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Article

Warehouse Management for Improving Operational Efficiency in a Private Freight Transport Company, Callao 2025.

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Abstract: Objective: To determine how warehouse management improves operational efficiency in a private freight transport company in Callao, 2025, in line with SDG 9 (Industry, Innovation and Infrastructure).
Methodology: Applied research with a quantitative approach, explanatory level, and pre-experimental design with pre-post measurement. The census sample comprised 50 dispatch order records collected between August and September 2025. Observation sheets and documentary analysis were used. Data were processed through descriptive statistics and the Wilcoxon signed-rank test in SPSS v.27.
Results: Time efficiency increased from 84.69% (pre-test) to 95.58% (post-test), representing a 10.89 percentage point improvement ($Z = -6.154$; $p < 0.001$). The average cost per order decreased from S/ 19.7 to S/ 16.1, a saving of S/ 3.6 per order ($Z = -2.892$; $p = 0.004$). Both improvements were statistically significant ($p < 0.05$).
Conclusions: The implementation of improvements in warehouse management, based on the PDCA cycle, significantly optimized the processes of receiving, storage, and dispatch, contributing to the overall increase in the company's operational efficiency.
Keywords: warehouse management, operational efficiency, freight transport, PDCA cycle, Wilcoxon.

1. INTRODUCTION

In the contemporary business environment, operational efficiency has established itself as a determining factor for the competitiveness of organizations. In this context, warehouse management plays a strategic role, since an efficient supply chain depends on the correct management of material and information flows. Effective coordination between warehousing, transportation, and distribution is the foundation for efficiency in logistics operations (Chopra and Meindl, 2019). This research was aligned with the Sustainable Development Goals (SDGs) 9, which promotes the construction of resilient and sustainable infrastructures, linking directly to the optimization of warehouse management to improve operational efficiency.

At the international level, the literature shows that the incorporation of specialized systems for warehouse management has a direct impact on operational efficiency. Rezeki et al. (2023) demonstrated that the adoption of a Warehouse Management System (WMS) significantly increases inventory accuracy and reduces errors in the registration and handling of goods, improvements that also translate into shorter order processing times. In a complementary way, Zhen et al. (2022) conducted a comprehensive review of smart warehouse operations, concluding that information interconnection, equipment automation, and process integration are the key perspectives for achieving efficiency in modern warehouses. Likewise, Abdul Rahman et al. (2021) determined, through a fuzzy hierarchical

analysis, that space, information systems, labor, and equipment are the most relevant productivity indicators for optimizing warehouse operations.

Along the same lines, Gómez-Velázquez et al. (2024) reported critical deficiencies in a Mexican service company, finding that 78% of the indicators evaluated were below industry standards, with deficiencies in inventory control (42%), safety conditions (38%), and material flows (35%). The multifunctionality of the space generated inefficiencies that increased logistics costs by 25%, and the lack of automated systems explained 68% of the discrepancies in physical inventories. In addition, Shanmugamani and Mohamad (2023) identified that the absence of organized procedures in warehouses increases travel times, deteriorates staff productivity, and generates delays in the delivery of products.

Basuki and Hutahaean (2025), in a case study in an Indonesian automotive company, measured the impact of implementing a WMS and reported a 57% reduction in receiving time, a 118% increase in storage productivity, and a 57% decrease in the shipment defect rate. Similarly, Alamsah et al. (2024) found that after implementing a WMS in Indonesian factories, staff productivity increased by 40%, the margin of error in inventories was reduced by 28%, and shipping times decreased by 32%. These findings are consistent with the review by Mohamud et al. (2023), who concluded that warehouse layout and operations are the attributes that make the most difference in supply chain efficiency.

In Latin America, Macias and Cuadros (2025) identified that the lack of standardized procedures, errors in inventory records, and poor staff training affect the competitiveness of companies. Campos and Campos (2024) showed that poor organization and inadequate computer systems produce excess stock, duplication of orders, and lack of availability of critical materials, increasing operating costs. In the Peruvian context, Castro and Chunga (2024) showed that many companies maintain traditional storage models based on empirical experience, which restricts efficiency and continuous improvement. For their part, Ventocilla-Cerrón et al. (2024) stated that, in freight transport companies in the district of Ate, the absence of strategic cost management generates operational difficulties that negatively impact profitability and quality of service.

