

Improving OTIF Performance Through SLP, 5S, and Demand Forecasting in a Commercial Warehouse Operation

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Abstract

This study proposes an integrated logistics improvement model aimed at increasing the On Time In Full (OTIF) indicator in a Peruvian company engaged in the commercialization and refurbishment of multifunction printing equipment. The initial diagnosis identified critical inefficiencies in warehouse organization, inventory planning, and facility layout configuration, which negatively affected service reliability and operational flow. The objective was to achieve an internal OTIF target of 76%. To address these issues, a sequential model integrating 5S methodology, ABC classification, demand forecasting, inventory policies through Material Requirements Planning (MRP), and Systematic Layout Planning (SLP) was implemented. Validation was conducted through a comparative before-and-after analysis complemented by process simulation. The results showed a significant improvement in OTIF performance, increasing from 50.9% to 77.8%. Overall, the proposed model proved effective in strengthening warehouse management, enhancing service performance, and contributing to sustainable operational practices.

Keywords

OTIF, SLP, MRP, 5S, Demand Forecasting

1. Introduction

The company under analysis belongs to the Peruvian tertiary sector, which accounts for approximately 60% of the national GDP, encompassing a wide variety of logistics and commercial activities that require high levels of operational efficiency (Banco Central de Reserva del Perú 2025; Instituto Nacional de Estadística e Informática 2023). In this context, the On Time In Full (OTIF) indicator has become an essential measure for evaluating service reliability and the ability of companies to meet delivery standards. However, the National Logistics Survey 2020 reported a national average OTIF of 59.8%, reflecting persistent gaps in warehouse organization, inventory control, and operations planning (Ministerio de Transportes y Comunicaciones 2023). In this context, the analyzed company recorded an average OTIF of only 50.9%, well below the national benchmark of 59.8% and far from its internal target of 76%, evidencing a significant performance gap that justified the need for improvement.

The company is dedicated to the commercialization and refurbishment of multifunction printing equipment. Its products undergo a maintenance and quality testing process before being delivered to customers to ensure proper operation. The most relevant sales category is refurbished equipment, which includes printing, scanning, and copying functions.

These difficulties are particularly evident in small and medium-sized enterprises in the technology sector, where dependence on manual processes, the absence of formal replenishment criteria, and the lack of structured space organization generate stockouts, extensive internal travel distances, and delays in order preparation (Panigrahi et al. 2024; Gunter 2021). Such limitations highlight the need to implement integrated improvement models that simultaneously address warehouse organization, inventory management, and the improvement of internal material flow.

The literature proposes various tools aimed at improving operational efficiency. The 5S methodology has been shown to contribute to restoring order, cleanliness, and standardization in the work environment (Shahriar et al. 2022; Espinoza-Camino et al. 2020). ABC classification enables the prioritization of products with the greatest operational impact (Özhan Doğan et al. 2024). Demand forecasting is key to reducing uncertainty in replenishment processes (Gunter 2021), while minimum–maximum inventory systems facilitate the control of adequate inventory levels to prevent stockouts and overstocking (Valdivia Alfaro et al. 2024). Finally, Systematic Layout Planning (SLP) constitutes a proven approach for optimizing warehouse layout and reducing travel distances (Kapou et al. 2024).

The justification for this study lies in the need for an integrated approach capable of simultaneously addressing the structural problems of the warehouse and the limitations of the replenishment system. Although the literature recognizes the potential of tools such as 5S, ABC classification, demand forecasting, minimum–maximum systems, and SLP to improve different aspects of logistics operations (Espinoza-Camino et al. 2020; Shahriar et al. 2022; Valdivia Alfaro et al. 2024; Gunter 2021; Salins et al. 2024), there is a lack of research integrating these tools within a sequential model specifically aimed at improving OTIF performance.

The operational hypothesis states that the combined application of these methodologies will significantly increase internal efficiency, inventory availability, and service reliability.

1.1 Objectives

General Objective:

To improve the company's warehouse and inventory management through the optimization of logistics process efficiency. The purpose is to improve the OTIF indicator and achieve a target of 76% by 2025.

