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Improvement of the OTIF Level of Lubricant Distributor Company through Poka Yoke, ABC And SLP Analysis

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Abstract

This paper addresses the problem of a low OTIF (On Time In Full) performance level in a lubricant distribution company operating in a highly competitive logistics environment. The initial OTIF level of 90.14% was below the industry benchmark of 95%, generating annual losses of approximately S/302,144.50 due to rescheduling, delivery penalties, additional logistics costs, and loss of customer confidence. To address this issue, a quantitative and applied research approach was adopted, integrating ABC Analysis, Systematic Layout Planning, and Poka-Yoke as complementary industrial engineering tools. ABC Analysis was used to reorganize inventory based on product rotation and criticality, reducing product search time, while SLP enabled the redesign of the warehouse layout to improve material flow and significantly decrease transfer distances between operational areas. In addition, Poka-Yoke mechanisms were implemented to eliminate human errors in picking and order assembly processes. The results demonstrated a complete elimination of picking and order assembly errors, a reduction of 26.4% in product search time, and a 51.45% reduction in transfer time between activities. As a result, the OTIF level increased to 95.8%, exceeding the industry standard. The findings confirm that the integrated application of industrial engineering tools provides an effective and replicable approach for improving logistics.

Keywords
OTIF, ABC Analysis, SLP, Poka Yoke, lubricant distributor.

1. Introduction
Logistics performance is a key determinant of competitiveness in industrial distribution, where customers demand accurate, complete, and timely deliveries to sustain operational continuity. In this context, the On Time In Full (OTIF) indicator is critical, as it measures the reliability of order fulfillment in terms of both timeliness and completeness.

This study examines a Peruvian industrial lubricant distribution company serving sectors such as mining, manufacturing, transport, and agriculture. Despite having an established logistics system, the company reports an OTIF level of 90.14%, falling below the industry benchmark of 95% and revealing a performance gap of 4.86%. Based on 1,425 analyzed orders, 1,339 were delivered in full and 1,367 on time. This gap generates significant operational inefficiencies and an estimated economic impact of S/302,144.50, driven by rescheduled deliveries, penalties, additional logistics costs, and lost sales.

A root-cause analysis identified four primary drivers: picking errors (39.58%), excessive transfer times (28.47%), order assembly errors (20.14%), and product search delays (11.81%), all predominantly associated with warehouse operations.

To address these issues, this research proposes an integrated improvement model combining ABC Analysis, Systematic Layout Planning (SLP), and Poka-Yoke. ABC Analysis enhances inventory classification and accessibility, SLP optimizes warehouse layout to reduce non-value-added movements, and Poka-Yoke minimizes human errors through preventive controls. Unlike isolated implementations, the proposed approach systematically links each root cause to a targeted solution, establishing a structured framework to improve operational efficiency and increase OTIF performance.

1.1 Objectives
The main objective of this study is to improve the OTIF level of a lubricant distribution company through the implementation of ABC Analysis, Systematic Layout Planning and Poka-Yoke in warehouse and logistics operations.

The specific objectives are to reduce picking errors through the application of Poka-Yoke mechanisms and standardized procedures; reduce order assembly errors through visual controls and working instructions; decrease transfer time between warehouse activities by redesigning the layout using Systematic Layout Planning; reduce product search time by reorganizing inventory through ABC Analysis; and validate the operational impact of the proposed improvements through numerical indicators and simulation results.

2. Literature Review
The improvement of OTIF performance in distribution companies is closely related to the efficiency of warehouse operations, inventory organization, layout design and error prevention during order preparation. In industrial distribution environments, the ability to deliver complete and timely orders depends on the proper coordination of internal processes, since the sector reference for OTIF performance is commonly associated with a 95% fulfillment level (Sagawa & Nagano, 2021). Likewise, warehouse efficiency can be strengthened through layout optimization, inventory classification and error-prevention practices. Systematic Layout Planning contributes to a more efficient distribution of facilities and material flow (Hu & Chuang, 2022), ABC Analysis supports inventory management by identifying critical products and improving stock control (Silva et al., 2022), and Poka-Yoke helps prevent process defects by reducing human errors during operational activities (Kumar & Kumar, 2019).

