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# WAREHOUSE MANAGEMENT APPLICATION TO IMPROVE SPARE PARTS WAREHOUSE PRODUCTIVITY IN A PORT COMPANY, CHANCAY, 2025

Julio Cesar Saravia Moran<sup>1</sup>, Veronica Betzabet Peña Fuentes<sup>1</sup>, Ronald Fernando Davila Laguna<sup>1</sup>

<sup>1</sup> *Universidad Cesar Vallejo*

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Corresponding author: Julio Cesar Saravia Moran  
(JSARAVIAMO88@ucvvirtual.edu.pe)

## ABSTRACT

The objective of the present study is to develop a warehouse management system with the aim of enhancing productivity in the spare parts warehouse of a port company situated in Chancay. The present study is predicated on the identification of deficiencies in logistics processes, including, but not limited to, inadequate inventory organization, protracted times required to locate materials, and limited technological integration in operational management. From a methodological perspective, a practical approach is employed, characterized by a non-experimental design and a descriptive level. This approach utilizes direct observation techniques, interviews, and documentary analysis to identify the primary causes of inefficiencies. Pursuant to the diagnosis, it is recommended that a warehouse management system (WMS) be implemented. The implementation of such a system would facilitate the automated control of inputs, outputs, and disposition of spare parts. The findings indicate a substantial enhancement in operational efficiency, a decline in inventory control errors, and an improvement in the responsiveness to internal requests. Therefore, the implementation of a warehouse management system is expected to have a positive impact on the logistics area's general productivity and to promote ongoing process improvement within the port company.

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**Keywords:** Warehouse, management, efficiency, effectiveness, dispatch.

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## 1. INTRODUCTION

Warehouse management constitutes a foundational element within the contemporary supply chain, serving as the nexus that integrates the processes of sourcing, production, and delivery. Effective management is essential for ensuring the seamless coordination of materials and products, thereby ensuring the timely availability of resources and the optimization of operating costs. According to Boyano and Machado (2020, p. 137), effective warehouse management optimizes the use of available space and reduces superfluous expenses. Furthermore, it improves the company's ability to react to market demands, thus increasing its competitiveness.

In this context, the supply chain can be conceptualized as an interconnected series of logistics processes, extending from the supplier to the end consumer. This encompasses inventory management, transportation, distribution, and service feedback. The coordination and efficiency of these elements are interdependent, thereby underscoring the pivotal role of the warehouse in ensuring the uninterrupted operation and the caliber of the logistics service. As illustrated in Figure 1, the various stages comprising the supply chain are interconnected, thereby emphasizing the pivotal role of the warehouse in orchestrating the movement of materials

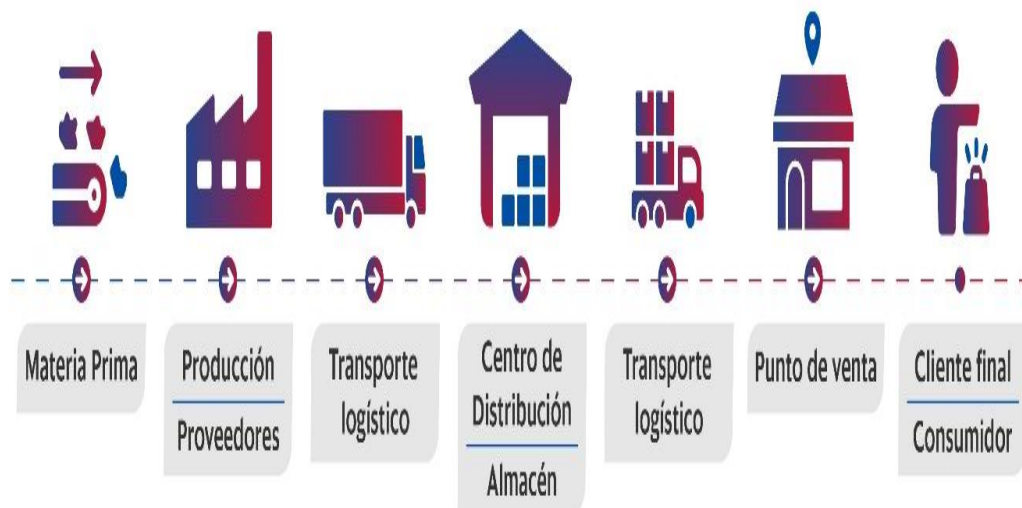


Figure 1: Supply chain.

Source: Own elaboration based on Boyano and Machado (2020).

In the contemporary era, significant advancements in technology, digitalization, and the integration of smart tools have precipitated a paradigm shift in logistics management across diverse industrial sectors. In this framework, the implementation of Warehouse Management Systems (WMS) enables the automation of receiving, sorting, storage, and shipping processes, thereby facilitating precise inventory control and comprehensive traceability of all actions. These solutions are a response to the need to merge technological innovation with continuous progress, aligning with Sustainable Development Goal (SDG) 9, "Industry, Innovation and Infrastructure," which advocates the modernization of industrial processes as a strategy to boost productivity and sustainability (United Nations, 2024, p. 1).

On a global scale, achieving optimal logistics efficiency is imperative for maintaining economic competitiveness. In the port area, productivity is

assessed by indicators such as efficiency in handling cargo, time spent on ships, and speed in the delivery of goods (Delfin & Navarro, 2021, p. 2). According to the World Bank and SandP Global Market Intelligence (2024, p. 1), over 80% of global trade is transported by sea, indicating that efficiency in ports is a fundamental component of economic development and international trade.

In the Latin American context, major ports have demonstrated notable advancements in enhancing their infrastructure and operational methodologies. In 2022, the ports of Colón, Manzanillo, and Cristóbal in Panama collectively managed more than 5.1 million TEUs, thereby solidifying their position as the largest port complex in the region. In contrast, the port of Santos in Brazil managed to mobilize 4.45 million TEUs. These statistics underscore the relevance of technological innovation and effective management as key factors of competitiveness in the maritime industry

(Statista Research Department, 2024, p. 1). The contemporary global trend is toward the automation of processes, the connection of digital systems, and the implementation of sustainable logistics models that improve productivity and mitigate the effects on the environment.

In Peru, there has been a consistent effort to modernize port infrastructure over the past two decades. According to the National Port Authority (APN, 2024, p. 1) and the Foreign Trade Society of Peru (COMEX, 2024, p. 1), both public and private terminals mobilized 53.8 million metric tons in the first half of 2022. This figure indicates a strengthening of the country's maritime trade in the region. The enhancement of the National Port System has led to an increase in the competitiveness of the sector, particularly at the Callao and Pisco terminals, which have demonstrated notable advancements in operational efficiency, technological sophistication, and environmental sustainability.

