ISBN: 978-628-96613-1-6. ISSN: 2414-6390. Digital Object Identifier: https://dx.doi.org/10.18687/LACCEI2025.1.1.1032

Optimization of Reception Dwell Time through Lean Manufacturing: A Case Study in a Logistics SME in Peru

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Abstract– ***The logistics industry faces significant challenges in managing product dwell time in warehouse reception areas. Delays in receiving and processing goods lead to inefficiencies and reduced productivity. Previous studies have demonstrated the benefits of Lean Manufacturing tools like 5S and Standardized Work in various sectors, but there remains a gap in their application to logistics reception areas. This research addresses these issues by proposing a model to reduce product dwell time. The main challenges include prolonged product separation, errors in pallet placement, and inaccurate data entry. These inefficiencies necessitate the urgent application of Lean tools to streamline processes and improve workflow. The study's key findings show a 50% reduction in dwell time, a significant boost in productivity, and a reduction in operational errors. These improvements validate the proposed model in real-world logistics setting. This research contributes to the literature by adapting Lean tools to logistics, with measurable results in cost reduction and increased operational efficiency, offering a foundation for further research in similar contexts.***

Keywords—Process Standardization, Operation Efficiency, Warehouse Management, Supply Chain Improvement, Lean Tools Implementation.

I. Introduction

Logistics is essential to the distribution and order preparation of various products, requiring technological advancements to meet performance goals. The integration of automation technologies has significantly optimized processes and improved operational efficiency in logistics companies, as noted by [1]. The implementation of artificial intelligence further reduces errors and enhances product control throughout each stage of the process [2]. Such strategies and tactics are essential for optimizing efficiency, accuracy, and decision-making across supply chains.

In logistics, order preparation is a core objective, which necessitates timely and accurate product reception. One of the major issues affecting the supply chain is delays in the merchandise reception process, which prevent products from being made available for sale [3]. This delay is further exacerbated by disorganization and the absence of clear, standardized procedures in companies with storage services or logistics operations. The lack of systematic processes in the reception area often results in products lingering in entry zones for extended periods, negatively impacting the supply of picking areas [4]. The case study presented in this research aims to reduce merchandise dwell time in the reception area by over 50%. These delays contribute to penalties amounting to 3.8% of annual revenue, representing significant financial losses. Additional objectives include minimizing the time required for separating and entering merchandise, reducing product disorganization, and minimizing pallet location errors. The study will also address the need to standardize unloading procedures. A thorough analysis of the delays in the reception process is necessary, as reducing dwell time could enhance sales, improve productivity, and lower operational costs [5]. Moreover, standardizing processes could reduce the workforce needed for merchandise separation and entry tasks. The study highlights the potential for a 50% increase in productivity through the application of Lean Manufacturing methodologies, avoiding annual penalties of approximately 36,000 PEN. This research fills a significant gap in the literature concerning the application of Lean Manufacturing tools in the Peruvian logistics sector. Although various industries have documented the successful implementation of Lean tools, their use in logistics reception areas has been understudied. This research presents a practical analysis of how Lean tools, such as the 5S methodology and Standardized Work, can address inefficiencies and errors in reception processes [6]. The findings are expected to not only resolve issues within the studied case but also provide a model that can be replicated in other logistics operations. This contribution helps fill a gap in the literature and serves as a framework for enhancing the competitiveness of logistics operations in similar contexts.

II. Literature Review

A. Process Optimization and Standardization in Logistics

The application of Lean Manufacturing tools, specifically work standardization and 5S, has shown promising results in enhancing productivity in various industries. According to [7], operators must be trained and follow a single, standardized procedure to avoid errors and ensure proper classification and organization of tools and materials. The study found that this approach led to a 17% increase in productivity, and processes were optimized by reducing outsourced material by 80%, demonstrating improvements in operational capacity [8]. However, the author only reports results from the proposed model and does not provide a detailed analysis of the pre-implementation situation.