Inventory classification is one of the most common approaches for improving warehouse performance because it allows companies to prioritize resources according to the importance, demand or value of each product. ABC Analysis supports inventory management by classifying items into categories that help companies focus their attention on the most relevant products. Hamed and Jawad (2023) applied inventory analysis through an ABC-VED matrix and showed that classification methods can improve inventory control by identifying items with higher operational or economic relevance. Similarly, Ahmed and Workneh (2020) used an ABC-VEN matrix in pharmaceutical inventory management, demonstrating that classification techniques are useful for prioritizing critical items and supporting decision-making in inventory control. In manufacturing and warehouse environments, Zapata Rodriguez et al. (2023) also applied ABC design as part of a broader improvement model to reduce costs, showing that inventory classification can contribute to better control and resource allocation.

In warehouse operations, ABC Analysis is especially relevant because the location of high-rotation products directly affects product search time and picking efficiency. When products with greater demand are located in accessible areas, operators require less time to find and handle them, which reduces delays during order preparation. Ramos-Valle et al. (2022) reported that the implementation of improvement tools in a spare parts trading company increased service level performance and improved operational indicators related to inventory and order preparation. This evidence supports the use of ABC Analysis in distribution warehouses where product rotation, availability and location have a direct impact on delivery performance. In this study, ABC Analysis is therefore considered an appropriate tool to reduce product search time and support the improvement of OTIF.

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Layout design has also been widely studied as a key factor in operational efficiency because the physical arrangement of areas determines the distance traveled by workers, the flow of materials and the time required to complete warehouse activities. Systematic Layout Planning provides a structured approach to redesign facility layouts according to the relationship between areas, operational flow and space requirements. Li et al. (2019) applied the SLP method together with a genetic algorithm to optimize ship cabin equipment layout, showing that SLP can be adapted to complex spatial arrangement problems. Rodriguez et al. (2023) evaluated layout design with an Industry 4.0 approach in a manufacturing laboratory, emphasizing the importance of layout analysis for improving the organization and efficiency of operational spaces.

Previous studies have also combined layout redesign with simulation techniques to evaluate the expected impact of proposed changes before full implementation. Kasemset et al. (2023) applied simulation to improve the plant layout of a ceramic factory and achieved a reduction in total transportation distance, demonstrating that layout redesign can reduce unnecessary movement and improve process flow. This is relevant for warehouse operations because excessive movement between areas increases preparation time and contributes to delays in order fulfillment. Khairuddin and Zainuddin (2019) also addressed warehouse network redesign through simulation-based strategies, showing that layout and network decisions can influence warehouse efficiency. These studies support the application of SLP in the present research, where high transfer time between activities was identified as one of the main causes affecting OTIF performance.

In addition to inventory organization and layout design, error prevention is essential for improving delivery accuracy. Poka-Yoke is a lean tool focused on preventing human errors before they generate defects or operational failures. Lazarevic et al. (2019) conducted a systematic literature review of Poka-Yoke and highlighted its role as a mechanism for preventing mistakes through simple, practical and preventive solutions. In production and service environments, Poka-Yoke can be implemented through visual controls, checklists, guides, physical devices or verification systems that reduce the probability of incorrect actions. For warehouse operations, this tool is particularly useful in picking and order assembly, where mistakes in product selection, packaging or configuration can lead to incomplete or incorrect deliveries.

Lean tools have also been applied in operational processes to reduce waste, improve flow and increase process reliability. Santos et al. (2023) implemented lean tools, including Poka-Yoke, in an upholstery manufacturing process and reported reductions in waste and cycle time. This supports the idea that error-prevention systems and visual control mechanisms can improve operational consistency and reduce process variability. Guo et al. (2018) also used value stream mapping to analyze process flow, showing that lean-based analysis can help identify inefficiencies and guide improvement actions. Although these studies were developed in different operational contexts, their findings are applicable to warehouse processes because picking and order assembly require accuracy, standardization and continuous flow.

The literature also suggests that the isolated application of improvement tools may solve specific problems, but integrated models can generate broader operational benefits. ABC Analysis improves inventory organization and product accessibility; SLP reduces unnecessary movement and improves the physical flow of activities; and Poka-Yoke reduces errors through preventive controls and standardized procedures. Ramos-Valle et al. (2022) demonstrated that combining different improvement tools can increase service levels in a spare parts trading company, while Santos et al. (2023) showed that lean tools can generate measurable improvements when applied to operational processes. In this sense, the integration of ABC Analysis, SLP and Poka-Yoke offers a complementary approach to address the main causes of low OTIF: product search delays, excessive transfer time, picking errors and order assembly errors.