Specific Objectives:

- Establish a warehouse cleaning and organization system through the implementation of the 5S methodology, with the objective of improving operational efficiency and reducing search times, while verifying compliance through checklists and internal audits.
- Reduce the average order picking and dispatch time through warehouse reorganization using engineering tools such as Systematic Layout Planning (SLP).
- Develop an inventory system that improves inventory management, control, and stock replenishment, ensuring the availability of key products and enabling the evaluation of improvements in inventory accuracy.
- Improve replenishment planning through the application of Demand Forecasting, enabling the evaluation of stockout reduction.

2. Literature Review

OTIF (On Time In Full) performance is often affected by deficiencies in warehouse organization, insufficient inventory controls, and inefficient internal flows, aspects identified in previous studies on logistics operations management in distribution companies (Valdivia Alfaro et al. 2024). These limitations occur more frequently in organizations that still depend on manual processes and operational structures with low levels of standardization, reducing the consistency of service performance (Panigrahi et al. 2024).

In response to these challenges, the literature proposes various methodologies aimed at improving warehouse efficiency, including 5S, ABC classification, demand forecasting, minimum and maximum inventory systems, Material Requirements Planning (MRP), and Systematic Layout Planning (SLP), whose contributions are reviewed in the following sections (Espinoza-Camino et al. 2020; Shahriar et al. 2022; Valdivia Alfaro et al. 2024; Gunter 2021; Salins et al. 2024). The OTIF indicator has been recognized as a comprehensive metric for evaluating distribution efficiency, as it combines timeliness and completeness into a single service performance measure (Tian et al. 2024).

2.1 5S

Available studies agree that the 5S methodology significantly contributes to improving order, cleanliness, and visibility within warehouses. Recent applications show that its implementation reduces search times, eliminates unnecessary material accumulation, and improves safety conditions in manufacturing and storage environments (Shahriar et al. 2022). In Latin American contexts, where heterogeneous inventories and limited storage spaces often coexist, the implementation of 5S has proven to be an effective initial tool for restoring operational control and facilitating the subsequent application of complementary methodologies (Espinoza-Camino et al. 2020). Furthermore, lean manufacturing progression models for small and medium-sized enterprises demonstrate that the structured adoption of practices such as 5S promotes continuous improvement and operational sustainability (Huang et al. 2022).

2.2 ABC Classification

ABC classification has become a key technique for prioritizing inventory based on consumption value and operational impact (Özhan Doğan et al. 2024). Its application has demonstrated improvements in picking efficiency, replenishment decision-making, and the utilization of available space, particularly in companies with high variability in product turnover (Valdivia Alfaro et al. 2024). Furthermore, studies highlight that ABC classification is particularly useful when implemented alongside physical organization tools, as it enables the assignment of strategic locations to items with the greatest operational importance (Özhan Doğan et al. 2024).

2.3 Demand Forecasting

Demand forecasting is a fundamental tool for planning replenishment in companies with variable replenishment cycles. Recent research has shown that low-complexity models, such as moving averages and their weighted variants, can provide adequate levels of accuracy in environments where data availability is limited (Gunter 2021). In turn, accurate forecasting helps reduce uncertainty, minimize stockouts, and avoid excess inventory, positively impacting service levels and OTIF performance (Gallego-García et al. 2021).

2.4 System of minimums and maximums

Inventory systems based on minimum and maximum levels are widely used in small and medium-sized enterprises due to their ease of implementation and low technological requirements. The literature demonstrates that their integration with ABC classification helps stabilize inventory levels and ensure the availability of critical products (Valdivia Alfaro et al. 2024). In environments with high demand variability, this system contributes to reducing stockouts and improving replenishment efficiency (Gallego-García et al. 2021). Likewise, recent systematic reviews confirm that effective inventory management directly influences the operational performance of small and medium-sized enterprises (Panigrahi et al. 2024).

2.5 Material Requirements Planning (MRP)

Material Requirements Planning (MRP) enables more accurate scheduling of replenishment needs based on projected demand. Several studies highlight its contribution to reducing emergency purchases, improving inventory planning, and increasing supply predictability (Sutrisno 2022). In addition, its combination with minimum–maximum systems improves synchronization between demand, replenishment, and inventory levels (Gallego-García et al. 2021).

