

Implementation of a Layout Design to Improve Storage Processes in a Raw Material Warehouse

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DOI: <https://doi.org/10.51584/IJRIAS.2026.11090013>

Received: 22 September 2026; Accepted: 27 September 2026; Published: 30 September 2026

ABSTRACT

This study analyzes the implementation of a layout design in a raw material warehouse with the aim of improving storage and order preparation processes. The project was developed through a diagnosis of the initial state, the application of the 5S methodology, the ABC inventory classification, and the redesign of the distribution using Systematic Layout Planning (SLP) principles. Information was collected through interviews with the personnel involved, process observations, a 5S checklist, inventory analysis, and before-and-after measurements. For order preparation, the project reports ten observations over ten working days in the initial and post-intervention measurement tables. The mean order-preparation time decreased from 105 ± 10.0 minutes ($n=10$) to 40 ± 5.7 minutes ($n=10$), equivalent to a 61.9% reduction. Travel distance decreased from 71 to 45 meters, corresponding to a 36.6% decrease; these distances are reported as total process-route values in the process-analysis diagrams, and repeated distance observations were not provided in the source project. The 5S order-and-cleanliness score increased from 23% to 94% using a weighted nine-item checklist. The new layout incorporated demarcated zones, storage systems, and material positioning based on inventory value and turnover. The results describe the changes observed in the analyzed warehouse and should not be interpreted as evidence that the same magnitude of improvement will occur in other warehouse environments.

Keywords: Layout, 5S, ABC classification, SLP, warehouse, logistics.

INTRODUCTION

Warehouse management constitutes a critical activity for logistical performance, as the physical arrangement of materials directly influences travel distances, preparation times, product identification, and space utilization. In the analyzed project, a raw material warehouse was identified as having severe distribution problems, accumulation of materials, lack of clearly defined locations, and excessive times required to prepare orders.

The operational issue was linked to the absence of a structured storage method, insufficient shelving, the mixing of raw materials with tools, and the lack of clearly designated areas for specific operations. The project measured order-preparation activities over ten working days. The initial time table contains ten total cycle observations, with a mean of 105 minutes and a sample standard deviation of 10.0 minutes. The associated process-analysis diagram reports a total travel distance of 71 meters. The source project also describes measurements in morning, midday, and afternoon time windows, but it does not report separate observation counts or distance values for each time window.

Based on this situation, the implementation of a layout design supported by 5S, ABC classification, and Systematic Layout Planning (SLP) was proposed to organize the warehouse, improve material flow, and reduce the times and distances associated with order preparation.

The objective of this work was to implement a layout design in a raw material warehouse to improve storage processes, prevent material losses, and reduce search times. The scope of the study includes the diagnosis, physical intervention, and comparison of indicators before and after implementation.

Background And Related Work

Logistics integrates activities related to storage, material handling, inventories, transportation, and information; therefore, the physical organization of a warehouse should facilitate material flow and reduce unnecessary movements [1], [2]. In this regard, the internal distribution or layout makes it possible to define the location of areas, equipment, aisles, and materials according to the characteristics of the operation [3], [5].

ABC classification was applied using the inventory price information, ordered from highest to lowest and evaluated according to the accumulated percentage. The project classified 336 inventory items into three groups: 9 items in category A, representing 78.55% of the reported turnover; 54 items in category B, representing 16.12%; and 273 items in category C, representing 5.33%. For the layout, high-demand category-A materials were positioned as close as possible to the loading and unloading areas, category-B materials were assigned intermediate positions, and lower-priority category-C materials were placed in less critical locations. The project also relocated steel, PPR, and PVC pipes and unicanal/rod profiles into racks and shelving according to their turnover.

The 5S methodology was implemented through a nine-item checklist covering the conditions evaluated in the warehouse. Each criterion was recorded as compliant or non-compliant, coded as 1 or 0, respectively. The checklist assigned weights of 20%, 15%, 10%, 10%, 10%, 10%, 10%, 10%, and 5%, which together total 100%; the overall 5S score was obtained by summing the weights of the compliant criteria. The initial checklist produced a score of 23%, while the post-intervention checklist produced 94%. The implementation also included red-tagging of unnecessary items, identification labels, racks and shelving, a daily cleaning program, and standardized tasks.