Additionally, the study focuses solely on format implementation, excluding the essential aspect of personnel training, which is critical for sustained improvement. The lack of validation in logistics settings suggests that the outcomes may not be directly transferable to this sector, especially when addressing challenges such as excessive processing times and low productivity. Unlike production environments where sequential activities are standardized, logistics operations often depend on individual discretion, leading to variability in manual tasks and data collection [8].

B. The Role of 5S in improving Warehouse Efficiency

The 5S methodology is widely recognized for its capacity to enhance efficiency across different sectors, including logistics. The work of [9] highlights how the 5S approach reorganizes materials and tools, directly addressing issues of low productivity caused by disorganization. In the case of the KP study, low productivity stemmed from disarray in the warehouse, similar to the situation described by [9]. Applying 5S can eliminate stockouts and improve service levels, preventing substantial financial losses for the company. The methodology also provides a structured framework for analyzing and improving logistics operations [10]. However, it is crucial to note, as the author does not, that 5S must be implemented in conjunction with standardized work processes to ensure logical, sequential task execution. Without this, even the best-organized workspaces may not deliver sustained improvements. Moreover, while 5S is effective in various sectors, its success in one area, such as healthcare, may not guarantee similar outcomes in other fields, like retail, due to differences in product types and operational requirements.

C. Standardized Work as a solution to errors and inefficiencies

Standardized work plays a crucial role in reducing errors and improving efficiency, particularly in manual processes. As noted by [11], without proper documentation of daily tasks, empirical work becomes the norm, which hinders the achievement of operational objectives. The author suggests that standardized work can be applied to any manual process with error-prone tasks, achieving improvements of up to 15% in areas such as product order and picking. However, this approach may not be equally effective in reception areas where processes rely on third-party performance, as in the case of external suppliers handling product entry. Therefore, improvements in one warehouse area may not translate to another, given the variability in task execution by external parties. Implementing a standardized process framework is essential for preventing the return to empirical actions, which can occur if operators are left unsupervised. Nevertheless, indicators from existing studies have not been validated in logistics, as the results are often based on simulation rather than real-world trials, leaving room for potential discrepancies when applied in practice [12].

D. Bottleneck Identification and task optimization through Standardization

Accurate identification of bottlenecks is a key aspect of implementing standardized work. According to [7], organizing workstations and creating standardized sheets with average task times is crucial for improving performance. Although this method was successfully applied in the agricultural sector, a field very different from logistics, it demonstrated how well-defined steps and procedures can help measure time, reduce errors, and increase productivity. These principles can be adapted to logistics settings, particularly in reception areas, to mitigate delays and optimize merchandise flow. However, despite its success in other industries, the transferability of such methods to logistics remains an area for further investigation, as the specific challenges faced in this sector, such as unpredictable delivery schedules and external dependency, may limit the effectiveness of standardization without proper customization to the sector's needs.

III. CONTRIBUTION

A. Model Justification

The proposed model is grounded in the principles of Lean Manufacturing, specifically leveraging 5S and Standardized Work, which have been successfully applied across various industries. The logistics sector, however, often faces unique challenges in the reception process, particularly concerning unproductive time and rework that affect overall performance [13]. Our model directly addresses these inefficiencies by focusing on the reception area of a logistics company, where unproductive time, disorder, and errors in product handling were significant issues. Compared to other models in the logistics sector, this research contributes by providing a specific analysis of these problems and offering solutions to optimize the management of time, personnel, and physical resources within the reception area [14].

B. Proposed Model

The model developed in this study aims to solve the key problems identified through the literature and field analysis, particularly the excessive time spent in the separation and entry of products.