Chancay has emerged as a prominent nexus for logistics development within the Peruvian context. The recent augmentation of its infrastructure—which now encompasses more than 108—is indicative of this commitment. The construction of a 000 m<sup>2</sup> storage facility is currently underway, representing an expansion of 96. The area is 000 m<sup>2</sup> for category A and 12 m<sup>2</sup> for category B. A total area of 000 m<sup>2</sup> classified under category B indicates a mounting demand for port services (Gestión, 2025, p. 1). However, the rapid escalation of operations and the entry of new market participants have exposed deficiencies in inventory management, product coding, and storage conditions. These issues directly impact the productivity and efficiency of the logistics system.

Port companies must confront the challenge of integrating technology, processes, and human resources to enhance their logistics management. Inadequate warehouse management has the potential to result in errors in parts identification, unproductive time in the search for materials, and delays in shipping handling, which can lead to a decrease in operational efficiency. In this context, the implementation of a warehouse management system is presented as a viable and necessary option to increase productivity and ensure a smoother and more accurate logistics flow.

A substantial body of research has emerged to support the efficacy of warehouse management systems in enhancing organizational performance. Harish (2024) conducted an analysis in India that demonstrated the implementation of management

strategies resulted in a 7.14% increase in efficiency and a 13.71% increase in effectiveness, thereby creating competitive advantages for logistics operators. A similar finding was reported by Untung, Anang, and Ria (2024) in Indonesia, who determined that the implementation of WMS systems, both internal and external, led to substantial improvements in inventory accuracy and responsiveness within the fast-moving consumer products sector. These findings underscore the significance of technology management as a catalyst for ongoing enhancement in intricate logistics environments.

In the Peruvian context, the implementation of a warehouse management system in the port sector is driven by two primary motivations. Firstly, it seeks to modernize internal processes, thereby enhancing operational efficiency. Secondly, it is intended to align with international regulations concerning productivity, traceability, and control. At the port company of Chancay, the optimization of the spare parts warehouse represents an opportunity to reduce non-productive times, eliminate non-value-added activities, and guarantee the availability of essential materials for operational maintenance.

The implementation of structured warehouse management, predicated on the principles of continuous improvement and the PHVA (Plan, Do, Verify, Act) cycle, will enable the attainment of heightened levels of efficiency and effectiveness in internal processes. Consequently, this paradigm will prioritize data-driven decision-making, rational utilization of physical space, and the standardization of procedures. These measures are expected to enhance the productivity of the spare parts warehouse, fortify the port company's competitive position, and bolster its contribution to local and national economic growth.

The primary objective of this study is to illustrate how the implementation of effective warehouse management contributes to enhancing productivity within the port environment. This, in turn, leads to the enhancement of logistics systems and the sustainability of the sector. The evidence obtained will serve as a foundation for the development of a reference model that can be replicated in other industrial and port environments throughout the country.

## 2. OBJECTIVES

### 2.1. General objective

To implement a warehouse management system (WMS) to improve the productivity of the spare parts warehouse in a port company located in

Chancay, optimizing the processes of reception, storage, control and dispatch of materials.

## 2.2. Specific objectives

1. Diagnose the current situation of the spare parts warehouse, identifying the main deficiencies in logistics and inventory control processes that affect productivity.
2. Analyze the critical causes that affect the low efficiency of the warehouse using quality management tools, such as the Ishikawa diagram and the 6M methodology.
3. Design a warehouse management proposal based on principles of continuous improvement and the use of automated systems (WMS), which allows optimizing the flow of materials and the organization of space.
4. Evaluate the impact of the application of the warehouse management system on the productivity of the area, considering indicators of operational efficiency, dispatch times, inventory control and internal satisfaction.
5. Propose sustainable improvement guidelines that guarantee the standardization of processes, staff training and long-term technological integration within the port company.

## 3. METHODOLOGY

The research employed a quantitative approach, emphasizing the measurement of results through the use of logistic indicators. The initiative was designated as applied due to its objective of addressing a particular challenge concerning the efficiency of a port company's spare parts warehouse in Chancay. This challenge was identified through the implementation of a warehouse management system (WMS). According to Castro, Gómez, & Camargo (2022, p. 3), the objective of applied research is to provide practical solutions derived from theoretical knowledge,

thereby contributing to the sustainable improvement of processes within organizations.

The methodology was designed following the PHVA (Plan, Do, Check, Act) cycle, a frequently utilized framework in quality management models. In this instance, the PHVA cycle was employed as a continuous improvement resource. The implementation of this method ensured the execution of an organized and quantifiable procedure in each phase of the project, thereby facilitating the technical validation of the results obtained.

### 3.1. Research level and design

The study was developed at an explanatory level and a pre-experimental design, with a focus on a single group of analyses with measurements before and after the intervention. According to García and Sánchez (2020, p. 164), this design facilitates the establishment of causal relationships between variables by quantifying the resulting changes subsequent to the application of the stimulus. The sequence of the design was as follows:

G: Port Company Spare Parts Warehouse

M1: Initial Productivity Measurement (Pretest)

E: Implementation of the warehouse management system

M2: Post-Application Measurement (Post-Test)

### 3.2. Variable and indicators

Two main variables were defined:

- **Independent variable:** *Warehouse management*
  - Dimensions: planning, organization, control and continuous improvement.
- **Dependent variable:** *Warehouse productivity*
  - Dimensions: efficiency, effectiveness and overall productivity.

The measurement indicators were constructed from validated record formats, using the following formulas:

#### Porcentaje de eficiencia (PE):

$$PE = \frac{\text{Tareas realizadas}}{\text{Tareas planificadas}} \times 100$$

#### Porcentaje de eficacia (PEF):

$$PEF = \frac{\text{Mercadería entregada a tiempo}}{\text{Total de mercadería entregada}} \times 100$$

#### Productividad (P):

$$P = \frac{PE \times PEF}{100}$$

Figure 2:

The following data collection techniques were used:

### 3.3. Techniques and instruments

- **Direct observation:** it allowed to measure the operating times and the flow of materials in real working conditions.
- **Document analysis:** review of entry and exit guides, inventory reports, control sheets and maintenance reports.
- **Structured interviews:** aimed at those responsible for the logistics area, in order to identify perceptions and difficulties in the procedures.
- **Registration cards and check lists:** designed to collect quantitative data from daily operations and verify compliance with standards.

The instruments were validated by expert judgment and presented adequate internal consistency according to Cronbach's alpha coefficient.

### 3.4. Methodological procedure

The methodological approach was structured into four distinct stages, each with specific objectives and associated actions that guarantee the validity, reliability, and practicality of the proposed management model. The phases—namely, diagnosis, analysis of causes, design and execution, and evaluation of results—were carried out in accordance with the principles of the PHVA (Plan, Execute, Verify, Act) cycle. The focus of this process was on the constant improvement of logistics processes.

