

Process Improvement and Reduction of Unproductive Time in a Manufacturing Company in Southern Sonora by Applying the 5S Methodology under a Lean Manufacturing Approach

María del Pilar Lizardi Duarte¹, Ernesto Ramírez Cárdenas², Héctor David Nieblas Valenzuela³, Ernesto Alonso Vega Telles⁴ and Julio Cesar Navarro Moreno⁵

Department of Industrial Engineering, Technological Institute of Sonora, Mexico

Abstract: This research aimed to develop improvement actions for the organization and flow of the process in the area under study, impacting operational efficiency and reducing unnecessary time in an automotive company in Sonora, using a lean manufacturing approach. The study arose from the identification of operational deficiencies related to space allocation, material flow, and unnecessary movements that affect process efficiency within the organization. The methodology employed was based on the 5S methodology and the lean manufacturing approach, allowing for the development of improvement actions focused on controlling process flow and eliminating movements that do not add value to the process. The results validated the effectiveness of the implemented improvement actions. Applying the 5S methodology transformed the area's operating conditions by reducing unproductive time per cycle by 70.91%. Final audits showed an increase in compliance with order and cleanliness standards, moving from critical conditions to outstanding levels in the Sorting and Setting phases. Safety risks related to materials handling were mitigated, creating a safe and efficient work environment.

Keywords: Process improvement, unproductive time, and lean manufacturing.

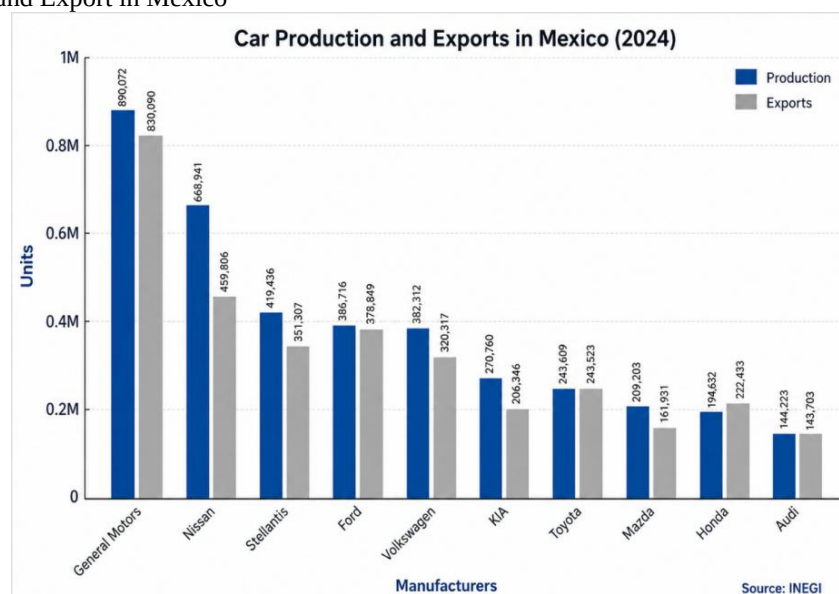
Introduction

Production sectors are areas in which economic activities are classified according to the type of production process. These are classified into three or more types, the main ones being the primary, secondary, and tertiary sectors. The secondary economic sector, called the manufacturing sector, focuses on the transformation of raw or intermediate materials into goods; this sector includes industries such as automotive, electrical, chemical, and food production and processing.

In Mexico, there are a large number of manufacturing sectors that are a fundamental part of the economy. Among the most prominent are the automotive, machinery and equipment, and metal industries, as well as the food, beverage, and tobacco production sectors, which have accounted for more than 60% of the manufacturing Gross Domestic Product (GDP) in recent years. (Romero, 2025)

OICA (2024) indicates that the automotive industry is one of the most important sectors worldwide due to its capacity to generate employment, innovation, and economic value. In 2023, more than 93 million vehicles were manufactured worldwide. It is estimated that this industry generates between 8 and 9 million direct jobs, in addition to more than 50 million indirect jobs related to suppliers, logistics, and services. Many governments have made strengthening the automotive industry a priority, recognizing its role in economic development, innovation, and job creation.