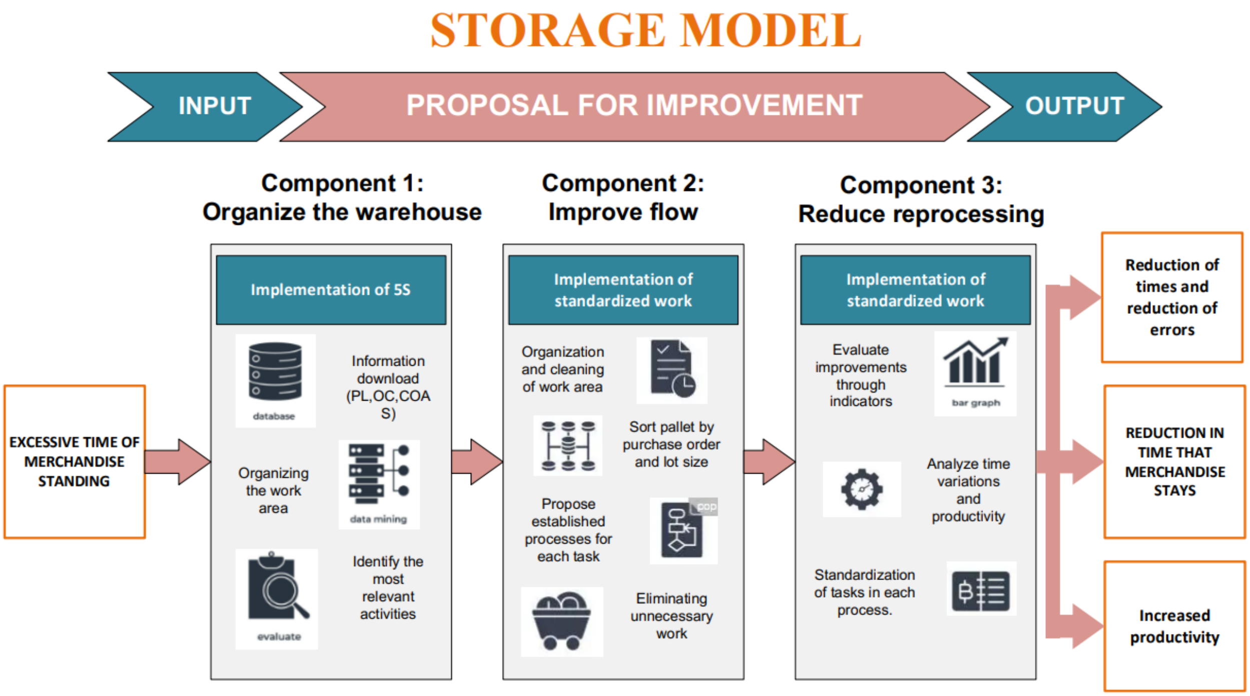

Fig. 1 Proposed innovative model

As shown in **Figure 1**, the model prioritizes the elimination of unproductive times by addressing root causes such as damaged products, delays in pallet changes, incorrect product identification, and errors in data entry into the Warehouse Management System (WMS) [12]. To enhance productivity, the model integrates the 5S methodology to reduce disorder and improve the organization of the work area. Additionally, Standardized Work was applied to establish systematic procedures that ensure efficiency in unloading and palletizing tasks. Rework due to improper pallet locations and poorly executed unloading processes was tackled by standardizing operational procedures. This standardization aimed to reduce the variability in tasks performed by different operators, creating a more consistent workflow. By implementing these tools, the model contributes to reducing unnecessary movements, optimizing space, and ultimately enhancing productivity.

C. Description of the model components

Component 1: Organizing Warehouse

This component uses the 5S tool to organize the workspace, starting with an initial audit to evaluate the current state. Based on the findings, materials and tools were classified, arranged, and labeled (1S and 2S).

A cleaning schedule was implemented (3S), followed by the creation of standardized procedures and periodic audits to ensure continuous improvement (4S and 5S). This systematic organization not only improved the order and cleanliness of the area but also laid the foundation for improving overall operational efficiency.

Component 2: Improving Workflow.

Process standardization was applied to reduce the time spent on merchandise separation and entry. By conducting a detailed analysis of these tasks, inefficiencies were identified and eliminated using the ECRS (Eliminate, Combine, Rearrange, Simplify) matrix.

This enabled the creation of a new workflow that reduced non-value-adding activities and streamlined the process. Training was provided to operators to ensure they understood and followed the new standardized processes, which significantly reduced reception times.