#### 3.4.1. Warehouse Situational Diagnosis

The initial stage entailed the characterization of the logistics process within the spare parts warehouse. The collection of information was conducted through three primary methods: direct observation, structured interviews with staff members, and a documentary review of entry and exit guides, inventory reports, dispatch times, and order fulfillment levels.

A meticulous mapping of the flow of materials from receipt to delivery was conducted, leading to the identification of unproductive times, duplication of tasks, and a lack of standardization. Utilizing flowcharts (PDO and DAP), the procedural framework was systematically documented and evaluated in relation to the ISO 9001:2015 standards for process management.

Concurrently, a comprehensive evaluation of the warehouse layout was conducted, encompassing the physical distribution of materials, the utilization of space, accessibility to the picking areas, and adherence to industrial safety protocols. The presence of bottlenecks was identified in the reception and dispatch areas. The low turnover of

category "A" products, as well as the unnecessary accumulation of low-turnover materials, were also contributing factors.

#### 3.4.2. Analysis of the causes of low productivity

In this phase, rigorous investigative methods were employed to ascertain the factors that precipitated the primary operational challenges. A brainstorming session was conducted with the logistics team, and the Ishikawa diagram was employed to identify the root causes, which were grouped under the classic categories of the 6Ms (Labor, Machinery, Method, Materials, Measurement, and Environment).

The relative importance of each cause was evaluated using an ordinal scale, with categories ranging from 0, indicating no relationship, to 2, indicating a high relationship. The results indicated that four causes accounted for 80% of the deficiencies:

1. Inadequate classification of products.
2. Poor and outdated coding.
3. Poor storage conditions (order, humidity, ventilation).
4. Insufficient training of personnel in logistical procedures.

Subsequently, the Multi-Criteria Prioritization Matrix was employed to select the most effective improvement alternative, evaluating four factors: implementation cost, impact on productivity, technical feasibility, and staff acceptance. In the analysis of relevant factors, warehouse management systems (WMS) were assigned the highest weighting. This is due to the capacity of WMS to digitize inventory control and enhance the traceability of spare parts.

#### 3.4.3. Design and implementation of the warehouse management model

In this stage of the project, an operational model of warehouse management was designed. This model was developed based on the principles of lean logistics and the 5S methodology.

The model was structured based on three operating subsystems:

1. Reception subsystem: redesign of processes for recording, verification, classification and location of materials by means of standardized alphanumeric codes.
2. Storage subsystem: implementation of an optimized layout that guaranteed accessibility, stock rotation according to the ABC method and the ergonomic arrangement of the space. Mobile shelving, safety zones and visual

signage were incorporated to reduce unnecessary travel.

3. Dispatch subsystem: efficient picking routes were designed, accompanied by the digitization of the outbound format and automated inventory control in real time.

To support the redesign, detailed flow charts (PDO and DAP) were developed that represented each operation with its standard time. The determination of these times was made by applying the Westinghouse and OIT methods, which enabled the evaluation of the worker's performance based on factors such as skill, effort, conditions, and consistency. This facilitated the determination of normal and standard times for critical tasks.

In a similar manner, personnel were trained in material handling, inventory control, use of logistics software, and application of the PHVA cycle. These measures served to reinforce the culture of continuous improvement. The implementation phase was executed in a phased manner over the course of twelve weeks, thereby enabling the operational staff to make adjustments to the procedures in accordance with their feedback.

#### **3.4.4. System Impact Assessment**

Subsequent to the implementation of the model, a pre-test-posttest benchmarking was conducted. To this end, the efficiency, effectiveness, and productivity indicators were measured before and after the implementation of the warehouse management system.

1. Efficiency: relationship between planned tasks and tasks performed within the established times.
2. Efficiency: proportion of shipments delivered correctly and on time to the total.
3. Productivity: combination of both metrics, expressed as a percentage of overall performance.

The statistical analysis was performed with the SPSS v.26 software, applying Shapiro-Wilk normality tests and the Wilcoxon test for related samples, in order to verify the significance of the improvements. The findings indicated a 56.12% surge in total productivity, a 36.82% enhancement in operational efficiency, and a 14.11% rise in effectiveness, with a p-value of 0.000, thereby substantiating a statistically significant impact.

Furthermore, a qualitative evaluation was conducted through interviews and internal satisfaction surveys, which indicated a favorable perception of the staff regarding the new system. The reduction of nonproductive time, the reduction of errors in inventory control, and the improvement in the work environment due to the new physical organization of the warehouse were all highlighted.

#### **3.3.5. Control and sustainability of the system**

Consequently, a series of control mechanisms were implemented to ensure the sustainability of the management system that had been installed. A proposed warehouse operating manual was presented, which included standardized procedures and designated managers for each process. Furthermore, a panel of logistics indicators (KPIs) was developed to ensure continuous monitoring of efficiency levels, inventory accuracy, and dispatch times.

The monthly follow-up meetings were defined under the Kaizen methodology, in which the results obtained are reviewed and corrective and preventive actions are formulated. Accordingly, the warehouse management system is consolidated as a dynamic instrument for continuous improvement, aligned with the strategic objectives of the port company.

## **4. RESULTS**

In relation to the results, the comparatives of the before and after are shown as shown in Figure 2.

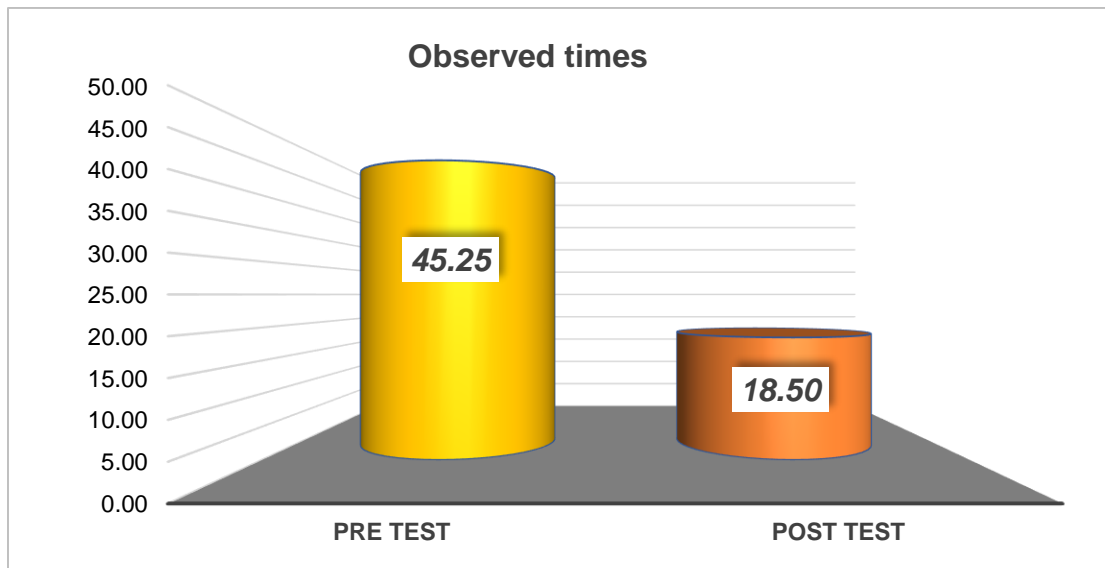


Figure 2: Results of both stages of the observed times

As illustrated in Figure 2, a substantial enhancement in observation time is evident, with a notable decrease from 45.25 minutes to 18.50 minutes. This decline could be indicative of process

optimization or the positive impact of post-test modifications. The reduction variation is displayed in Table 1.