From the perspective of validation, simulation and numerical analysis are important because they allow researchers to compare current and improved scenarios using measurable indicators. Kasemset et al. (2023) used simulation to evaluate layout alternatives and quantify operational improvements, while Rodriguez et al. (2023) emphasized the value of layout evaluation for supporting industrial decision-making. In the same line, the present study uses Arena simulation and operational indicators to validate the expected impact of the proposed improvements. This is consistent with the requirement for numerical and graphical results in industrial engineering research, where improvement proposals must be supported by data rather than only descriptive analysis.

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3. Methods

This study followed a quantitative, non-experimental and cross-sectional research design, focused on improving warehouse and logistics operations in a lubricant distribution company. The methodological approach aimed to identify the operational causes of low OTIF performance, select appropriate industrial engineering tools and validate the proposed improvements through operational indicators and simulation.

The research was developed in four stages. The first stage consisted of diagnosing the current warehouse operation, identifying the main causes affecting OTIF through process observation, operational records and root-cause analysis, with emphasis on product search, internal transfer, picking and order assembly activities.

The second stage involved selecting improvement tools according to the identified causes. ABC Analysis addressed high product search time by reorganizing inventory based on rotation and priority, Systematic Layout Planning reduced transfer time by redesigning the warehouse layout, and Poka-Yoke minimized picking and order assembly errors through visual controls, working instructions and standardized procedures.

The third stage consisted of designing the integrated improvement proposal. Products were classified into A, B and C categories to prioritize accessibility, the warehouse layout was optimized to reduce unnecessary movements, and Poka-Yoke mechanisms were incorporated into the order preparation process to prevent errors before dispatch.

The fourth stage validated the proposed model using Arena simulation and operational indicators related to product search time, transfer time, picking errors and order assembly errors, allowing comparison between the current and improved scenarios and confirming the feasibility of the integrated model.

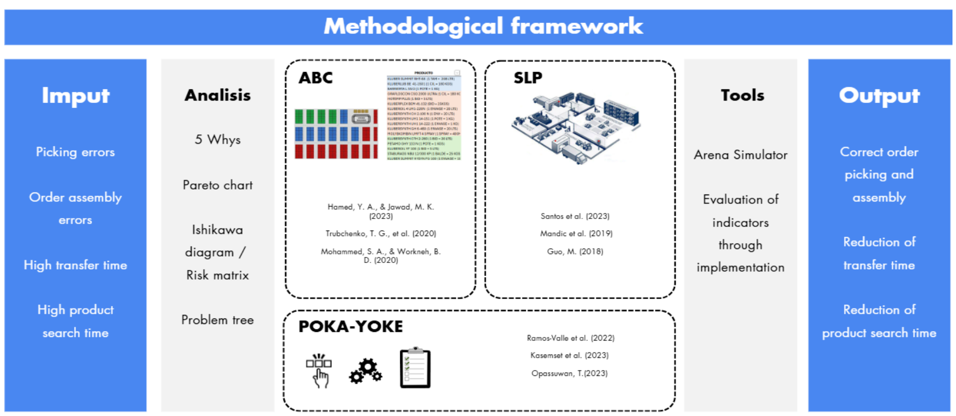

Figure 1. Methodological framework

Figure 1 presents the general framework of the proposed improvement model. The model links the main operational causes of low OTIF with the selected tools and shows how the proposal is validated through simulation and performance indicators.

4. Data Collection

The data collection process was carried out in the main warehouse of the lubricant distribution company. The information was obtained from internal operational records, direct observation of warehouse activities and time measurements collected during the order preparation and dispatch process. The data focused on the activities that had the greatest impact on OTIF performance: product search, internal transfer between activities, picking and order assembly.

The unit of analysis was the customer order processed in the warehouse. Each order was considered as an operational event that passed through the main stages of the logistics process, including order reception, order assignment, forklift preparation, product search, picking, order preparation, order confirmation, product loading, internal transfer and final delivery. This approach made it possible to identify the activities that generated delays, errors or incomplete deliveries.

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The initial diagnosis considered the company's OTIF performance during the evaluated period. The company processed 1,425 orders, of which 1,339 were complete and 1,367 were delivered on time. Based on these values, the initial OTIF level was calculated as 90.14%, compared with the sector reference value of 95%. This difference represented a technical gap of 4.86%, confirming the need to improve the warehouse processes associated with order fulfillment.