According to a study by the Mexican Automotive Industry Association (AMIA) (2022), Mexico has 20 assembly plants for light duty vehicles (Light Duty) Vehicles, LDVs / cars and trucks). Figure 1 shows the location of assembly plants in Mexico by federal entity.



The automotive industry in Mexico is a pioneer of competitiveness in the regions where it has established itself, which translates into more skilled, better-paid jobs and greater development of human capital. On average, wages in the automotive assembly industry in Mexico are 2.1 times higher than those in other manufacturing sectors (Ministry of Economy, 2014).

There are a number of companies in the automotive sector that stand out for their participation in the manufacture of electrical, electronic and interior components for vehicles; these companies are part of global supply chains that supply major automakers such as Toyota, Ford, General Motors, Honda, Mazda, Nissan and Volkswagen.

This project focuses on the analysis and improvement of an area within an automotive manufacturing company located in the north of the country, dedicated to the production of electronic components and wiring for vehicles. The area under study exhibits operational deficiencies related to space allocation, material flow, and unnecessary movements that negatively impact process efficiency.

Table 4 presents inputs, internal outputs, customers, suppliers, and processes carried out in the area under study in a SIPOC diagram.

Table 1
SIPOC of the area under study

Suppliers (S)	Tickets (YO)	Process (P)	Departures (EITHER)	Customers (C)
Raw material warehouse.	Production labels	1. Cut and strip cables.	Automotive circuits	Quality Department
	Component specifications	2. Insert retainers and seals.	Faulty circuits	Final assembly lines
Production control	Cables	3. Cut the mesh at both ends.	Inspection reports	Engineering Department
	Stamps	4. Strip the internal cable insulation at both terminals.	Scrap (Waste)	Store
Maintenance	Bushings	5. Insert bushings into both terminals.		
	Retainers	6. Press the bushing onto both terminals.		
Engineering Department	Terminals	7. Press terminal on both terminals.		
	Applicators	8. Perform final inspection.		
	Machinery			

The area under study for manufacturing the circuits has 12 production workstations and one final inspection station for the entire area.

The following have been detected in the area covered:

- A pattern of unnecessary movements between workstations, causing stops in the continuous flow.
- It is necessary to search for the deck to be worked on in its storage locations, which results in operational losses and continuous flow stops due to the unproductive time involved in carrying out these search activities.
- The flow of operations in the studied area is hampered by an inefficient storage system,
- Non-ergonomic material transfers and manual material searches are performed, activities that do not add value and result in unproductive time, decreasing efficiency and process flow.
- There is no specific order for identifying the components needed by operators such as seals, retainers, and bushings, requiring a search for the required component to find the correct one.

The company presents areas for improvement in the area to be addressed, which currently exhibits unnecessary movement and disorganization. The research question is:

How can the organization and process flow of the High Voltage area of an automotive company be improved to increase operational efficiency and reduce unnecessary time?

Therefore, the objective was set to: develop improvement actions for the organization and flow of the process in the area under study that impact operational efficiency and reduce unnecessary time.

Materials and Methods

Object of Study

The object under study in this research was the production process of an electronic components company in the automotive sector located in northern Mexico.

Materials

For the development of the research, computer tools, a waste identification form, a stopwatch for recording unproductive times, the ISO 45001:2018 and ISO 14001:2015 standards for the direct and standardized evaluation of safety risks and working conditions, documented information from the company such as plant layout plans and process flow diagrams, and Valdez's 5S checklist (2019) were used, which allowed for the collection of information, evaluation of compliance with requirements, and identification of areas of opportunity for organizational improvement.