Table 1: Observed times

OBSERVED TIMES		$\%Reducción = \left( \frac{45.25 - 18.50}{45.25} \right) \times 100$
PRE TEST	45.25	
POST TEST	18.50	
(▼) REDUCTION	59.12%	$\%Reducción = 59.12\%$

Source: Own elaboration

As illustrated in Table 1, the observed 59.12% reduction signifies a substantial enhancement in the efficacy of the process, as the recorded duration was diminished from 45.25 minutes in the preliminary test to 18.50 minutes in the subsequent post-test. This finding suggests that the tools, techniques, or conditions employed as Warehouse Management in the post-test may be significantly more effective than those utilized in the previous test. The following non-value-adding activities must be eliminated:

2. Count the quantities ordered
3. Check the condition of the product
4. Check the expiration date
5. Select the quantities ordered
6. Check the product

In a similar vein, the preceding and subsequent comparisons are delineated in the ensuing Figure 3, illustrating the standard time.

1. Search for the product on the scaffolding

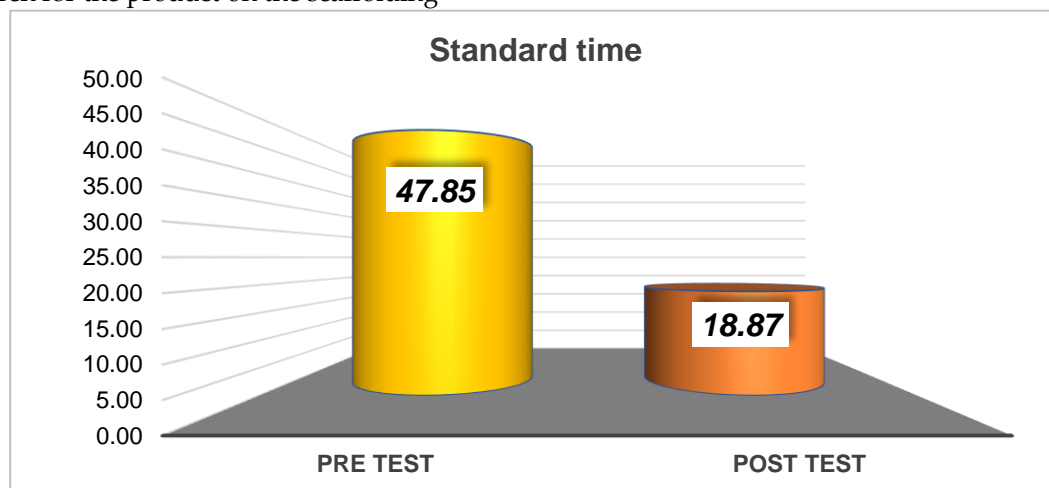


Figure 3: Results of both stages of standard time

Figure 3 shows a significant improvement in the standard time, which drops from 47.85 to 18.87 minutes; This could be an indication that the

process was optimized or that some change made after the pre-test had a positive effect. The reduction variation is shown in Table 2.

**Table 2: Standard Time**

EFFICIENCY	
PRE TEST	63.34%
POST TEST	86.67%
IDEAL	100.00%
(▲) INCREASE	36.83%

$$\%Incremento = \left( \frac{86.67 - 63.34}{63.34} \right) \times 100$$

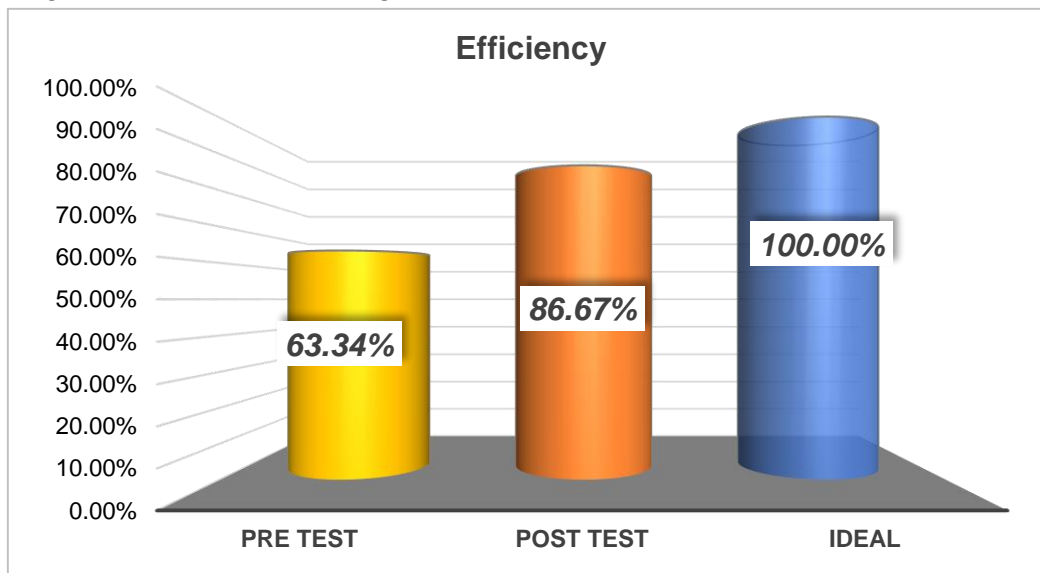
$$\%Incremento = 36.83\%$$

Source: Own elaboration

From Table 2, the 60.56% decrease is a clear sign that the intervention between the pre-test and the post-test has benefited efficiency, by reducing the time it takes to perform the activity. To this end, it is indicated that it was possible to eliminate unproductive times in the following activities: entering the registration base, printing the dispatch order, moving to the scaffold according to the

order, moving to the applicant, entering the registration base, registering the output of the product in the registration base and saving the output.

In the same way, for efficiency, the before and after comparisons are detailed as shown in Figure 4.



**Figure 4: Results of both stages of efficiency**

In Figure 4, efficiency increased from 63.34% to 86.67%, which is a significant improvement. However, the efficiency is still not 100 per cent,

indicating that the process can be further improved. The variation of the increment is shown in Table 3.