At the local level, several companies in Callao dedicated to trade and distribution have deficiencies in the management of their warehouses, such as the absence of updated inventories, physical disorder of materials and lack of performance indicators. These limitations have a direct impact on operational efficiency, understood as the ability of a company to produce goods or services with the least use of resources and with high quality standards (Franco and Velázquez, 2000). After observing this problematic reality, the following research question was asked: how does warehouse management improve operational efficiency in a private cargo transport company in Callao, 2025? As specific problems: how does warehouse management improve time efficiency? And how does warehouse management improve cost efficiency?

The study was justified from multiple perspectives. Theoretically, it was based on the Integrated Logistics Theory and the Operational Efficiency Model, contrasting both frameworks with empirical findings. Methodologically, documentary analysis was used as the main technique, providing instruments that could be replicated by other researchers. In practice, the results contribute to the strengthening of logistics competitiveness in the transport sector of Callao, one of the main entry and exit points for goods in Peru. On the social side, efficient warehouse management not only improves internal performance, but also guarantees quality service to customers.

The general objective was to determine how warehouse management improves operational efficiency in a private cargo transport company in Callao, 2025. The specific objectives were: (a) to determine how warehouse management improves time efficiency, and (b) to determine how warehouse management improves cost efficiency. The hypotheses postulated that warehouse management significantly improves operational efficiency, time efficiency, and cost efficiency in the company studied.

2. METHODOLOGY

2.1. Type, approach and design of research

Due to its purpose, the research was applied, since a specific problem was identified and a solution was implemented through the Warehouse Management methodology based on the Deming Cycle (PHVA). This type of research is responsible for solving practical problems or improving circumstances using existing knowledge (Hernández et al., 2014).

The approach was quantitative, since the results of each dimension were numerical values and statistical analyses were applied in SPSS v.27 to confirm the hypotheses raised. According to Hernández et al. (2014), the quantitative approach is based on the collection and analysis of numerical data in order to verify hypotheses. Due to its level of depth, the research was explanatory, focusing on analyzing the causes of low operational efficiency in the warehouse and providing a solution through warehouse management.

The design was pre-experimental, without a control group, applying two measurements (pre-test and post-test) on a single group constituted by the records of merchandise shipments. The schema is represented as: G: $M_1 \rightarrow E \rightarrow M_2$, where G is the warehouse service orders, M_1 is the calculation of the pre-test of operational efficiency, E is the application of warehouse management according to the stages of the PHVA, and M_2 is the calculation of the post-test. Due to its temporality, the study was longitudinal, since two measurements were carried out at different times (August-September 2025 for the pre-test and the post-intervention period for the post-test).

2.2. Variables and operationalization

Independent variable: Warehouse management. It is defined as the logistics process that seeks to monitor and optimize the daily operations of the warehouse, encompassing fundamental procedures to ensure that products and materials flow efficiently from receipt to shipment (Escudero, 2019). It was operationalized through three dimensions: (a) receipt of goods, measured through the efficient reception rate (EROI = TOSRc / TOSR × 100); (b) storage of goods, measured by the efficient storage rate (TA = TOSc / TOS × 100); and (c) clearance of goods, measured with the efficient clearance rate (TPE = TPEc / TP × 100). All dimensions were measured on a ratio scale.

Dependent variable: Operational efficiency. It is characterized as the ability of a company to improve the use of its resources, optimize productivity, and reduce costs without harming the quality of products or services (Franco and Velázquez, 2000; Rodríguez & Cevallos, 2024). It was operationalized in two dimensions: (a) time efficiency, measured by the time level (NT = TOC / TE × 100), where TE is the standard time calculated according to the methodology of Kanawaty (1996) with ILO supplements; and (b) cost efficiency, measured through cost per order (CP = CTPE/TOEC). Both dimensions were measured on a ratio scale.

2.3. Population, sample and sampling

The population was made up of all the orders for the dispatch of merchandise from the warehouse, evaluated during 50 days of records (August-September 2025). The inclusion criteria considered the dispatch orders made in the indicated period; those of exclusion ruled out non-working days (holidays and Sundays). The sample was census-based, consisting of 50 records of dispatch orders, coinciding with the entire population, so no sampling technique was applied (Hernández et al., 2014).

2.4. Data collection techniques and instruments

The technique used was documentary analysis, a procedure that allowed the selected variables to be measured (Hernández et al., 2014). The instruments were record formats designed to collect data from each dimension: merchandise receipt cards, storage cards, dispatch cards, time efficiency cards, and cost efficiency sheets. The validity of the content was determined by the judgment of three experts familiar with the variables. Reliability was evaluated using the Test-Retest method with the pre-test values, confirming the consistency and stability of the measurements.