The OTIF indicator was calculated using the following formula:

$$OTIF = \left(\frac{Complete\ Orders}{Total\ Orders}\right) \times \left(\frac{On\ Time\ Orders}{Total\ Orders}\right) \times 100$$

For the validation stage, the sample size was calculated using the finite population formula. The population considered for this stage was 1,176 orders. A confidence level of 95%, a margin of error of 5%, and success and failure probabilities of 0.5 were used to ensure a representative sample. The formula applied was:

$$n = \frac{Z^2 \times p \times q \times N}{e^2 \times (N-1) + Z^2 \times p \times q}$$

where N is the population size, Z is the confidence level coefficient, e is the margin of error, p is the probability of success and q is the probability of failure. Applying the formula, the required sample size was 290 orders. This sample was used to evaluate the operational behavior of the warehouse and compare the current scenario with the improved scenario (Table 1).

Table 1. Sample size calculation parameters

Parameter	Value
Population size (N)	1,176 orders
Confidence level	95%
Z value	1.96
Margin of error (e)	0.05
Probability of success (p)	0.5
Probability of failure (q)	0.5
Sample size (n)	290 orders

The operational data collected included the time required for each activity in the order management process. These data were necessary to characterize the current warehouse condition and to feed the simulation model. The current process showed the following times: order reception, 1.92 minutes; order assignment to the operator, 2.92 minutes; forklift preparation, 7.75 minutes; product search, 10.08 minutes; picking, 26.83 minutes; order preparation, 27.33 minutes; order confirmation, 4.42 minutes; product loading, 27.33 minutes; transportation to destination, 118.83 minutes; and transfer time between warehouse activities, 32.5 minutes. The total time of the order management process was 259.92 minutes (Table 2).

Table 2. Current process activity times

Activity	Time (min)
Order reception	1.92
Order assignment to operator	2.92
Forklift preparation	7.75
Product search	10.08

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Picking	26.83
Order preparation	27.33
Order confirmation	4.42
Product loading	27.33
Transportation to destination	118.83
Transfer time between warehouse activities	32.5
Total order management time	**259.92**

In addition to time measurements, error data were collected to determine the main causes of incomplete or delayed deliveries. The root-cause analysis identified four critical causes: picking errors, order assembly errors, high transfer time between activities and high product search time. Picking errors represented 39.58% of the recurrence, order assembly errors represented 20.14%, high transfer time represented 28.47%, and high product search time represented 11.81%. These values were used to prioritize the improvement tools according to their operational impact (Table 3).

Table 3. Root causes affecting OTIF performance

Root cause	Frequency	Percentage
Picking errors	57	39.58%
Order assembly errors	29	20.14%
High transfer time between activities	41	28.47%
High product search time	17	11.81%
Total	**144**	**100.00%**

The collected information was organized into operational indicators to compare the current condition with the proposed improvement. The main indicators were product search time, transfer time between activities, picking errors and order assembly errors. These indicators were selected because they were directly linked to the causes of low OTIF performance and could be measured before and after the proposed improvements (Table 4).

Table 4. Operational indicators used for the study

Indicator	Unit	Initial value	Purpose
OTIF level	%	90.14	Measure delivery compliance
Product search time	min	10	Identify delays in product location
Transfer time between activities	min	32.5	Measure internal movement inefficiency
Picking errors	No.	7	Identify product selection failures
Order assembly errors	No.	4	Identify preparation and packaging failures

It is important to clarify that the annual recurrence data were used to identify and prioritize the root causes of the problem, while the monthly error data were used as the baseline for the before-and-after comparison of the improvement proposal. This distinction allowed the study to combine a broader diagnostic view with specific operational indicators for validation.

Finally, the collected data were used as input for the Arena simulation model. The current scenario represented the original warehouse process, while the improved scenario incorporated the changes proposed through ABC Analysis and Systematic Layout Planning. The comparison between both scenarios allowed the evaluation of the expected impact of the improvement proposal on the main operational indicators before its full implementation.

5. Results and Discussion

The proposed improvement model generated positive operational results in the warehouse of the lubricant distribution company. The integration of ABC Analysis, Systematic Layout Planning and Poka-Yoke addressed the main causes

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of low OTIF performance: high product search time, high transfer time between activities, picking errors and order assembly errors. The results show improvements in both time-related and accuracy-related indicators, which are directly connected to complete and timely order fulfillment.