**Table 3 : Efficiency**

EFFICIENCY	
PRE TEST	63.34%
POST TEST	86.67%
IDEAL	100.00%
(▲) INCREASE	36.83%

$$\%Incremento = \left( \frac{86.67 - 63.34}{63.34} \right) \times 100$$

$$\%Incremento = 36.83\%$$

Source: Own elaboration

From Table 3, the Pre Test (63.34%) indicates that the efficiency is low before the test, which indicates that the process or activity was not being carried out properly, for the Post Test (86.67%) after the test, the efficiency increases to 86.67%, which demonstrates the positive impact of the intervention. This means an increase of (36.83%), in addition to indicating that efficiency has improved

considerably after the implementation of Warehouse Management, providing a solution to the main causes that generated the problem.

In the same way, for effectiveness, the before and after comparisons are detailed as shown in Figure 5.

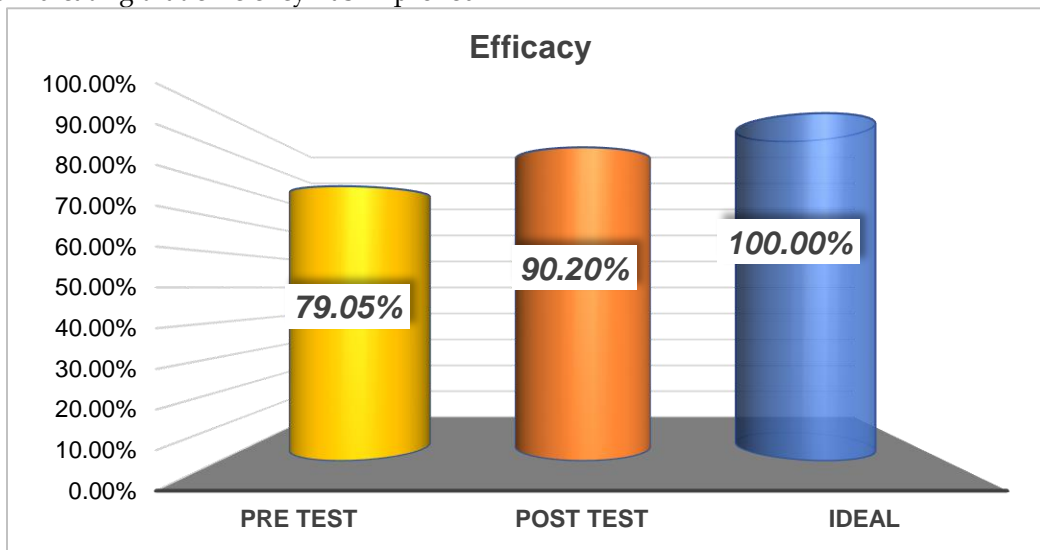


Figure 5: Results of both stages of standard time

Figure 5, the efficacy increased from 79.05% to 90.20%, which is a significant improvement. However, the efficiency is still not 100%, which

indicates that the process can be further improved. Table 4 presents the variation of the increment.

Table 4: Efficiency

EFFICIENCY		$\%Incremento = \left( \frac{90.20 - 79.05}{79.05} \right) \times 100$ $\%Incremento = 14.11\%$
PRE TEST	79.05%	
POST TEST	90.20%	
IDEAL	100.00%	
(▲) INCREASE	14.11%	

Source: Own elaboration

As illustrated in Table 4, the Pre Test (79.05%) suggests that the efficacy is suboptimal prior to the test, indicating that the process or activity was not being executed correctly. Following the test, the Post Test (90.20%) demonstrates an improvement in efficacy, suggesting a positive impact from the intervention. This indicates a 14.11% increase, suggesting a substantial enhancement in efficiency

following the implementation of Warehouse Management. This development offers a comprehensive solution to the underlying causes that initially gave rise to the problem.

Similarly, the figures illustrate the before-and-after comparisons in terms of productivity, as demonstrated in Figure 6.

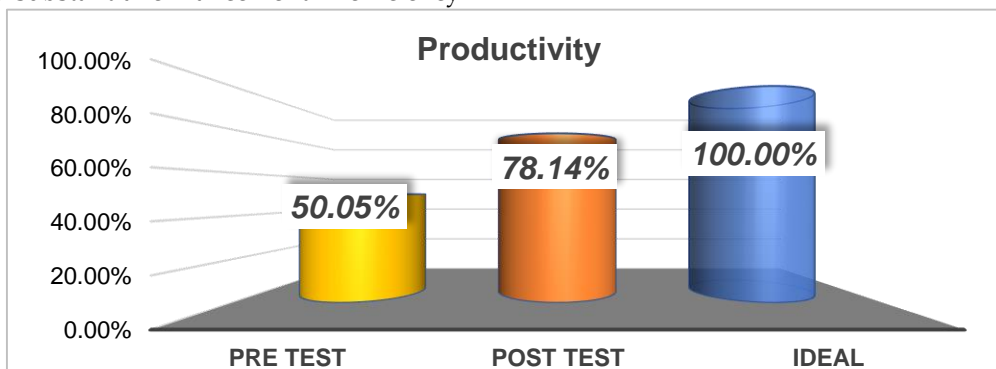


Figure 6: Results of both stages of productivity

Figure 6, productivity increased from 50.05% to 78.14%, which is a significant improvement. However, productivity is still not 100 per cent,

indicating that the process can be further improved. Table 5 shows the variation of the increment.

Table 5: Productivity

PRODUCTIVITY	
PRE TEST	50.05%
POST TEST	78.14%
IDEAL	100.00%
(▲) INCREASE	56.12%

$$\%Incremento = \left( \frac{78.14 - 50.05}{50.05} \right) \times 100$$

$$\%Incremento = 56.12\%$$

Source: Own elaboration

As illustrated in Table 5, the Pre Test (50.05%) indicates that productivity levels were suboptimal prior to the test, suggesting that the process or activity was not being executed effectively. In contrast, the Post Test (78.14%) demonstrates a significant increase in productivity following the implementation of the intervention, thereby substantiating the positive impact of the intervention. This indicates a 56.12% increase, suggesting that productivity has improved

significantly following the implementation of a warehouse management system. This system has addressed the primary causes of the problem, thereby resolving the underlying issues.

#### 4.1. Descriptive analysis of productivity

According to the results of the 12 weeks for both stages, the productivity values are shown in Figure 7.