2.5. Data procedure and analysis

The intervention was structured following the four stages of the PHVA cycle. In the Plan phase, the initial situation of the warehouse was diagnosed using the pre-test indicators. In the Do phase, improvements were implemented: reorganization of the layout, application of the ABC classification, standardization of reception, storage and dispatch processes, and staff training. In the Verify phase, the data from the post-test were collected and compared with the pre-test. In the Act phase, successful improvements were standardized and new opportunities for optimization were identified.

For the descriptive analysis, mean, median, mode, standard deviation, variance, asymmetry and kurtosis of each dimension were calculated, both in the pre-test and in the post-test. For the inferential analysis, the Shapiro-Wilk normality test (n = 50) was applied and, as it was identified that not all the data followed a normal distribution, the non-parametric Wilcoxon sign range test was chosen to test the hypotheses, with a significance level of $\alpha = 0.05$.

2.6. Ethical aspects

The ISO 690-2 standard was respected for citations and bibliographic references. The information collected from the company was used exclusively for academic purposes, in accordance with the Code of Ethics of the César Vallejo University. The company's general manager was authorized to validate the veracity of the information provided.

3. RESULTS

3.1. Descriptive analysis

3.1.1. Time efficiency

Pre-test. The results of the pre-test indicated that time efficiency ranged from 79.8% to 88.4%, with a majority concentration of records in the range of 83% to 87%, which shows a relatively uniform execution of operations, although with opportunities for improvement in the management of reception, storage and dispatch activities. The mean time efficiency was 84.69%, with a standard deviation of 2.50% (low variability), a median of 85.01%, a mode of 83.1%, asymmetry of −0.413, and kurtosis of −0.929. These descriptives reflect a slightly discussive distribution with a slight negative bias, indicating that most of the values were grouped at the top of the range, but with a longer left tail that denotes records with below-average performance.

Post-test. After the intervention, the time efficiency was significantly increased. The values ranged between 92.7% and 99.0%, with most of the records concentrated between 94% and 96%. The mean was 95.58%, with a standard deviation of 1.51% (very low variability), median of 95.30%, mode of 95.1%, asymmetry of 0.408 and kurtosis of −0.578. The reduction of variability between pre-test and post-test shows that the improvements implemented allowed to standardize processes and reduce differences in operational performance. The absolute improvement was 10.89 percentage points, representing a relative increase of 12.86% compared to the pre-test.

Table 1

Comparison of Descriptive Statistics — Time Efficiency

Statistician	Pre-test	Post test
Media	84,69 %	95,58 %
Medium	85,01 %	95,30 %
Fashion	83,10 %	95,10 %
Desv. Standard	2,50 %	1,51 %
Variance	6,248	2,267
Minimum	79,80 %	92,70 %
Maximum	88,40 %	99,00 %

Note. Prepared by the author with data processed in SPSS v.27.

3.1.2. Cost efficiency

Pre-test. Cost efficiency showed significant variation among the records analyzed. The cost per order ranged between S/ 10.8 and S/ 30.0, evidencing heterogeneity in the use of the resources assigned to logistics operations. The mean was S/ 19.70, with a standard deviation of S/ 6.53 (medium-high variability), median of S/ 17.95, mode of S/ 13.0, asymmetry of 0.261 and kurtosis of −1.577. The platicurtic distribution and the distance between mean and median suggest the presence of high values that influence the average, reflecting inconsistencies in the processes that generate excessive costs in certain operations.

Post-test. After the intervention, the cost per order was reduced and stabilized, ranging between S/ 13.2 and S/ 18.8. The mean decreased to S/ 16.11, with a standard deviation of S/ 1.39 (low variability), median of S/ 16.09, mode of S/ 15.2, asymmetry of −0.093 and kurtosis of −1.013. The reduction of the standard deviation from S/ 6.53 to S/ 1.39 is one of the most relevant findings, as it indicates that the improvements not only decreased the average cost, but also homogenized operations, eliminating the extreme disparities observed in the pre-test. The absolute reduction was S/ 3.59 per order, equivalent to a percentage saving of 18.22%.