Procedure

This section describes the steps of the established methodological route, which is based on the following principles: principles of the 5S methodology and the Lean Manufacturing approach proposed by Vargas Crisostomo & Camero (2021). The phases unfolded as follows:

1. Diagnose the current situation of the company. During the visit, using a stopwatch, a waste analysis form, a checklist for 5S diagnosis and Safety Conditions, unproductive times due to unnecessary movements, searching for materials and disorganization were recorded, establishing the baseline to quantify waste and determine the magnitude of the problem.
2. Establish safety improvements and address waste. The root causes of unproductive time and occupational hazards were identified to design solutions aligned with the 5S methodology, and to generate a work plan to guide the execution phase.
3. Train Staff in 5S. Training on the 5S methodology was carried out for all operational and supervisory staff in the area, focusing on raising awareness of the problems detected (unnecessary movements, disorder).
4. Implement the first three 'S's: Seiri, Seiton, and Seiso. In the Seiri (Sort) phase, the necessary was separated from the unnecessary, and items not used daily were removed. In the Seiton (Set in Order) phase, a place was assigned for each tool and material. In Seiso (Clean), a thorough cleaning was carried out, and responsibilities and cleaning frequencies were established.
5. Implement Improvement (Seiketsu and Shitsuke). This is to ensure the permanence of the changes and continuous improvement. In Seiketsu (Standardize), manuals and standard operating procedures were created for operators. In Shitsuke (Discipline), a system of periodic audits was implemented to ensure compliance with the standards.
6. Evaluate the Results and Comparative Analysis. Once the 5S methodology was implemented and maintained for a defined period, a second measurement of unproductive time was taken using the same analysis formats, comparing the data obtained with the baseline to quantify the improvements made.

Results and their Discussion

Following the established sequence in the procedure below, the results are presented:

1. Current situation of the diagnosed company.

Table 2 shows the results of the identification of molts in the area under study.

Table 2
Results of the time (Mudas) diagnosis by station

Season	Duration (Sec)	Observed Activity	Molt Classification
AND	10.54	Transfer to collect hammer	Transport
	25.53	Transporting the hammer to the container	Transport
	15.00	Search for materials (supplies)	Movement / Waiting
ESC	14.48	Transfer to collect hammer	Transport
	10.41	Transporting the hammer to the container	Transport

EST	16.69	Transfer to collect hammer	Transport
	14.76	Transporting the hammer to the container	Transport
IS	18.71	Transfer to collect hammer	Transport
	06.21	Transporting the hammer to the container	Transport
	20.00	Search for material (bushings)	Movement / Waiting
EB	07.87	Transporting the hammer to the container	Transport
EP	08.29	Transfer to collect hammer	Transport
	17.67	Transporting the hammer to the container	Transport
	25.00	Search for material (terminals)	Movement / Waiting
TOTAL	211.16	Total unproductive time per cycle	

Analysis of Table 2 reveals that waste is not uniform; stations E, ES, and EP are the most critical, presenting three areas of accumulated inefficiency. Specifically, station E, being the first station, results in a total loss of 51.07 seconds per cycle due to the sum of the two transfers (picking up and putting down bundles) plus the material search. Furthermore, the "Material Search" activity at stations EP and ES consumes an additional 20 to 25 seconds, time that could be completely eliminated with better organization (Seiton). The predominant waste classification is Transportation, due to the current physical layout, followed by Movement/Waiting due to the lack of order in the supplies.

After the checklist was applied to assess the status of the 5S methodology in the area. The findings are detailed in Table 3.