2.6 Systematic Layout Planning (SLP)

Systematic Layout Planning (SLP) is a widely used methodology for redesigning warehouse layouts by considering flow relationships, proximity requirements, and space constraints. Recent studies report significant reductions in travel distances, movement times, and internal congestion following layout optimization (Espinoza-Camino et al. 2020; Salins et al. 2024). In warehouses with poorly structured layouts, the application of SLP improves operational flow, reduces unnecessary movements, and enhances the efficiency of storage and picking processes (Salins et al. 2024; Kapou et al. 2022).

3. Methods

The study was conducted under an applied and quantitative approach, using a before–after design to evaluate the effect of a logistics improvement model on warehouse performance. The dependent variables were the service level indicators: On Time, In Full, OTIF, Stockout Rate, 5S Compliance, and Travel Effort. The independent variables correspond to the six interventions applied in the model: 5S methodology, ABC classification, demand forecasting using WMA, minimum–maximum system, Material Requirements Planning (MRP), and Systematic Layout Planning (SLP).

3.1 Proposed model

The proposed model is based on four main components: the 5S methodology, ABC classification, the Responsible Purchasing Plan—which integrates demand forecasting, the minimum–maximum system, and MRP planning—and Systematic Layout Planning (SLP). These components work in an integrated manner to improve warehouse organization, prioritize critical products, prevent stockouts, and optimize the internal flow of materials. In addition, the model seeks to establish a sustainable operational culture that maintains order and efficiency over the long term. Figure 1 shows the sequence of these components and the steps required to achieve the objective of improving the OTIF indicator.

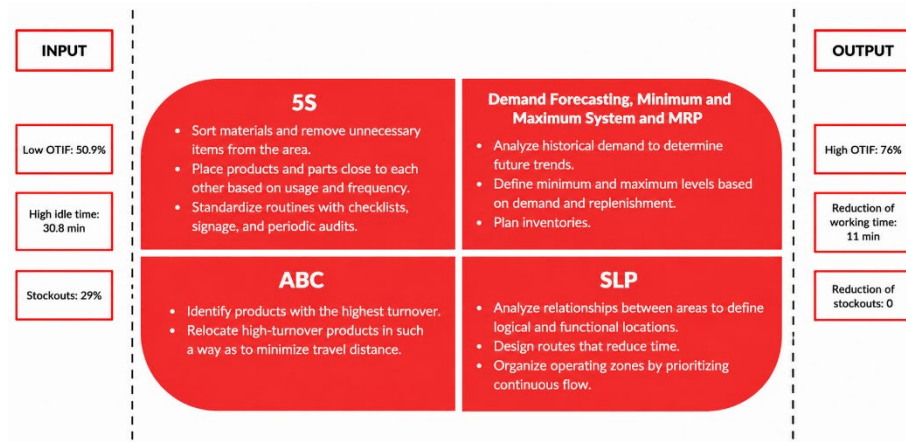


Figure 1. Proposed Model for OTIF Improvement

3.2 Model Components

5S Implementation: This component aimed to restore warehouse order, visibility, and cleanliness in order to reduce search times and picking errors.

Sort: Identification and removal of obsolete, discontinued, or non-value-added products using a classification form to determine whether items should be retained, relocated, or discarded.

Set in Order: Reorganization of useful products by assigning defined and accessible locations to improve visibility, accessibility, and optimize internal travel during picking activities.

Shine: Execution of deep cleaning activities throughout all warehouse areas following checklists and manuals that establish standards, responsibilities, and cleaning frequency by warehouse zone.

Standardize: Consolidation of routines and procedures through a visual management board integrating classification criteria, cleaning standards, assigned locations, and required controls.

Sustain: Implementation of weekly schedules and periodic audits using the technical 5S checklist to ensure sustainability and continuous compliance.

ABC Implementation: This component prioritizes inventory according to annual sales value and classifies products into categories A, B, and C. This classification made it possible to identify critical products and establish the basis for

warehouse redesign through SLP and for the Responsible Purchasing Plan by focusing replenishment and demand analysis on products with the greatest operational impact.