Table 2

Comparison of Descriptive Statistics — Cost Efficiency

Statistician	Pre test	Post test
Media	S/ 19,70	S/ 16,11
Medium	S/ 17,95	S/ 16,09
Fashion	S/ 13,00	S/ 15,20
Desv. Standard	S/ 6,53	S/ 1,39
Variance	42,675	1,943
Minimum	S/ 10,80	S/ 13,20
Maximum	S/ 30,00	S/ 18,80

Note. Prepared by the author with data processed in SPSS v.27.

3.2. Inferential analysis

3.2.1. Normality test

The Shapiro-Wilk test (n = 50) was applied to assess the normal distribution of the data collected. The results are presented in Table 3.

Table 3

Shapiro-Wilk normality test

Variable	W	gl	Say.	Decision
Pre Efic. Time	0,943	50	0,019	No normal
Pre Cost/Pedido	0,875	50	0,000	No normal
Post Efic. Time	0,966	50	0,152	Normal
Post Cost/Pedido	0,956	50	0,062	Normal

Note. Criterion: $p < 0.05$ = non-normal distribution.

Given that two of the four distributions (pre-test of time efficiency and pre-test of cost per order) did not present normality ($p < 0.05$), Wilcoxon's non-parametric test was chosen to contrast the hypotheses, ensuring the robustness of the statistical analysis.

3.2.2. Testing of specific hypothesis 1: Time efficiency

H_0: Warehouse management does not improve time efficiency in the company studied.

H_1: Warehouse management improves time efficiency in the company studied.

Wilcoxon's test showed that the 50 cases presented negative ranges (pre-test < post-test), with an average range of 25.50 and a sum of ranks of 1275.00, without positive ranges or ties. The Z statistic was −6.154 with a bilateral significance of $p < 0.001$, which allowed us to reject the null hypothesis and accept that warehouse management significantly improves time efficiency. The average difference between the pre-test (84.69%) and the post-test (95.58%) confirms an improvement of 10.89 percentage points.

3.2.3. Specific Hypothesis Testing 2: Cost Efficiency

H_0: Warehouse management does not improve cost efficiency in the company studied.

H_1: Warehouse management improves cost efficiency in the company studied.

The Wilcoxon test showed 21 negative ranges (pre-test < post-test), 27 positive ranges (pre-test > post-test) and 2 draws. The Z statistic was −2.892 with a bilateral significance of p = 0.004, which allowed us to reject the null hypothesis and accept that warehouse management significantly improves cost efficiency. The average cost per order was reduced from S/ 19.7 in the pre-test to S/ 16.1 in the post-test, representing a decrease of S/ 3.6 per order.

Table 4

Summary of Hypothesis Testing

Hypothesis	Z	Sig.	Decision
H_1: Efic. Time	−6,154	< 0.001	H_0 rejected
H_2: Effective. Costs	−2,892	0,004	H_0 rejected

Note. Level of significance: $\alpha = 0.05$.

4. DISCUSSION

The findings of this research confirm that warehouse management significantly improves operational efficiency in a private freight transport company in Callao. This result is based on the theoretical proposals of Escudero (2019), who establishes that warehouse management encompasses actions aimed at regulating, coordinating, and optimizing the receiving, storage, and dispatch processes, and of Rodríguez and Cevallos (2024), who link operational efficiency with a company's ability to use its resources optimally. Wilcoxon's test yielded significance values of less than 0.05 in both dimensions, statistically confirming the improvement.

In relation to time efficiency, the increase from 84.69% to 95.58% (improvement of 10.89 percentage points) is consistent with the findings of Basuki and Hutahaean (2025), who reported a 57% reduction in receiving time after implementing a WMS in an automotive company. He also agrees with Quispe and Ruiz (2022), who demonstrated that warehouse organization through PHVA improves the order preparation process and the circulation of goods, and with Castro and Ruiz (2022), who concluded that optimizing logistics processes increases productivity and decreases non-productive time. Padilla and Fernández (2022) obtained similar results, improving efficiency from 82.21% to 94.66%, magnitudes comparable to those of the present study. The coincidence can be explained by the fact that, in all cases, the standardization of procedures and the reorganization of the layout reduced unnecessary travel, downtime and errors in the location of products. These improvements are also consistent with the finding of Mohamud et al. (2023), who concluded that warehouse layout and operations are the attributes that have the greatest impact on efficiency. However, studies such as that of Alamsah et al. (2024) and Phan and Tran (2022) suggest that digital automation can further enhance the reduction of times, a variable not incorporated in the present intervention, which represents a limitation of the study and an opportunity for future research.