5.1 Numerical Results

Table 5 presents the operational indicators before and after the implementation of the proposed improvement model. The product search time decreased from 10.00 minutes to 7.36 minutes, representing a reduction of 26.40%. This improvement was mainly associated with the ABC Analysis, which reorganized products according to their rotation level and located high-demand items in more accessible areas. Although the target of 5.00 minutes was not fully reached, the reduction shows a relevant improvement in product location efficiency.

Table 5. Operational indicators before and after the improvement proposal

Indicator	Unit	Before	After	Variation (%)	Target
Product search time	min	10	7.36	26.40%	5
Transfer time between activities	min	32.5	15.78	51.45%	20
Picking errors	No.	7	0	100.00%	0
Order assembly errors	No.	4	0	100.00%	0

The transfer time between activities decreased from 32.50 minutes to 15.78 minutes, equivalent to a reduction of 51.45%. This result exceeded the target value of 20.00 minutes, which indicates that the warehouse layout redesign had a strong effect on the internal movement of operators and products. The improvement confirms that Systematic Layout Planning contributed to reducing unnecessary movements and improving the relationship between operational areas.

Regarding accuracy-related indicators, picking errors decreased from 7 to 0, while order assembly errors decreased from 4 to 0. Both indicators achieved a 100% reduction. These results were associated with the implementation of Poka-Yoke mechanisms, including visual controls, working instructions and standardized preparation configurations. This reduction is highly relevant because picking and order assembly errors directly affect whether orders are delivered complete and according to customer requirements. As a consequence of these operational improvements, the OTIF level increased from 90.14% to 95.8%, exceeding the sector reference value of 95%. This result shows that the proposed model contributed to closing the initial technical gap and improving the reliability of the company's order fulfillment process. The economic impact associated with the original low OTIF level was estimated at S/302,144.50, which reinforces the importance of reducing failures related to rescheduled orders, cancelled orders, penalties and additional logistics costs.

5.2 Graphical Results

The graphical results support the numerical findings by showing how the warehouse operation changed after the application of the proposed tools. Figure 2 presents the ABC matrix used to classify products according to their inventory rotation. Category A products represented 80% of the inventory rotation and were located in priority-access areas; Category B products represented 15% and were placed in intermediate zones; and Category C products represented 5% and were assigned to less critical locations. This classification allowed the company to reorganize the warehouse according to operational relevance and contributed to reducing product search time (Figure 3).

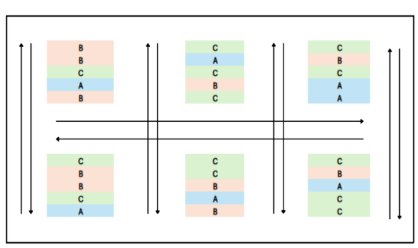

Figure 2. ABC Matrix (before)

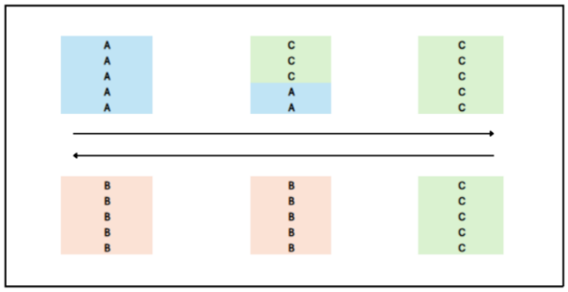

Figure 3. ABC Matrix (after)

Figure 4 and Figure 5 show the comparison between the current warehouse layout and the improved warehouse layout. The initial layout generated unnecessary movements between storage, quality, dispatch and maneuvering areas. After applying Systematic Layout Planning, the warehouse areas were reorganized according to operational relationships and frequency of interaction. This redesign contributed to reducing transfer time between activities from 32.50 minutes to 15.78 minutes.