Component 3: Reducing Rework.

The final component addressed rework issues by implementing standardized procedures for unloading containers and locating pallets. Time studies were conducted to measure and standardize the steps required for each task, leading to the creation of standardized work routines. These standardized operations helped prevent errors and inconsistencies in the reception process, leading to a measurable reduction in rework and improved efficiency in product handling. As shown in **Figure 2**, the workflow chart illustrates the standardized steps involved in container unloading and pallet placement. This visual representation helped in formalizing the proposed procedures and ensured clear communication and training for the personnel involved.

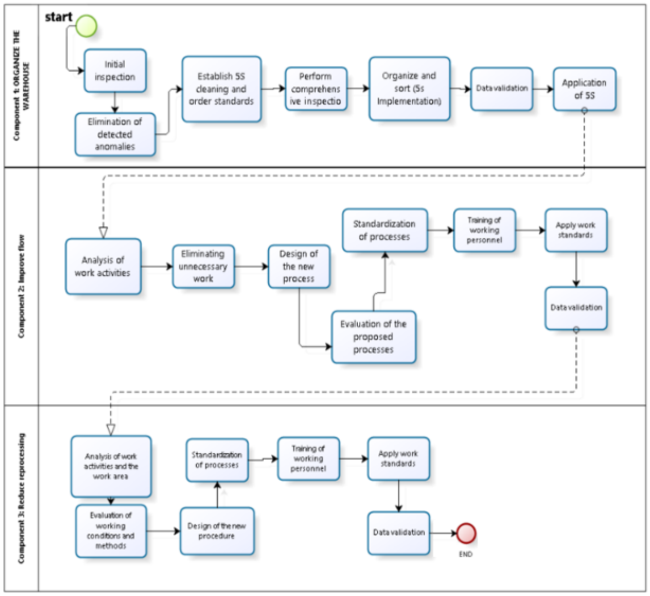

Fig 2. Implementation Process of the Proposed Solution Model

D. Indicators

Table 1 shows the management indicators to measure the reception processes that are to be improved. These KPIs focus especially on productivity, time measurements and operational failures. This table provides details on the use and the formula to obtain the result.

TABLE I
INDICATORS

Indicators	Formula	Use
Average time of product separation	Average product separation time = Boxes/Min	Measures boxes separated by minute
Average time of product entry	Average product entry time = Boxes/Min	Measures boxes entered per minute
Productivity	Productivity = Boxes/H-H	Calculate the boxes worked per man hour
Failure in unloading merchandise	Failures in unloading merchandise = Imp. /Month	Badly executed import downloads per month
Pallet location failure	Pallet location errors = Pallets/Month	Pallets misplaced per month

IV. VALIDATION

A. Validation Scenario

To validate the proposed improvements, the Arena software was used to simulate both the current and enhanced systems. The simulation focused on the reception area of a logistics company, incorporating the processes from the arrival of containers to the generation of the reception report. The scope, variables, and key elements of the simulation were carefully identified to ensure accurate representation of the workflow.

B. Initial diagnosis

The initial diagnosis revealed that the primary issue in the reception area was excessive merchandise dwell time, which averaged 3.7 days, compared to the sector's standard of 1 day. This delay translated into an economic impact of 3.8% of annual revenue, equivalent to 37,000 PEN. The main contributors to this problem were unproductive time (65.5% from product separation, 34.5% from product entry), low efficiency in product identification (100%), pallet misplacement (60%), and poorly executed unloading (40%). Lean tools such as 5S and Standardized Work were selected to address these inefficiencies. The detailed analysis, depicted in **Figure 3** (problem tree), identified these root causes and laid the foundation for targeted interventions.