Regarding cost efficiency, the reduction in the average cost per order from S/ 19.7 to S/ 16.1 (savings of 18.22%) is consistent with what was reported by Gómez-Velázquez et al. (2024), who determined that the implementation of logistics improvements reduces unnecessary operating costs, and with Serrano et al. (2024), who concluded that the ABC classification optimizes resource allocation and decreases material handling costs. Similarly, the results coincide with Mero and Zambrano (2025), who demonstrated that empirical inventory management generates increases in administrative expenses and reduces net profit. The similarity lies in the fact that, by organizing and classifying products, warehouse tasks are simplified and errors and delays that generate additional costs are reduced. It is important to note that the most notable reduction was observed in cost variability (the standard deviation went from S/ 6.53 to S/ 1.39), which suggests that the improvements not only reduced the average, but also homogenized the processes. Aulin et al. (2020) obtained a comparable result in a Ukrainian logistics center, where workflow optimization reduced total costs by 17.2%. However, external factors such as inflation, input price fluctuations, and logistics market conditions could moderate these results in other contexts.

Among the limitations of the study are: (a) the pre-experimental design, which does not include a control group and limits the ability to infer strict causality; (b) the sample size (n = 50), which, although census-based, is small; (c) the intervention did not include advanced technological tools such as digital WMS; and (d) the evaluation period was relatively short. Despite these limitations, the results provide valuable empirical evidence that complements the existing literature on warehouse management in the context of Latin American freight transport.

In summary, warehouse management is an essential instrument to increase operational efficiency in freight transport companies, since it facilitates the control of logistics activities, improves the use of resources and favors the

achievement of organizational goals. These findings reinforce the relevance of SDG 9 and demonstrate that improvements in internal logistics infrastructure contribute to more efficient and sustainable processes.

5. CONCLUSIONS

First. Warehouse management significantly increased operational efficiency in the private cargo transport company of Callao, 2025. The improvements implemented in the processes of receiving, storing and dispatching goods, supported by the PHVA cycle, optimized logistics operations and reinforced operational performance. Wilcoxon's test confirmed the statistical significance of the improvement ($p < 0.05$), accepting the alternative hypothesis. It is concluded that an organized and controlled warehouse management is an essential factor to optimize resources, improve operational control and strengthen logistics efficiency.

Second. Warehouse management improved time efficiency significantly. The mean time efficiency increased from 84.69 % in the pre-test to 95.58 % in the post-test, which represents an improvement of 10.89 percentage points ($Z = -6.154$; $p < 0.001$). This result shows that the reorganization of receiving, storage and dispatch tasks, together with the standardization of processes and the optimization of the layout, reduced delays, accelerated the workflow and decreased activities that do not add value.

Third. Warehouse management improved cost efficiency significantly. The average cost per order was reduced from S/ 19.7 in the pre-test to S/ 16.1 in the post-test, representing a decrease of S/ 3.6 per order ($Z = -2.892$; $p = 0.004$). In addition, the standard deviation was reduced from S/ 6.53 to S/ 1.39, which indicates not only cost savings, but also a homogenization of operations. It is concluded that warehouse management directly contributes to improving the financial performance of logistics operations and promotes a more efficient use of resources.

6. RECOMMENDATIONS

First. It is recommended that the company continue to apply warehouse management tools focused on control, organization and continuous improvement, with the aim of consolidating the results achieved in operational efficiency. It is suggested that internal oversight mechanisms be strengthened to verify compliance with established procedures and to detect possible deviations in a timely manner.

Second. To optimize time efficiency, it is recommended to implement continuous training programs for logistics personnel, focused on inventory management, process control, and continuous improvement. Likewise, it is suggested to periodically optimize the physical distribution of the warehouse through ABC classification and the redesign of the layout, in order to reduce unnecessary transfers and shorten non-productive periods.

Third. Regarding cost efficiency, the implementation of digital warehouse management systems (WMS) is recommended to improve inventory control, optimize merchandise tracking, and reduce operational errors. Regular evaluations of time efficiency and cost indicators are advised to monitor performance and identify opportunities for continuous improvement.

Fourth. It is recommended to develop future research that incorporates additional variables such as logistics automation, digitalization, strategic inventory management and personnel performance, expanding the scope to various sectors and with longer evaluation periods to generate greater scientific evidence.

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