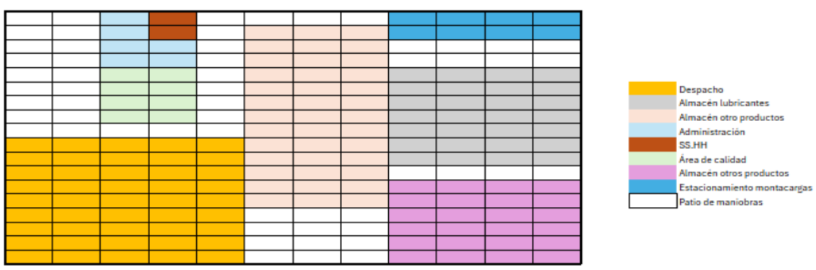

Figure 4. Systematic Layout Planning (before)

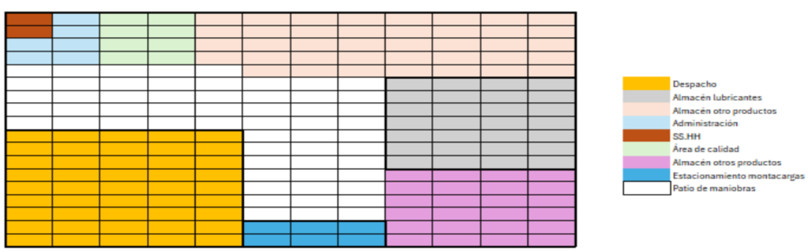

Figure 5. Systematic Layout Planning (after)

Figure 6 presents the standardized order preparation instructions used as part of the Poka-Yoke proposal. These instructions considered different pallet types, strap types and packaging orientations according to customer requirements. The visual and procedural controls helped operators prepare orders with greater consistency and contributed to the elimination of picking and order assembly errors.

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Jose Campos	Author Signature	30/10/2024
	Management Approval	30/10/2024
	Thecnical Approval	30/10/2024

Version: 5.0

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Figure 6. instructions used as part of the Poka-Yoke proposal

5.3 Proposed Improvements

Figure 7 presents the integrated improvement model for OTIF performance. The model starts from the main problem, which is the low OTIF level in the warehouse operation. This problem was associated with four critical causes: high product search time, high transfer time between activities, picking errors and order assembly errors. Based on these causes, the model assigns a specific improvement tool to each operational need. ABC Analysis addresses product search time, Systematic Layout Planning addresses transfer time between warehouse activities, and Poka-Yoke addresses picking and order assembly errors.

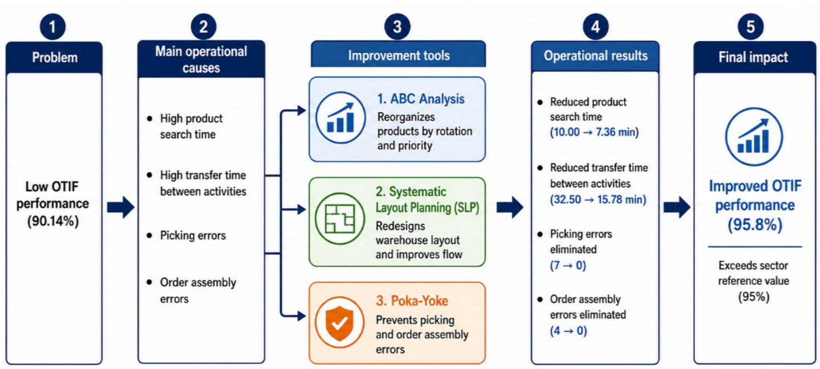

Figure 7. improvement model for OTIF performance

5.4 Validation

The validation of the proposed model was carried out through the comparison of the current scenario and the improved scenario. The current scenario represented the original warehouse operation, while the improved scenario incorporated the changes developed through ABC Analysis, Systematic Layout Planning and Poka-Yoke. Arena simulation was used to evaluate the effect of the proposed changes on the operational indicators related to product search time and transfer time between activities.

Figure 8 shows the Arena simulation model for the improved scenario. This model incorporated the changes generated through ABC Analysis and Systematic Layout Planning, allowing the comparison between the current process and the proposed scenario. The simulation was useful to evaluate the expected impact of the improvements before a broader implementation in the warehouse.

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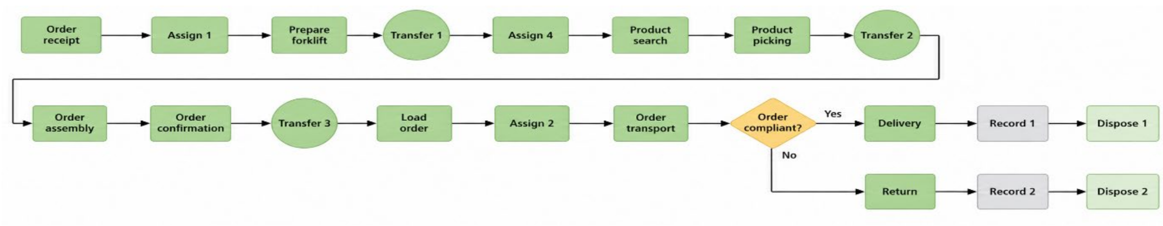

Figure 8. the Arena simulation model

Figure 9 presents the Arena simulation results. These results confirmed improvements in the main time-related indicators, especially product search time and transfer time between activities. The simulation output supported the feasibility of the proposed layout and inventory reorganization, since both changes reduced delays in the order preparation process.