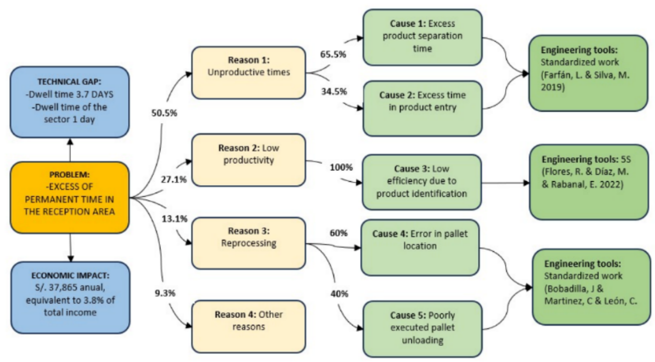

Fig 3. Problem Tree

C. Validation design

The validation process began with the system representation, which modelled the processes from container arrival to the completion of the reception report. Each activity, including unloading, separation, and entry into the Warehouse Management System (WMS), was simulated with appropriate timing. To determine the optimal sample size, 385 boxes were randomly selected from the total 10,803,130 boxes processed in 2023. The sample size was calculated using a 95% confidence level and a 5% margin of error, ensuring the statistical reliability of the simulation. The simulation's results, generated using the Arena software's Input Analyzer, provided distributions for each process activity. For instance, the documentary verification process followed a beta distribution, as did unloading, order search, and other tasks. These distributions were key in modelling the variability of each task, thereby offering a realistic simulation of the warehouse operations.

$$Sample\ size = \frac{\frac{z^2\ x\ p(1-p)}{e^2}}{1 + \frac{z^2\ x\ p(1-p)}{e^2 N}}$$

Where:
Z= Level of confidence
e = Margin of error
p = Standard deviation
N = Population size

The type of sampling used is simple random, since all members of the sample size have the same probability of being chosen and there are no specific groups. For our pilot, we will choose 2 purchase orders at random, which will be called OCMUES0001 and OCMUES0002.

Table 2 shows the results obtained from the Input Analyzer of the Arena software. The processes and their respective distributions are summarized in the following model.

TABLE II
DISTRIBUTION BY ACTIVITIES

Processes	Distribution
Verification documentary	2.24 * BETA (1.16, 1.43)
Container unloading	1.81 * BETA (1.16, 1.43)
OC Search	1.14 * BETA (1.16, 1.43)
OC Printing	1.12 * BETA (1.16, 1.43)
Search for tools	1.21 * BETA (1.16, 1.43)
Inspection of work area	1.14 * BETA (1.16, 1.43)
Arrange pallets in the area	1.47 * BETA (1.16, 1.43)
Send waste to collection area	1.18 * BETA (1.16, 1.43)
Search Product Packing List	1.22 * BETA (1.16, 1.43)
Separate damaged boxes	1 + 2.36 * BETA (1.16, 1.43)
Palettizing to standard pallets	0.39 + 3.19 *BETA (1.16, 1.43)
Separate product by Lotey FV	1 + 2.34 * BETA (1.16, 1.43)
Sort Pallets by OC	1.34 * BETA (1.16, 1.43)
Squaring quantities	1.21 * BETA (1.16, 1.43)
Separation Report Review	1.16 * BETA (1.16, 1.43)
Search for OC and PL	1.14 * BETA (1.16, 1.43)
Search for RF equipment	1.21 * BETA (1.16, 1.43)
Paste LPN labels	1.36 * BETA (1.16, 1.43)
Product entry	2 + 2.41 * BETA (1.16, 1.43)
Product Intake Report Review	1.20 * BETA (1.16, 1.43)
Pallet location	1.57 * BETA (1.16, 1.43)
Generate Reception Report	1.14 * BETA (1.16, 1.43)

Figure 4 shows the enhanced simulation model for the merchandise reception process, implemented in the arena simulator. This model describes the stages starting with the arrival of the containers, their unloading, merchandise separation, entry into the WMS system and storage in their rack positions. Each activity in the process includes processing times, highlighting the verification of merchandise in the separation. This model aims to optimize the workflow, reduce times and improve work efficiency.