Systematic Layout Planning (SLP) was used to structure the general distribution plan and the physical flow of the warehouse. The project adopted a U-shaped flow, unified receiving and dispatching at the front area, established a central circulation aisle, separated the warehouse from the workshop, removed materials that obstructed circulation, and created defined workstations for order preparation, labeling, and document validation. Location decisions were therefore based on process flow, material turnover, access to receiving and dispatch areas, available space, obstruction removal, and safety conditions, in combination with the ABC classification.

MATERIALS AND METHODS

The study corresponds to an applied intervention in a raw material warehouse at a construction project in León, Guanajuato, Mexico. The procedure was developed in six stages: data collection, current-state analysis, application of 5S, ABC classification, layout design based on SLP principles, and post-intervention measurement. The measurement protocol documented ten working days of order-preparation observations in the initial and final time tables. The project additionally describes observation periods in the morning, midday, and afternoon, although the available tables summarize ten observations per condition rather than providing separate results for each time period.



Fig. 1. General stages of the methodology used in the project.

Information was collected through interaction with the general manager and those responsible for purchasing and warehousing. The operational personnel directly involved in warehouse activities were also considered: six warehouse workers and the warehouse supervisor. For order preparation, the project monitored the process for ten working days. The initial time table contains ten cycle observations, and the final table contains ten post-intervention observations. The initial values listed in the project total 113, 88, 114, 118, 101, 96, 111, 107, 93, and 109 minutes, producing a mean of 105 minutes and a sample standard deviation of 10.0 minutes. The post-intervention values total 42, 37, 35, 32, 40, 41, 42, 48, 49, and 34 minutes, producing a mean of 40 minutes and a sample standard deviation of 5.7 minutes. The project does not provide repeated daily measurements of travel distance; therefore, variability for that indicator is not reported.

A 5S checklist was applied before and after the intervention. The checklist contained nine evaluated criteria, each coded as compliant (1) or non-compliant (0), with criterion weights totaling 100% (20%, 15%, 10%, 10%, 10%, 10%, 10%, 10%, and 5%). The resulting score was the sum of the weights corresponding to compliant criteria. The initial score was 23% and the final score was 94%. Inventory turnover analysis and ABC classification were also performed. Based on the annual inventory price information, items were ordered from highest to lowest and classified using their accumulated contribution. The resulting categories were 9 A items, 54 B items, and 273 C items. These results were then used to define storage priorities and locations.

The design stage considered the separation between the warehouse and workshop areas, the incorporation of racks and shelving, the delimitation of workstations, the establishment of a U-shaped flow, and the organization of materials according to their turnover and ABC category. Category-A materials were positioned near loading and unloading areas, while B and C materials occupied intermediate and lower-priority positions. The project also relocated materials that obstructed circulation, established a central aisle, and created specific areas for order preparation, labeling, and document validation. Finally, order-picking time and the process-route distance were documented before and after implementation, together with the weighted order-and-cleanliness indicator.

RESULTS AND DISCUSSION

The intervention produced changes in the physical distribution and organization of the warehouse. The previous distribution presented materials located without a clearly defined sequence and mixed work areas. After the intervention, differentiated zones were established and materials were reorganized according to their turnover.