Discrete-Time Statistics (Tally)

Project Name	Name	Type	Source	Average	Accr Half-Width	Overall StDev Across Replica	Min Replication Value
Unnamed Project	Search time	Time Between	User Specified	7.3604	5.69	10.8263	3.2461
	Transfer time	Time Between	User Specified	15.783	6.21	13.0289	13.8439
	Total Time	Time Between	User Specified	131.285	6.17	10.2367	125.0374

Figure 9. the Arena simulation results

The validation process considered a representative sample of 290 orders, calculated from a population of 1,176 orders with a 95% confidence level and a 5% margin of error. This sample supported the comparison between the initial warehouse performance and the improved scenario.

The results validated the effectiveness of the proposed model. Product search time was reduced by 26.40%, transfer time between activities was reduced by 51.45%, picking errors were eliminated and order assembly errors were eliminated. These results indicate that the proposed model improved both operational speed and order preparation accuracy. Since OTIF depends on delivering complete and timely orders, the reduction of delays and errors directly contributed to the increase of the OTIF level from 90.14% to 95.8%.

The economic validation also supported the feasibility of the proposal. The implementation budget was estimated at S/104,000, including the implementation of SLP, ABC Analysis, Poka-Yoke, supervisors and personnel training. The financial evaluation showed a Net Present Value of S/142,139, an Internal Rate of Return of 39% and a Benefit-Cost ratio of 2.37. These values indicate that the project is economically viable because the expected benefits exceed the implementation cost

6. Conclusion

This study demonstrated that the integrated application of ABC Analysis, Systematic Layout Planning and Poka-Yoke can improve OTIF performance in a lubricant distribution company by addressing the main operational causes of incomplete and delayed deliveries. The proposed model reduced product search time from 10.00 to 7.36 minutes, transfer time between activities from 32.50 to 15.78 minutes, and eliminated picking and order assembly errors. As a result, the OTIF level increased from 90.14% to 95.8%, exceeding the sector reference value of 95%.

The main contribution of this research is the integration of three industrial engineering tools into a single improvement model. ABC Analysis improved product accessibility, Systematic Layout Planning improved warehouse flow, and Poka-Yoke improved order preparation accuracy through visual controls and standardized procedures. Together, these tools addressed both time-related and error-related causes of low OTIF performance.

The study was limited to warehouse operations and did not include other stages of the supply chain, such as transportation routing or supplier performance. Future research could expand the model to other logistics processes, incorporate real-time monitoring technologies and evaluate advanced inventory management systems to strengthen OTIF performance over time.

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Biographies

Rafael Mauricio Villanueva Flores is an Industrial Engineer from Universidad de Lima and holds a Master of Science from Kansas State University. He currently serves as Operations Manager at Anita Food and is a professor at the Faculty of Engineering and Architecture of Universidad de Lima. He is an executive with extensive experience in managing industrial operations and has authored multiple publications related to the food industry.

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Rodrigo Campos holds a Bachelor's degree in Industrial Engineering from the University of Lima, with experience in commercial and logistics functions within the industrial sector. He began his professional career as a pre-professional intern in commercial support and logistics at Manuchar Perú, where he was involved in order management, coordination with internal teams, customer follow-up, and support of operational and commercial processes, contributing to supply chain efficiency and effective customer service.Currently, he works as a Commercial Advisor in the lubricants and industrial maintenance business line at Manuchar Perú, providing technical and commercial advisory services to industrial clients. His role focuses on identifying operational needs, developing tailored solutions, strengthening client relationships, and supporting the achievement of sales objectives, with a strong orientation toward value creation and customer satisfaction.He has academic training in process analysis and improvement, operational management, and logistics, and is characterized by his analytical mindset, adaptability, and strong communication skills. He seeks to continue developing professionally in industrial and commercial environments where he can integrate technical and strategic knowledge to contribute to organizational growth and competitiveness.