Table 3
Initial 5S Checklist Results

No.	ELEMENT TO BE EVALUATED	Spot (0-3)	Observations/Evidence
1. SEIRI (Sorting)			
1.1	Unnecessary materials, equipment, and documents have been identified and removed.	1	They have bags and papers that they don't need in the area
1.2	The materials in use are clearly differentiated from those that are not in use.	1	Materials in use are located closer to the work area, while those not in use are stored in the mini-warehouse.
1.3	Work areas are free of objects that do not add value.	2	Cell phones, scissors, and other tools from adjacent stations are found.
1.4	There is a procedure in place for disposing of obsolete materials.	0	
1.5	Inventory control is in place to prevent unnecessary accumulation.	0	
1.6	Waste is properly managed and segregated.	1	They throw everything in the same trash can
2. SEITON (Order)			
2.1	Every tool, piece of equipment, or material has a designated place.	0	
2.2	The corridors are signposted and free of obstructions.	2	They are signposted, but some have obstructions, such as the mini supply warehouse.
2.3	The storage areas have visible and understandable signage.	0	

2.4	The equipment and tools are organized for quick access.	2	They are placed in the work area for easy access, but they are not signposted.
2.5	Color coding or labels are used to identify materials.	0	
2.6	The documents have an organized and accessible filing system.	2	They are arranged inside a folder.
3. SEISO (Cleaning)			
3.1	The work area is kept clean at all times.	1	Only at the end of the shift, while cable shedding, mesh filaments and shims are found
3.3	There are scheduled daily and weekly cleaning routines.	2	At the end of the shift, the area is cleaned 5 minutes before the end of the shift.
3.4	There are designated personnel responsible for cleaning activities.	0	No, the same workers take turns, but nothing is standardized and there are discussions in the area .
3.5	Cleaning equipment available and in good condition.	2	They are available, but not in good condition
3.6	The floor, furniture, shelves and production/warehouse areas are kept clean.	1	5 minutes before the end of the shift , the area is cleaned; the mini supply storage area is not cleaned.
3.7	Equipment and tools are cleaned before and after use.	1	The equipment is only blown out with compressed air , but there is no cleaning.
4. SEIKETSU (Standardization)			
4.1	Clear rules have been established to maintain classification, order, and cleanliness.	1	The only cleaning rules are, one cleaning at the end of the shift
4.2	There are written procedures or visual instructions.	0	
4.3	Safety procedures are integrated into the 5S standards.	0	
4.5	Periodic internal 5S audits are conducted.	0	
4.6	There are performance indicators related to order and cleanliness.	0	
5. SHITSUKE (Discipline)			
5.1	Personnel consistently comply with the rules.	2	They don't really respect the rules, and the supervisor doesn't tell them off.
5.2	The staff demonstrate habits of order and cleanliness without needing reminders.	0	
5.3	There is a 5S training program for all workers.	0	
5.4	The supervisor reviews compliance with 5S.	0	
5.5	Employee participation in improvement proposals is encouraged.	2	The workers are informed that their improvements are important.
5.6	Public recognition is given to achievements in the implementation of 5S.	0	A 5S system is not in place.

Analysis of Table 3 reveals that the area lacks an organizational system. The Seiton (Order) and Shitsuke (Discipline) phases received the lowest scores (averages of 0.6), with criteria evaluated at zero. This confirms that the long search times are caused by the lack of designated places for tools and materials. Furthermore, the

absence of designated cleaning personnel (Seiso) and auditing personnel (Seiketsu) hinders the maintenance of order.

Finally, the safety conditions resulting from the disorder were assessed, revealing:

- There is adequate lighting, but in some stations it is necessary to have more lighting for visual inspections.
- In terms of ventilation, it has air conditioners, but on hot days it's not enough.
- Regarding storage areas with respected load limits, they are often found to be above the established limits.
- The containers for waste and recyclable materials are 9, which is insufficient.
- There is no accessible first aid kit.
- The workers have not received training in safety and emergencies.

The results show that the Materials Handling criterion was deficient due to the overload of inventory and lack of containers, which obstructs the flow; the Personnel Safety section is alarming where the lack of a first aid kit and specific training exposes workers to unnecessary risks, aggravated by the operational disorder detected.

2. Security improvements and established changes.

Strategies were designed to mitigate the detected waste and correct unsafe conditions, with an action plan based on the phases of the 5S methodology and attacking the root causes of unproductive times, see table 4.