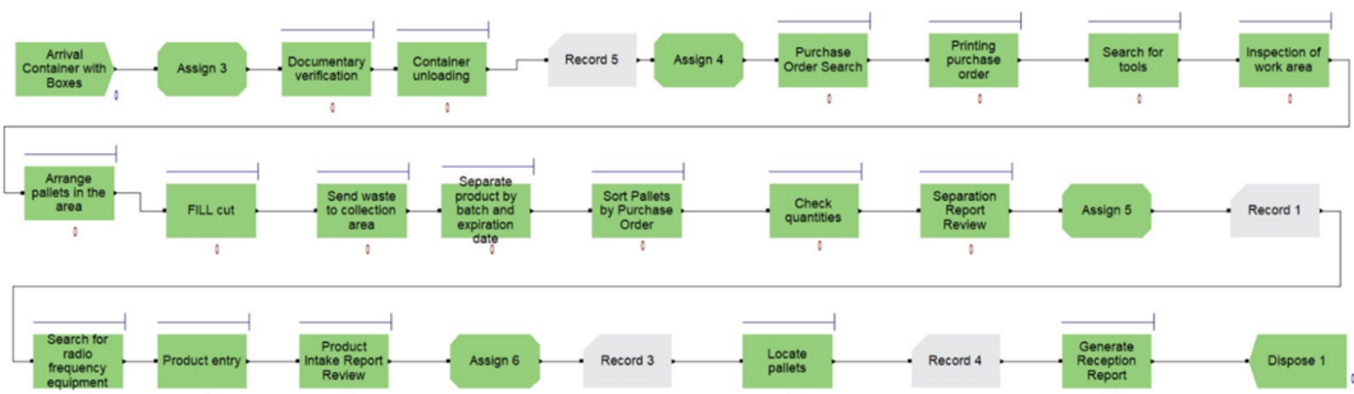

Fig. 4 Optimized state model in Arena simulation software

D. Pilot Test of 5S

The initial 5S audit of the reception area revealed a low score of 23 out of 100. During the pilot test, the 1S (Sort) stage identified unnecessary items in the work area, which were subsequently removed.

The 2S (Set in Order) stage involved organizing tools and materials for easy access, while the 3S (Shine) stage focused on establishing a cleaning schedule to maintain workplace order. The 4S (Standardize) stage implemented routines and procedures to ensure consistency, and the 5S (Sustain) stage involved training staff to maintain the improvements. **Figure 5** presents the results of the 5S tool, showing clear improvements in the organization and cleanliness of the reception area.

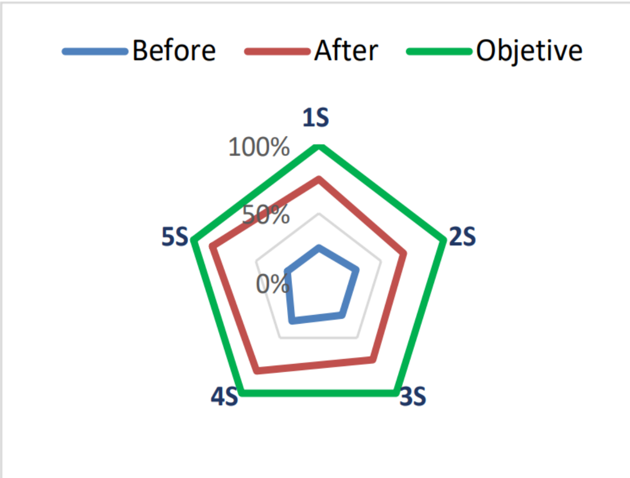

Fig. 5 5S Audit Results

Figure 6 is a comparison of the before and after of the work area. Before, the area where merchandise was unloaded was clogged and merchandise was always placed in a disorderly manner in various places. Afterwards, the area was cleaned and organized, and the merchandise began to be arranged in rows to maintain order.

Fig. 6 Before and after images of the aoolication of the 5S

E. Simulation validation

The simulation results showed significant improvements in productivity and error reduction. Productivity increased from 803 to 1,261 units processed per hour after implementing the 5S and Standardized Work tools. The reorganization of the workspace allowed for more efficient use of resources, particularly tools. The number of errors in pallet placement decreased by 15%, and errors in merchandise unloading dropped by 12%, reflecting a reduction in reprocessing and unnecessary handling. These improvements, depicted in Figure 4, demonstrate the model's success in optimizing the workflow and reducing processing times in key areas of the reception process.