Responsible Purchasing Plan Implementation: This component integrated demand forecasting, the minimum–maximum system, and MRP to prevent stockouts and ensure the availability of A-category products. Using WMA, future demand was projected, specific minimum and maximum inventory levels were established, and through MRP these projections were translated into purchasing requirements adjusted to lead times, reducing emergency purchases and strengthening the In Full indicator.

SLP Implementation: This component optimized the warehouse layout to reduce travel times during picking and dispatch operations. Based on the ABC classification, flows and proximity relationships were analyzed to relocate A-category products to accessible areas and reorganize aisles and workspaces. SLP improved the On Time component of OTIF by reducing internal travel distances and streamlining material flow.

3.3 Indicators

To evaluate the impact of the model, the initial and final performance were compared using indicators of timeliness, completeness, and inventory availability:

$$On\ Time = \frac{Orders\ delivered\ on\ time}{Total\ orders} \times 100$$

$$In\ Full = \frac{Orders\ delivered\ in\ full}{Total\ order} \times 100$$

$$OTIF = On\ Time \times In\ Full \times 100$$

$$Stockout\ Rate = \frac{Number\ of\ stock\ failure}{Total\ demand\ during\ the\ period} \times 100$$

$$Effort = Distance\ traveled \times Weight\ transported$$

$$\% \ 5S\ Compliance$$

The combination of these indicators made it possible to comparatively evaluate the improvement achieved in terms of timeliness, accuracy, and availability, which are essential elements for warehouse performance and compliance with the OTIF indicator.

4. Data Collection

The study population consisted of all orders processed during the year 2024, working with the entire set of records without applying sampling. The analyzed portfolio was composed of 47 products, grouped into categories A, B, and C according to their sales value, on which the analysis of replenishment and availability was focused. Data collection was carried out using internal delivery records, compliance reports, historical demand from 2024, and field measurements of picking times, travel distances, and transported weight. For this purpose, operational instruments such as internal formats, checklists, visual dashboards, and technical records specific to the operation were used. Prior to analysis, the data were organized to ensure consistency, removing only incomplete or duplicate records and consolidating valid information on demand, inventory, and deliveries into standardized formats. As a baseline, the records indicated an average annual OTIF compliance of 50.9% during 2024, a figure that evidenced the low performance of the logistics process and served as a comparison point for the intervention.

Additionally, data corresponding to the post-implementation phase were collected: during six weeks, for each dispatched order, compliance with the On Time and In Full conditions was recorded. This information formed the basis for the subsequent calculation and comparison of indicators before and after the intervention.

5. Results and Discussion

5.1 Numerical Results

Table 1 presents the results of the validation of the 5S methodology, obtained through planned audits across five dimensions. The initial audit was conducted before the implementation of the tool to determine the baseline condition of the warehouse, while the intermediate audit was carried out during the staff training week, and a final audit was performed upon completion of the implementation. Average compliance increased from 7% to 83%, equivalent to an improvement of 76 percentage points. The cleaning dimension showed the greatest progress, reaching 84%, followed by order and discipline at 78% each, while classification and standardization exceeded 65%, reflecting the sustained adoption of organizational practices.

Table 1. Results of the 5S Validation

Dimension	Initial audit	Second audit	Final audit	Improvement (%)
Sort	8%	67%	83%	75%
Set in order	11%	67%	89%	78%
Shine	8%	83%	92%	84%
Standardize	7%	67%	73%	66%
Sustain	0%	78%	78%	78%
Overall average	7%	72%	83%	76%

Table 2 of the ABC classification presents the final segmentation of inventory into categories A, B, and C, which made it possible to identify the critical products involved in the initial stock shortages. Category A products represent 80% of the accumulated value despite accounting for only 21.3% of the portfolio (10 products), while categories B and C account for 15.2% (12 products) and 4.8% (25 products) of the value, respectively.

Table 2. ABC Classification

Classification	Number of products	Unit sold	Sales	% Cumulative
A	10	151	S/ 2,748,712	80%
B	12	87	S/ 523,622	95%
C	25	78	S/ 163,449	100%
Total	47	316	S/ 3,435,782	100%

Given their high impact on total value, Category A products receive the highest priority for control, monitoring, and replenishment. Table 3 details these ten products, ordered according to their accumulated sales value, showing that a small group of equipment—led by the Canon ImagePRESS C750 and C810 models—accounts for most of the inventory value.