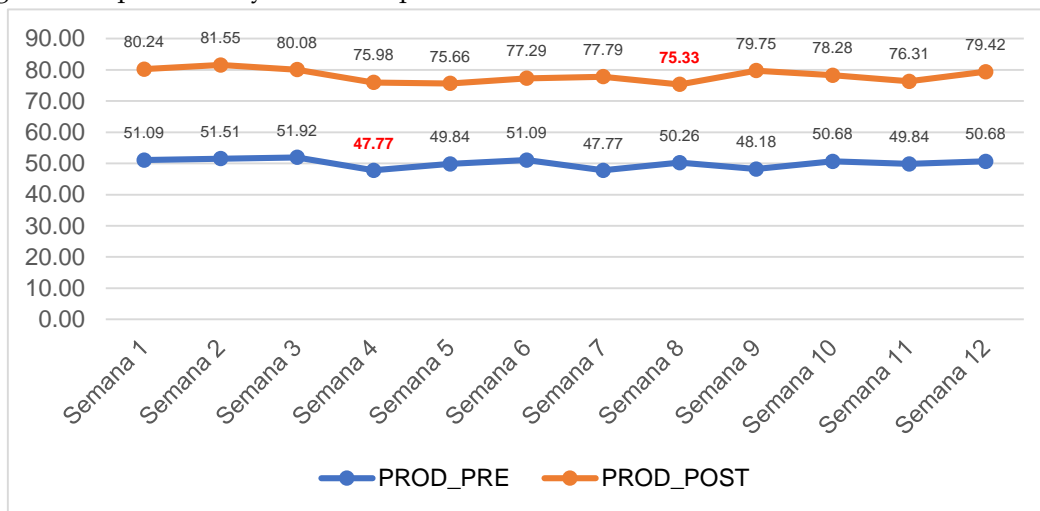


Figure 7: Weekly productivity results

As illustrated in Figure 7, which depicts the baseline scenario (PROD\_PRE), productivity levels initially manifest at a modest percentage of 51.09%, subsequently maintaining a steady level of approximately 50.68% during the twelfth week. In the fourth week, a decline was observed, with the percentage dropping to 47.77%. This could be indicative of challenges or difficulties experienced during that period. Subsequent to the intervention of the Warehouse Management, the (PROD\_POST) indicator signaled that, over the course of the specified period, productivity levels commenced at 80.24%, exhibiting consistent upward trends, with occasional fluctuations, yet consistently surpassing

75%. Despite registering a 75.33% reduction in Week 8, the data may be indicative of a slight decrease. However, the course of the following weeks is generally positive. Subsequently, the indicated values were entered into SPSS version 26 and transferred to Excel. The values were classified according to the following measures: mean or average arithmetic, median, and mode; standard deviation and variance; and measures of asymmetry and kurtosis. The table or graphs of the frequency distribution of the 12 weeks of productivity were also included. As shown in Table 6.

Table 6: Productivity Description

Type of description	N	PROD_PRE		PROD_POST	
		Valid	Lost	Valid	Lost
Central Tendency Measure	Stocking	50.0525	0	78.1400	0
	Median	50.4700	0	78.0350	0

	Fashion	47.77a	75.33a
Dispersion measures	Desv. Deviation	1.43373	2.06613
	Variance	2.056	4.269
Graphic measurements	Asymmetry	-0.667	0.101
	Kurtosis	-0.830	-1.336

Source: Authors' elaboration in SPSS v.26

As illustrated in Table 6, prior to the implementation of the intervention (PROD\_PRE), the productivity values exhibited a slightly left-skewed distribution, with a mean of 50.05. The standard deviation of the data is 1.43, which indicates that the dispersion is not excessively high. The mean value of 47.77 indicates that the most prevalent value was marginally below the mean. The implementation of a Warehouse Management system at the PROD\_POST stage resulted in a substantial enhancement in productivity, with an

average of 78.14 and a mode of 75.33, indicating that the majority of the figures were elevated. Although the standard deviation increased, indicating a greater dispersion of values, the observed asymmetry indicates that the distribution of values is more balanced than it was prior to the administration of the test.

**4.2. Descriptive analysis of efficiency**

According to the results of the 12 weeks for both stages, the efficiency values are shown in Figure 8.

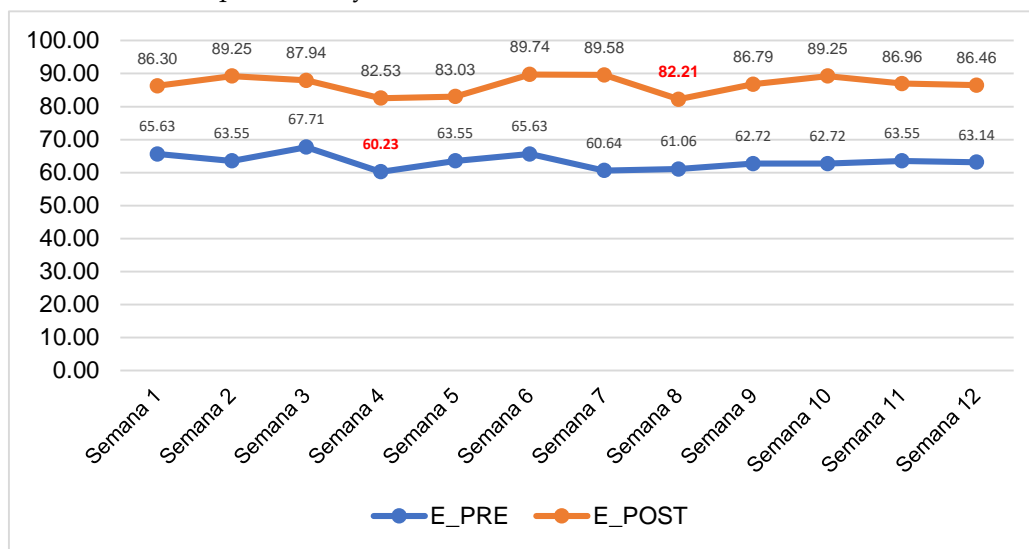


Figure 8: Weekly efficiency results

Figure 8, prior to the intervention (E\_PRE), demonstrates that the efficiency initially exhibits a high value in Week 1 (65.63%), which subsequently experiences a substantial decline in Week 4, reaching 60.23%, which is the lowest recorded value. However, it then begins to restore more stable levels. Preliminary findings suggest that the efficiency of the system under investigation (E\_POST) begins at 86.30 during the first week and remains relatively stable over the subsequent weeks. However, a slight decline is observed in the eighth week. This observation is consistent with the

intervention of Warehouse Management. In general, the efficiency values subsequent to the test exceed those of the preceding test. Subsequently, the indicated values were entered into SPSS version 26 and transferred to Excel. The values were classified according to the following measures: central tendency (arithmetic mean, average, median, and mode); dispersion (standard distribution and variance); and asymmetry and kurtosis. The table or graphs of the frequency distribution of the 12 weeks of efficiency were also included. As demonstrated in Table 7.