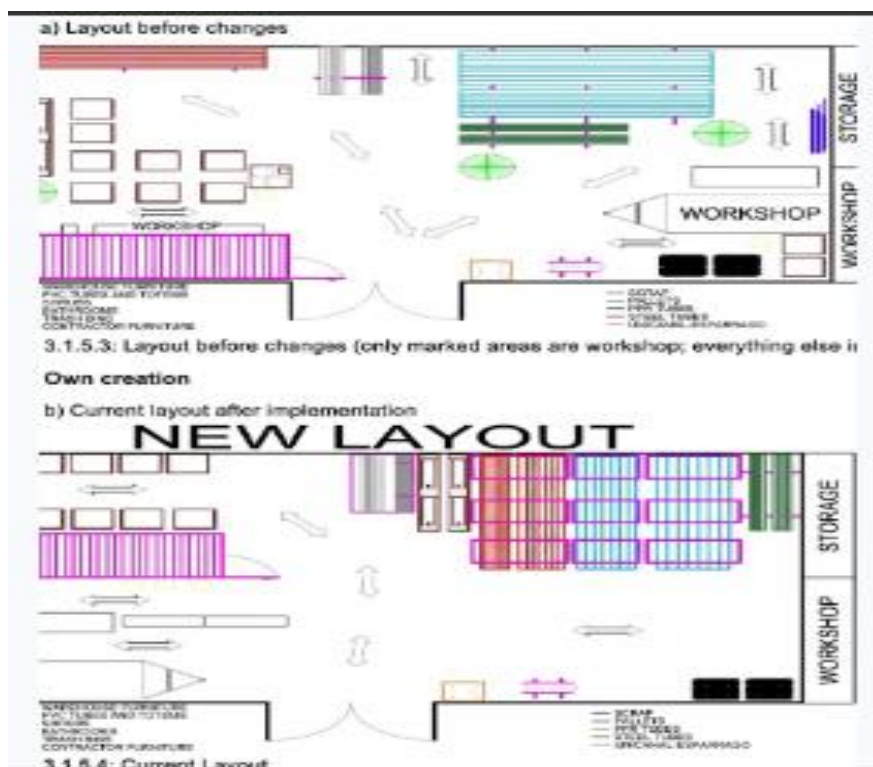


Fig. 2. Comparison of the warehouse layout before and after implementation.

Fig. 2 shows the change in the spatial configuration. The proposal freed circulation areas, concentrated high-demand materials near the loading and unloading areas, and established specific spaces for order preparation. According to the project, flammable materials were also relocated and an area for waste was delimited.

Table I. Performance Indicators Before And After Implementation

Indicator	Before	After	Change
Order preparation time	105 min	40 min	61.9%
Travel distance during order preparation	71 m	45 m	36.6%
Order and cleanliness	23%	94%	71 percentage points

The quantitative indicators show that the mean order-preparation time decreased by 65 minutes, from 105 ± 10.0 minutes ($n=10$) to 40 ± 5.7 minutes ($n=10$), corresponding to a 61.9% reduction. Travel distance decreased from 71 to 45 meters, a 26-meter or 36.6% reduction. The source project does not provide repeated daily distance measurements, so a mean or variability measure cannot be calculated for this indicator. For order and cleanliness, the weighted 5S checklist score increased from 23% to 94%, an increase of 71 percentage points. The 24.46% improvement value appearing in the original project table is not retained because its calculation is not defined and is inconsistent with the reported before-and-after scores.

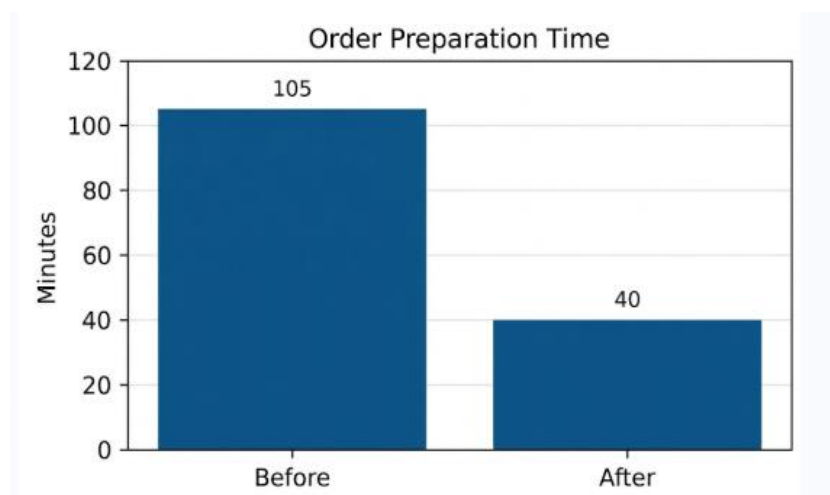


Fig. 3. Order-picking time before and after implementation.