Table 3. Class A Products

Products	Total quantity	Price	Quantity x price	%	% Cumulative	Classification
CANON IMAGEPRESS C750	42	S/ 24 052	S/ 1 010 166	29,4%	29,4%	A
CANON IMAGEPRESS C810	15	S/ 29 935	S/ 449 020	13,1%	42,5%	A
CANON IR ADVANCE C5550i	39	S/ 6 044	S/ 235 718	6,9%	49,4%	A
CANON IMAGEPRESS C710	6	S/ 32 910	S/ 197 459	5,7%	55,1%	A

IMAGEPRESS V700	2	S/ 86 025	S/ 172 050	5,0%	60,1%	A
CANON IMAGEPRESS C8000VP	3	S/ 51 979	S/ 155 937	4,5%	64,6%	A
CANON IR ADVANCE C5540i	31	S/ 4 807	S/ 149 002	4,3%	68,9%	A
CANON IR ADVANCE 8505i	5	S/ 27 274	S/ 136 370	4,0%	72,9%	A
CANON IMAGEPRESS 10000VP	3	S/ 44 351	S/ 133 052	3,9%	76,8%	A
IMAGEPRESS C850	5	S/ 21 987	S/ 109 937	3,2%	80,0%	A

To illustrate the development of the Responsible Purchasing Plan, the case of the leading A-category product, the Canon ImagePRESS C750, is presented. This product accounts for 29.4% of the inventory value. Based on demand forecasting using a weighted moving average, minimum, maximum, and safety stock levels were defined to govern its replenishment. Table 4 shows the resulting inventory policy for this product throughout the year.

Table 4. Inventory policy for the Canon ImagePRESS C750 2025

Concepto	Ene	Feb	Mar	Abr	May	Jun	Jul	Ago	Set	Oct	Nov	Dic
Demanda pronosticada	3	3	2	3	2	2	3	3	3	1	1	2
Stock de seguridad	4	3	1	4	2	1	5	3	2	2	2	1
Stock mínimo	12	8	3	11	6	3	14	9	5	6	5	3
Stock máximo	16	11	4	15	8	4	19	12	7	8	7	4

Inventory levels are dynamically adjusted to the forecasted demand for each month, rather than maintaining a fixed replenishment volume. The central objective of the Responsible Purchasing Plan is to ensure the supply of critical products, which is directly reflected in the stockout rate indicator. Before implementation, the company recorded a stockout rate of 33%, evidencing a high frequency of shortages due to the lack of replenishment criteria. After applying demand forecasting, the minimum and maximum policy, and MRP, the stockout rate was reduced to 0%, ensuring the availability of A-category products. The requirements resulting from this policy fed into the MRP calculation, which consolidates planned purchase orders (Table 5).

Table 5. Consolidated MRP of the ImagePRESS Family 2025

IMAGEPRESS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Set	Oct	Nov	Dec
Beginning inventory	22	36	29	22	33	27	21	47	39	30	22	21
Forecasted demand	5	7	7	10	6	6	7	8	9	8	1	4
Safety stock	10	8	4	12	6	3	13	9	6	7	3	2
Net requirements	2	0	0	2	0	0	5	0	0	0	0	0
Planned purchase	19	0	0	21	0	0	33	0	0	0	0	0
Ending inventory	36	29	22	33	27	21	47	39	30	22	21	17

Finally, Table 6 presents the indicators before and after the implementation of the model in a consolidated manner, allowing a comprehensive evaluation of the model's effects on the On Time, In Full, OTIF, Stockout Rate, 5S Compliance, and Logistics Effort components.

Table 6. General Implementation Results

Indicator	Before implementation	After implementation	Improvement
% On Time	61.40%	86.1%	+24.7%
% In Full	82.90%	91.7%	+8.8%
% OTIF	50.90%	77.6%	+26.7
Stockout rate	33%	0%	+33%
5S Compliance	7%	83%	76%
Logistics effort	723 214 kg·m	395 357 kg·m	45.3%

5.2 Graphical Results

The 5S radar chart in Figure 2 shows the improvement achieved in warehouse organization, cleanliness, and standardization, demonstrating a more organized environment aligned with the defined operational routines. The comparison between the initial and final audits visually confirms the improvements reported in Table 3.