V. Discussion

The study demonstrates that applying Lean Manufacturing tools, specifically 5S and Standardized Work, significantly improved the reception processes in logistics, reducing merchandise dwell time from 3.7 days to 1 day. These findings align with [9], but our study goes further by incorporating an initial audit of the reception area. The reduction in product separation and entry times, driven by process standardization and task elimination, proved essential in enhancing operational efficiency. Additionally, workspace reorganization and employee training helped reduce pallet placement errors by 15% and product unloading errors by 12%. This research fills a gap in the logistics sector, where Lean methodologies are less frequently applied compared to production environments. The study confirms that Lean tools, when adapted to logistics, can deliver similar improvements in time and error reduction, as seen in manufacturing [7]. This highlights the versatility of Lean principles, even in logistics environments with variable tasks and external dependencies. While the study succeeded in optimizing internal processes, future research should explore external factors, such as supplier lead times and transportation delays, that impact overall logistics efficiency. Integrating automation and real-time tracking systems could further enhance the performance of Lean tools by providing more accurate data and quicker responses to changes in the supply chain. In conclusion, this study confirms the effectiveness of Lean tools in logistics, particularly in reducing dwell time and improving efficiency. Future research should explore broader applications of Lean principles across the logistics chain and consider the role of advanced technologies in further optimizing these processes.

VI. Conclusions

The study presented significant improvements in the optimization of the reception process of logistics warehouses, particularly in the reduction of product dwell time. Key findings indicate a reduction in the time merchandise stays in the receiving area by 72%, which aligns with industry standards. This reduction was achieved through the application of Lean Manufacturing tools, such as 5S and standardized work, which addressed key inefficiencies in product separation, improper pallet placement, and product entry into warehouse systems. In addition, productivity increased significantly, with a 50% improvement in goods processing rates and a notable reduction in operational errors, including a 15% decrease in incorrect pallet placement and a 12% reduction in goods unloading errors.

This research is important because it addresses the challenges logistics companies face in maintaining efficiency in their reception areas. Inefficiencies in this process often result in financial penalties, delays in product availability, and increased operational costs. By improving the flow and standardizing the process through Lean tools, the study not only optimizes time but also enhances overall productivity. This focus on reducing unproductive time and operational errors has a direct impact on improving customer service and reducing costs, ultimately leading to higher profitability.

The study contributes significantly to the field of logistics management by providing a detailed application of Lean Manufacturing tools to a sector that has not been widely studied in this context.

While Lean methodologies have been applied in various industrial processes, their use in optimizing logistics reception areas is less explored. This research offers a replicable model that demonstrates how tools such as 5S and Standardized Work can be adapted to logistics operations to streamline processes, reduce errors, and improve efficiency. The findings contribute to the literature by showing the measurable impact of Lean tools on operational performance in logistics, offering a framework for further studies and implementations in similar contexts.

Companies that seek to implement solutions should consider an initial investment that focuses on the adequacy of the environment and the quality of all the resources that they want to use to develop the activities. In addition, training for staff should be based on training programs that explain Lean principles and promote constant participation to identify, analyze, and take action on any activity that does not generate value for the process. And, finally, take into consideration that the adaptation to a new work mechanism is progressive, so it is important to have constant and measurable feedback

Further research should explore the broader applicability of these Lean tools across different sectors within logistics, such as transportation and distribution, where similar inefficiencies might exist. Additionally, future studies could focus on integrating advanced technologies, such as automation or artificial intelligence, to further enhance the efficiency of reception processes. The combination of Lean methodologies with modern technologies has the potential to create even greater improvements in time management and error reduction. Finally, continuous monitoring and improvement of these processes should be prioritized to ensure sustained benefits and adaptability to future challenges in logistics operations.

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