Table 4
Action plan for the improvement of the High Voltage area

Problem Detected (Diagnosis)	Associated Change	5S Phase to Apply	Improvement Proposal (Action)
Excess of materials unrelated to the process (bags, papers, tools from other areas).	N/A (Disorder)	Seiri (Sort)	Implementation of a "Sorting and clearing" campaign to segregate and remove unnecessary items.
Searching for supplies (bushings, terminals) takes between 15-25 seconds due to lack of order.	Movement / Waiting	Seiton (Order)	Reorganization of the "mini warehouse" by assigning fixed locations and visual labels.
Excessive transfers up to 25 seconds in E to drop off/pick up decks.	Transport	Seiton (Order)	Bring the containers (bins) closer to the point of operation.
Accumulation of dirt and lack of responsibility.	N/A (Dirt)	Seiso (Clean)	Definition of a cleaning role and assignment of specific zones per operator.
Lack of standardization and monitoring.	N/A (Indiscipline)	Seiketsu / Shitsuke	Creation of visual aids and one-point lessons (OPL) to maintain the standard.

Focusing improvements on eliminating physical movements (Transportation) and micro-stops for searching (Movement/Waiting), seeking to optimize process flow.

3. Staff trained in 5S.

Training was conducted for operational and supervisory staff in the study area, covering the following topics:

- **Waste Identification:** Operators were instructed on how clutter impacts their daily fatigue and line efficiency.
- **Industrial Safety:** The relationship between order (Seiton) and accident prevention was reinforced.
- **5S Methodology:** The five principles were explained, with emphasis on their role and importance.

To ensure the understanding of theoretical concepts and their practical application, support was provided to ensure that human capital has the necessary knowledge to sustain the standards of the implemented 5S methodology.

4. Seiri, Seiton and Seiso actions executed.

This stage transformed the work environment with the sequential application of Sorting, Setting in Order, and Cleaning. To facilitate sorting, the "Sorting and Clearing Campaign" was implemented at workstations and in the intermediate storage area. During this campaign, items unrelated to the process that obstructed the flow were removed, such as:

- Tools not assigned to the station (scissors, scales, bags, vernier calipers, etc.).
- Obsolete documentation accumulated on the tables.
- Excess supplies (bushings, seals and retainers) that did not correspond to the production of the hub.

The result was the freeing up of space on work tables and the elimination of obstacles in corridors, facilitating the movement of operators.

To begin the Sorting phase (Seiri), hand tools and materials scattered across the work surface without a designated location, mixed with the work-in-process, were removed. Additionally, aisles with pallets and material handling equipment obstructing traffic were identified, confirming the need to separate essential items from temporary ones. Tables were found to be overloaded with tools unrelated to the process, and excessive materials had accumulated. By applying the sorting criteria and removing obsolete or unassigned items, a clear work surface was achieved, containing only the components required for immediate production and eliminating visual and physical obstacles that caused confusion.

Once the area was cleared, the organizational improvements designed to reduce search and transport waste were implemented, applying the following actions:

- a) Relocation of Bins:** The material bins were moved closer to stations E and ES, reducing the distance the operator had to travel. The existing storage rack was removed, eliminating the need to retrieve supplies such as bushings, seals, and retainers. The same bins were then placed directly below each station, eliminating the need to go to the rack and allowing the materials to be accessed directly from the station.
- b) "Mini Warehouse" Organization:** A fixed and exclusive location was assigned for each part number (bushings, seals and retainers).
- c) Visual Identification:** Labels with the name and code of the materials were placed on the front of each bin, allowing the operator to visually locate the supply in less than 5 seconds, eliminating the need to manually search through the boxes.

After clearing the area, the remaining items were organized according to the principle of "a place for everything and everything in its place," with the goal of eliminating search time (motion waste) through the implementation of visual controls. Standardized blue labels were placed on the front of each bin. These labels detail the component name and specific part numbers, allowing the operator to verify they are taking the correct material without having to manually check the contents.