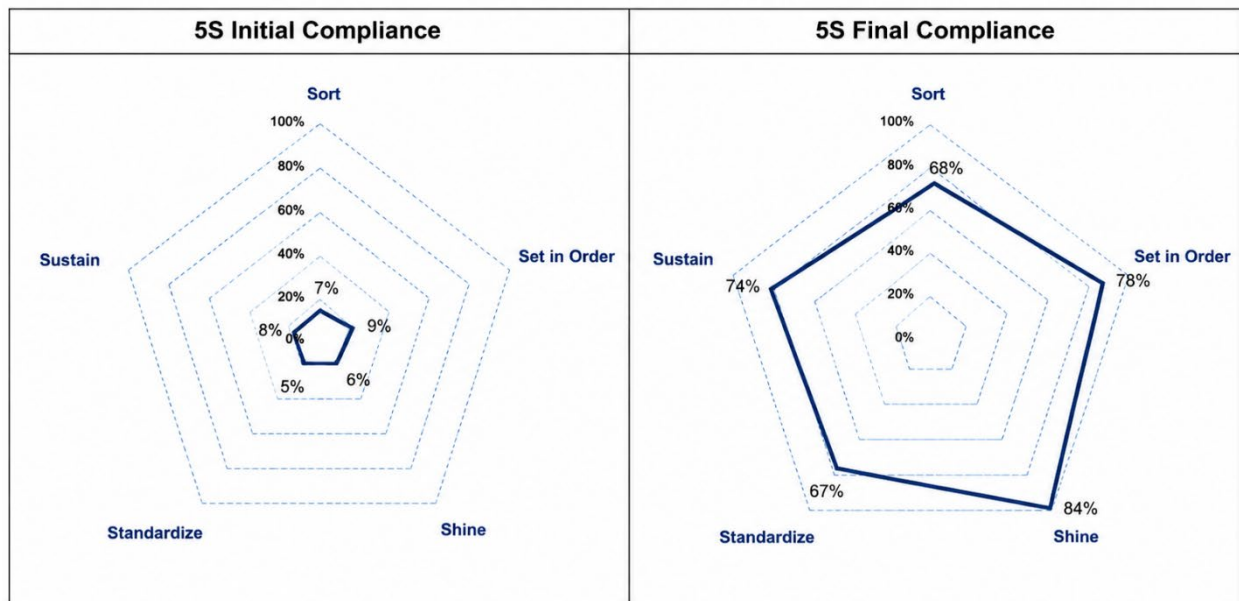


Figure 2. Comparison of the Radial Diagram.

Comparison of the 5S compliance radar chart Figure 3 presents the new warehouse layout obtained through Systematic Layout Planning (SLP). The redesign prioritized placing the highest-turnover products closer to work and dispatch areas, reducing unnecessary travel distances. As a result, the total travel distance was reduced from 1,125 m to 615 m, and logistics effort decreased from 723,214 kg·m to 395,357 kg·m, equivalent to a reduction of 45.3%.

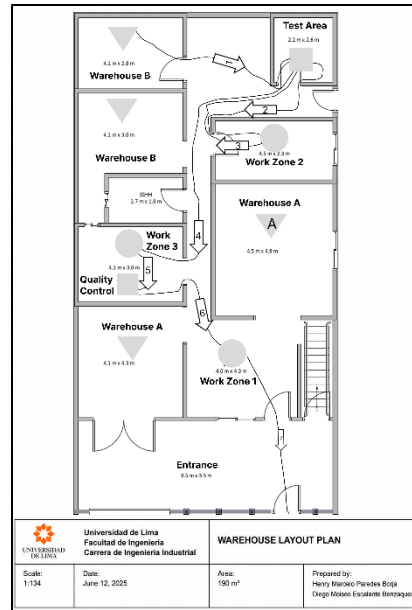


Figure 3. Flowchart after SLP implementation

5.3 Proposed Improvements

In the current operation, demand forecasting and inventory policy calculations are performed manually by an operator using Excel spreadsheets, creating dependency on personnel, increasing the risk of data entry errors, and causing delays in information updates. The proposed improvement is to automate the spreadsheets through macros and dynamic formulas, allowing forecasts and minimum and maximum inventory levels to be recalculated automatically based on demand. This would reduce the time and costs associated with manual work, eliminate calculation errors, and decrease reliance on a single individual.