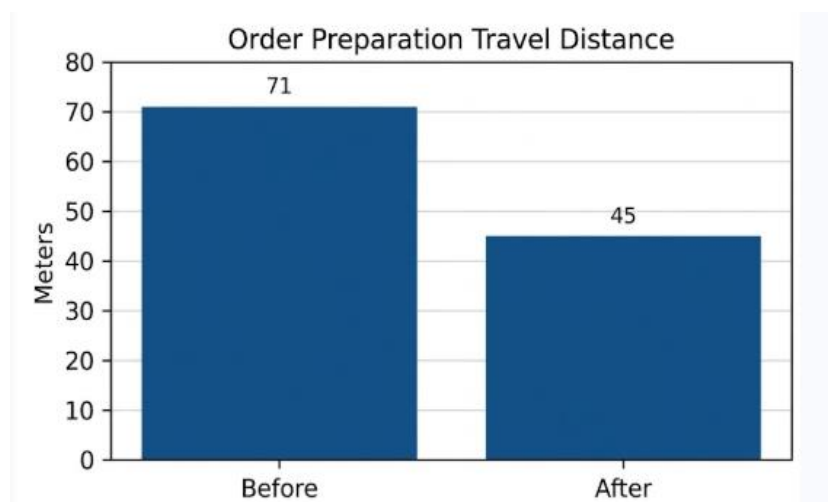


Fig. 4. Travel distance during order preparation before and after implementation.

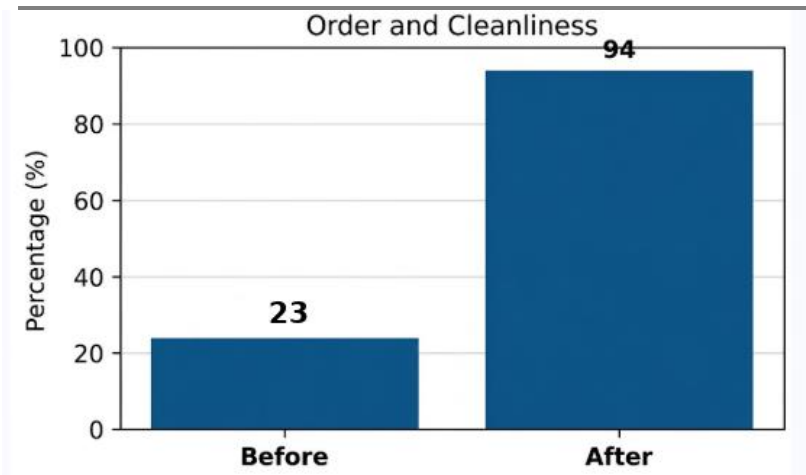


Fig. 5. Order-and-cleanliness indicator before and after implementation.

The reduction in preparation time is consistent with the physical reorganization reported in the project: products were identified and located according to turnover and ABC category, while order-preparation areas were delimited and circulation was improved. The reduction in travel distance is associated with the assignment of storage locations, the U-shaped flow, the central circulation aisle, and the increased availability of unobstructed movement space. These relationships are interpreted as observations from this specific warehouse intervention rather than as proof of a universal effect of 5S, ABC classification, or SLP.

Qualitatively, the project reports that after implementation no unclassified products were found during inspections, inventory remained updated, and the volume of accumulated merchandise decreased through the incorporation of racks and improved control of incoming and outgoing materials. These observations are specific to the analyzed warehouse and implementation period; the project does not include a control warehouse or a comparison across different warehouse types, so transferability to other environments should be considered conditional on similarities in layout, demand, inventory profile, order characteristics, and operational constraints.

CONCLUSIONS

The implementation of the layout design, complemented by 5S, ABC classification, and SLP principles, modified the physical and operational organization of the warehouse analyzed. In this warehouse, the mean order-picking time decreased from 105 ± 10.0 minutes to 40 ± 5.7 minutes across ten observations in each measurement condition, while the reported process-route distance decreased from 71 to 45 meters. The intervention combined a U-shaped flow, defined workstations, racks and shelving, turnover-based positioning, and the separation of warehouse and workshop areas.

The weighted 5S checklist score increased from 23% to 94%, representing a 71-percentage-point increase. The findings document changes in the selected indicators after the intervention in the studied warehouse. They should not be generalized as a fixed expected improvement for other warehouses because the project did not test multiple sites or control for differences in demand, SKU mix, order profiles, available space, or operating constraints. Accordingly, the transferability of the approach should be evaluated case by case using the same type of baseline and post-intervention measurements.

To maintain the conditions achieved, the project recommends conducting periodic 5S audits, updating the ABC analysis every six months, integrating layout location codes into the ERP/SAP system, and continuing personnel training in safety and operation of material-handling equipment.

ACKNOWLEDGMENT

The participation of the warehouse personnel and the organizational staff who facilitated information collection and implementation of the actions described in the project is acknowledged.

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