across key processes, and the perfect order rate improved by 74.3%, demonstrating the effectiveness of process standardization and layout optimization in the case study. These results validate the positive impact of these tools in addressing inefficiencies in last-mile logistics operations.

The importance of this research lies in its practical application to small and medium-sized enterprises (SMEs), particularly in developing economies like Peru. Last-mile logistics is a critical component of the supply chain, and inefficiencies can have significant repercussions on customer satisfaction and overall competitiveness. By addressing key operational issues such as delayed deliveries, incomplete orders, and non-standardized processes, the research provides a pathway for SMEs to enhance their service levels and remain competitive in an increasingly demanding market. The findings underscore the need for systematic approaches in tackling logistics inefficiencies, especially in sectors with limited resources and fluctuating demands.

The contributions of this study extend beyond immediate operational improvements. It offers a replicable model for integrating Lean Service tools in logistics operations, combining process standardization with spatial optimization. This holistic approach not only improves day-to-day operations but also provides a framework for continuous improvement. The study adds to the existing body of knowledge in industrial engineering, particularly in the application of Lean methodologies to logistics services. By focusing on SMEs, the research addresses a gap in the literature, where most studies have historically concentrated on larger enterprises. The findings have the potential to influence future logistics strategies for small businesses, driving innovation and efficiency.

Final observations suggest that while the research achieved substantial improvements, further study is warranted to explore the integration of emerging technologies, such as automation and artificial intelligence, into last-mile logistics. These technologies could offer additional opportunities for enhancing route planning, inventory management, and customer service. The study also highlights the importance of employee training and engagement in sustaining long-term improvements. Future research should delve deeper into the human factors involved in implementing Lean methodologies, examining the role of leadership and organizational culture in sustaining changes. Moreover, expanding the study to different geographical contexts and logistics sectors could provide valuable insights into the adaptability and scalability of the proposed model.

In conclusion, this research provides a strong foundation for improving operational efficiency in last-mile logistics, particularly for SMEs in developing economies. The successful application of Lean Service tools has demonstrated that systematic process and layout optimization can yield significant improvements in service levels and productivity. The study calls for further exploration into technological advancements and human factors to sustain and expand these improvements. Future research should continue to build on these findings, seeking innovative ways to enhance the performance of last-mile logistics in an ever-evolving global market.

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