Table 7: Efficiency Description

Type of description	N	E_PRE		E_POST	
		Valid	Lost	Valid	Lost
Central Tendency Measure	Stocking	63,3442	0	86,6700	0
	Median	63,3450		86,8750	
	Fashion	63,55		89,25	
Dispersion measures	Desv. Deviation	2,18853		2,75316	
	Variance	4,790		7,580	
Graphic measurements	Asymmetry	,466		-,617	

	Kurtosis	,040	-.970
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Source: Authors' elaboration in SPSS v.26

As illustrated in Table 7, the preliminary data (E\_(PRE)) indicate that the efficiency values have a mean of 63.34 and a mode of 63.55, with a standard deviation of 2.18. This suggests that the data exhibit moderate dispersion. The implementation of Warehouse Management for the (E\_POST) stage has been shown to result in a substantial enhancement in efficiency, as evidenced by the observed metrics. The mean efficiency score attained was 89.25, while the mode was recorded at 89.25, indicating a notable improvement in

efficiency levels. However, the variance and standard deviation increased, indicating that the post-test values were more dispersed. The kurtosis and asymmetry of the post-test data are indicative of a flatter and more symmetrical distribution in comparison to the initial distribution.

### 4.3. Descriptive analysis of effectiveness

According to the results of the 12 weeks for both stages, the values are shown in Figure 9.

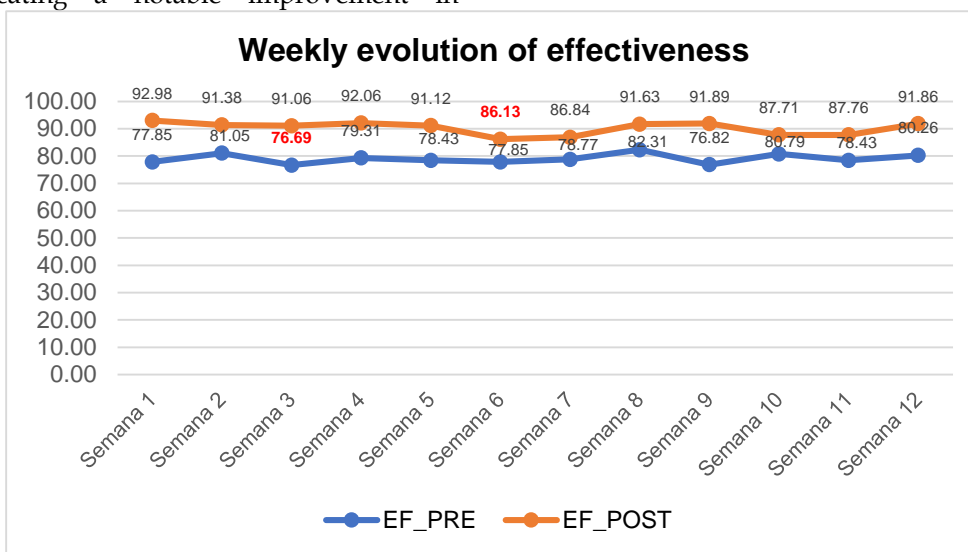


Figure 9: Weekly Effectiveness Results

As illustrated in Figure 9 before intervention (EF\_PRE), the efficacy levels remained within a stable range, with figures ranging from 77.85% to 80.26% in most weeks. Although slight variations are observed, no significant change is perceived. Following the intervention of the Warehouse Management team, the efficiency metrics have shown a substantial enhancement, with figures ranging from 92.98% to 91.86% in the majority of weeks. Subsequent to the intervention, the efficacy exhibited variability; however, it consistently surpassed the pre-intervention levels, attaining figures as high as 91.86 in week 12. Consequently,

the efficacy prior to the intervention exhibits stability, while the efficacy post-intervention demonstrates an upward trend, maintaining levels above those observed pre-intervention. Subsequently, the indicated values were entered into SPSS version 26 and transferred to Excel. The values were classified according to the following measures: mean or average arithmetic, median, and mode; standard deviation and variance; and measures of asymmetry and kurtosis. The table or graphs of the frequency distribution over the 12-week period of efficacy were also included. As demonstrated in Table 8.

Table 8: Effectiveness Description

Type of description	N	Valid	EF_PRE	EF_POST
		Lost		
Central Tendency Measure	Stocking		50.0525	78.1400
	Median		50.4700	78.0350
	Fashion		47.77a	75.33a
Dispersion measures	Desv. Deviation		1.43373	2.06613
	Variance		2.056	4.269
Graphic measurements	Asymmetry		-0.667	0.101
	Kurtosis		-0.830	-1.336

Source: Authors' elaboration in SPSS v.26

As illustrated in Table 8, the efficiency values prior to the intervention (EF\_PRE) indicate a high level of efficiency. The standard deviation of 1.43 indicates a moderate dispersion of information. The implementation of Warehouse Management for the average (EF\_POST) stage has yielded notable enhancements in efficiency, as evidenced by the observed mean of 78.14 and the mode of 75.33. This substantial increase in efficiency is indicative of a significant impact on operational processes. A

**Table 9: Productivity Description**

	Shapiro-Wilk		
	Statistical	Gl	Gis.
PROD_PRE	,890	12	,119
PROD_POST	,941	12	,514

Source: Authors' elaboration in SPSS v.26

As indicated by the results presented in Table 9, the PROD\_PRE data demonstrates a p-value of 0.119, which exceeds the 5% threshold. This finding suggests that the data continues to follow a normal distribution. Subsequent to the intervention of the Warehouse Management, the data for PROD\_POST also exhibited a value of  $p = 0.514$ , which is greater than 5%. This finding suggests that the data is normally distributed.

## 5. DISCUSSION

According to the overarching productivity objective, there was a 56.12% improvement, with a pre-test score of 50.05% and a post-test score of 78.14% following the implementation of the Warehouse Management intervention. The reduction and elimination of superfluous times from 45.25 minutes per dispatch to 18.50 minutes per dispatch has been achieved. This hypothesis was subsequently confirmed through statistical analysis, which yielded a p-value of 0.00. As Anaya (2011, p. 15) asserts, the objective of this productivity study is to ascertain the logistics operation procedures involved in the reception, storage, and movement of materials, raw materials, intermediate products, and final products within a warehouse to their intended location. The study encompasses the management and communication of the data generated during these processes. A comparison of the two studies reveals notable distinctions. In their scientific study on warehouse management, Untung, Anang, and Ria (2024) sought to ascertain the impact of outsourced and internal warehouse management systems on productivity and stock accuracy in the fast-moving consumer goods sector of a logistics services company in Palembang. Their study population comprised 20 records of articles processed per unit of time. Depending on the methodology employed,

comparative analysis of the pre-test and post-test results reveals a modest increase in both variance and standard deviation. This observation suggests that the data have become more dispersed.