5.4 Validation

The validation of the model was carried out by comparing warehouse performance before and after implementation based on the defined service level indicators. The results obtained allow verification of the operational hypothesis, which states that the combined application of methodologies increases internal efficiency, inventory availability, and service reliability.

The OTIF indicator increased from 50.9% to 77.8%, exceeding the internal target of 76%, as a result of the simultaneous improvement of its components: On Time, which increased from 61.4% to 86.1%, and In Full, which increased from 82.9% to 91.7%. Likewise, stockouts were completely eliminated, 5S compliance reached 83%, and logistics effort was reduced by 45.3%, confirming the positive effect of the model on the set of indicators.

As a complementary validation, the logistics process was simulated under the initial and proposed scenarios. The simulation showed that order fulfillment increased from 55% to 100%, the stockout rate decreased from 18% to 0%, and the average processing time per order was reduced, confirming a more stable and consistent service flow compared to the initial scenario. These results reinforce the improvement observed in physical and operational intervention (Figure 4).

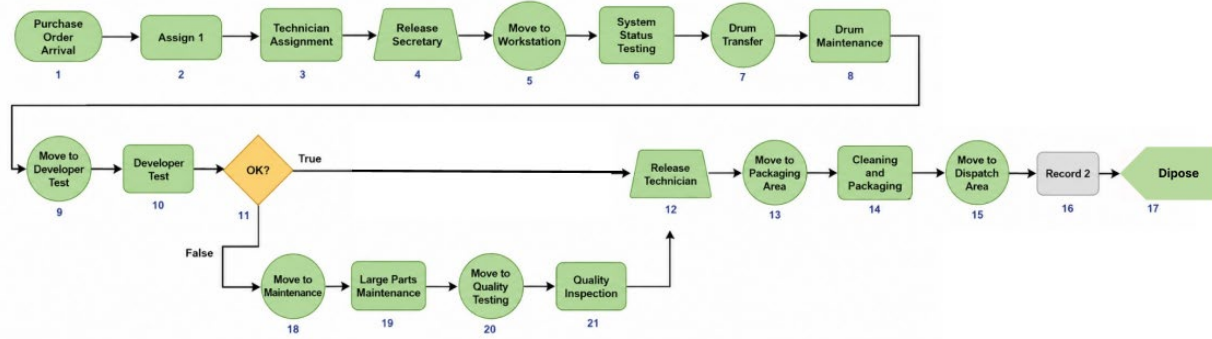


Figure 4. Logistics Process Simulation Model

6. Conclusion

The present study designed and implemented an integrated model that combines the 5S methodology, ABC classification, demand forecasting, minimum and maximum inventory system, MRP, and Systematic Layout Planning (SLP) to improve the performance of the OTIF indicator in a commercial warehouse. In relation to the proposed objectives, the main conclusions are:

- The general objective was achieved, as the OTIF indicator increased from 50.9% to 77.8%, exceeding the internal target of 76% and confirming the effectiveness of the integrated model.
- Through the implementation of the 5S methodology, the warehouse organization and cleanliness compliance improved from 7% to 83%, reducing search times and establishing a more orderly and standardized work environment.
- The warehouse reorganization using Systematic Layout Planning (SLP) reduced the logistics travel effort by 45.3%, contributing to shorter order picking and dispatch times.
- The inventory system based on demand forecasting, minimum-maximum policies, and MRP ensured the availability of key products, reducing the stockout rate from 33% to 0%.
- The main contribution of the study lies in integrating these tools within a sequential improvement framework rather than applying them individually, demonstrating that this approach is applicable to companies facing similar logistics challenges. As future work, the model can be strengthened through the automation of processes currently performed manually—such as demand forecasting, inventory policy management, and stock control through barcodes and an inventory management system.

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