### 4.4. Inferential analysis of productivity

Then, the analysis of normality and the hypothesis for productivity is carried out, as shown in Table 9.

the study was of an experimental and quantitative nature, which necessitated the implementation of techniques such as surveys and evaluation sheets. The result of the study demonstrated a significant improvement in productivity, with a notable increase from 52.5% to 62.5%. The findings indicated that the subjects exhibited superior operational efficiency, storage accuracy, and response capacity. Consequently, the implementation of the procedure resulted in a 19.05% increase in productivity. From a statistical standpoint, the study obtained a significance value of 0.068, indicating a substantial inventory accuracy. In their scientific study on warehouse management, Larutama et al. (2022) sought to determine the management of finished product warehouses in order to improve operational efficiency and logistical control, with the ultimate goal of increasing productivity. The researchers considered a population of 60 records of shipments of finished products from the warehouse for their study. The methodology employed determined the application of quantitative techniques, which in turn dictated the utilization of tools such as surveys, evaluation sheets, and checklists. The result of the study demonstrated a significant enhancement in productivity, with an observed increase from 64.3% to 73.7%. The analysis concluded that this enhancement is attributable to an increase in the number of orders received and an improvement in the operational efficiency of the company. The provision of stock data in real time is instrumental in preventing excess stock, thereby ensuring the effective utilization of resources. The application of the procedure in a precise manner is found to be directly correlated with an increase in productivity, with a calculated increase of 14.62%.

According to the initial efficiency objective, a 36.82% improvement was achieved, with a pre-test

result of 63.34% and a post-test result of 8.67% following the implementation of the Warehouse Management intervention. The standard time was reduced by 60.58% from 47.85 minutes to 18.87 minutes. This hypothesis was subsequently confirmed through statistical analysis, which yielded a p-value of 0.00. At the conceptual level, this study of efficiency was based on Ramon et al. (2021, p. 9), who in turn refer to the results obtained in relation to the objectives and achievements of the organization. A comparison of the aforementioned points can be made with the research conducted by Harish (2024). In his scientific study on warehouse management, Harish set the objective of examining key strategies to improve efficiency and effectiveness in 3PL warehouses. The study considered 10 weeks of warehouse shipment records as a population. The methodology employed in the study determined the applied, experimental, and quantitative nature of the research, which subsequently influenced the utilization of instruments as recording formats. The resultant findings indicated an enhancement in efficiency from 70.0% to 75.0%, and an escalation in effectiveness from 62.0% to 70.5%. It has been determined that these metric evaluations facilitate the implementation of performance and continuous improvement initiatives, thereby ensuring the maintenance and optimization of warehouse operations. The correct application of the procedure has been shown to enhance efficiency by 7.14% and effectiveness by 13.71%. This, in turn, enables the attainment of competitive advantages and customer satisfaction within the contemporary dynamic logistics landscape.

According to the second specific objective related to efficacy, there was an improvement of 14.11%, with a pre-test result of 79.05% and a post-test result of 90.20% following the implementation of the Warehouse Management intervention. This increase in orders is evident in the substantial rise in orders dispatched, which has grown from 120 to 477. The statistical analysis yielded a value of 0.00, thereby substantiating the hypothesis. At the conceptual level, the efficacy of the intervention was predicated on adherence to the prescribed operational procedures, which, as posited by Romero and Pacheco (2024, p. 3), is instrumental in attaining the anticipated outcome. For instance, the provision of timely orders, the maintenance of adequate inventory levels, and the assurance of product availability are all crucial elements in ensuring the smooth functioning of the supply chain. In their scientific study on warehouse

management, Becerra and Fernández (2025) set out to determine the improvement of productivity in the warehouse of an agro-industrial company. They considered 12 weeks of warehouse shipments as a population for their study, and their objective was to improve warehouse productivity. The methodology employed determined the application of quantitative techniques, which in turn guided the utilization of techniques such as documentary analysis. The final result of the study yielded a productivity rate of 85%, an efficiency rate of 94%, and an effectiveness rate of 91%. The analysis revealed a strong correlation between the two variables. The application of the procedure in a correct manner was found to enhance productivity by 31%, efficiency by 17%, and effectiveness by 20%. The present study makes a contribution through its analysis of the ABC model, the 5-pillar technique, control sheets, the design of office operations, training programs, and the application of Ishikawa and Pareto for the initial diagnosis.

## 6. CONCLUSIONS

The study's findings indicate that the general objective related to productivity exhibited a substantial enhancement, with a recorded increase of 56.12% from the initial 50.05% to a notable post-intervention level of 78.14% following the implementation of the Warehouse Management intervention. The reduction and elimination of superfluous times from 45.25 minutes per dispatch to 18.50 minutes per dispatch has been achieved. This hypothesis was statistically validated, yielding a p-value of 0.00, thereby substantiating H1 (i.e., the improvement of productivity in conjunction with Warehouse Management).

Consequently, it was determined that for the initial objective concerning efficiency, there was a 36.82% improvement, with a pre-test result of 63.34% and a post-test result of 86.67% following the implementation of the Warehouse Management intervention. The standard time was reduced by 60.58% from 47.85 minutes to 18.87 minutes. This hypothesis was statistically validated, yielding a p-value of 0.00, thereby substantiating the H1 (i.e., the efficiency enhancement hypothesis, contingent upon the efficacy of Warehouse Management Systems).

It is concluded that, with regard to the second specific objective related to efficacy, there was an improvement of 14.11%. Prior to the implementation of the Warehouse Management intervention, the pre-test result was 79.05%. Following the intervention, a post-test result of

90.20% was obtained. This increase in orders is evident in the substantial rise in orders dispatched, which has grown from 120 to 477. This finding was corroborated by statistical analysis, which yielded a value of 0.00, thereby validating Hypothesis 1 (H1), which posited that efficiency would improve with the implementation of Warehouse Management.

## 7. RECOMMENDATIONS

The area supervisor is advised to ensure that the new processes are clearly defined for the inspection, storage, and receipt of products. It is imperative that the goods be tagged and recorded in the system without delay. In order to ensure the distribution of products according to their expiration date, the FIFO (first in, first out) or LIFO (last in, first out) method is employed, depending on the type and expiration date of the products.

It is recommended that the supervisor continually assess and monitor warehouse Key Performance Indicators (KPIs), encompassing aspects such as inventory turnover rate, storage cost, inventory accuracy, and pick cycle time. This systematic approach enables the identification of areas requiring enhancement and facilitates the formulation of decisions grounded in empirical evidence to enhance operational efficiency.

It is recommended that the area supervisor optimize the warehouse space through an appropriate design, choosing shelves that can be adjusted and specific storage areas for products with high turnover or volume. The implementation of dynamic racking and vertical storage systems will optimize the utilization of available space.

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