This sorting strategy transformed the "mini warehouse" from an accumulation point to an efficient assortment system, where the location of each item is obvious and standardized.

A thorough cleaning was carried out, including the removal of accumulated dust from the rack structures and the cleaning of cable and tape debris from the floor. Unlike the previous surface cleaning, this activity aimed to identify sources of dirt. It was discovered that cable stripping and mesh cutting were generating waste that fell outside the trash containers, so their position was adjusted. With the implementation of these three phases, the area was prepared for standardization, exhibiting a clear visual and operational improvement.

5. Improvement actions (Seiketsu and Shitsuke) implemented

To prevent the area from reverting to its previous state of disarray, visual aids and simple controls were developed to make it easier for operators to maintain order. The following actions were implemented:

- a) Cleaning Standard:** Instructions were created and placed in the work methods folders of each station on "How the tidy station should look" and "Where each material goes", serving as a quick reference guide.
- b) Area Demarcation:** Visual aids (labels) were used to mark the exact location of hand tools and materials on the worktables, standardizing the spatial organization. Labels were placed on the worktables indicating where objects and tools should go, with a separate label for the most frequently used items during a shift.
- c)** To foster the habit and commitment, the monitoring system was activated through audits. A schedule of random reviews was established using the "5S Checklist" (the same one used in the diagnostic).
- d)** The shift supervisor was assigned to designate someone to conduct a quick visual inspection at the end of the day and feedback was given to the operators on the findings, congratulating those who kept their area clean and pointing out deviations for immediate correction.

This stage was key to transforming sporadic cleaning actions into a constant work habit, preparing for the final evaluation of results.

6. Evaluated Results and Comparative Analysis.

A second measurement of times and evaluation of conditions was carried out after the implementation of the 5S methodology with the aim of quantifying the impact of the improvements and determining the real reduction of the waste from the initial diagnosis.

Using the same format as for the waste analysis, the times for moving, collecting, and searching were recorded under the new working conditions (cleared areas, relocated bins, and identified materials). The results are shown in Table 5.

Table 5
Unproductive time recorded after implementation

No.	Duration (sec)	Observed Activity	Molt Classification
AND	5.2	Transfer to collect hammer	Transport
	3.55	Transporting the hammer to the container	Transport
	4.36	Search for materials (supplies)	Movement / Waiting
ESC	4.23	Transfer to collect hammer	Transport
	3.55	Transporting the hammer to the container	Transport
EST	4.00	Transfer to collect hammer	Transport
	3.13	Transporting the hammer to the container	Transport
IS	4.78	Transfer to collect hammer	Transport
	2.20	Transporting the hammer to the container	Transport
	6.38	Search for material (bushings)	Movement / Waiting
EB	3.89	Transporting the hammer to the container	Transport
EP	4.66	Transfer to collect hammer	Transport
	3.40	Transporting the hammer to the container	Transport
	8.10	Search for material (terminals)	Movement / Waiting
TOTAL	61.43	Total unproductive time per cycle	

Analyzing Table 5 reveals a general decrease in all activities. Search times, which previously reached up to 25 seconds, were reduced to between 4 and 8 seconds. This demonstrates the effectiveness of the Seiton (Order) phase, as the use of labels and fixed locations allows the operator to locate supplies almost immediately. Similarly, transport times decreased dramatically thanks to the rearrangement of the containers.

To assess the impact of the project, the baseline results (Table 2) were compared with the final measurement (Table 5). Table 6 summarizes this comparison.

Table 6
Comparison of unproductive time and percentage of improvement

Indicator	Initial Diagnosis (Before)	Final Situation (After)	Reduction (Seconds)	Improvement (%)
Total Change Time per Cycle	211.16 s	61.43 s	149.73 s	70.91%
Average Material Search	20.00 s	6.28 s	13.72 s	68.60%

Maximum Transfer Recorded	25.53 s (E)	5.20 s (E)	20.33 s	79.63%
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The comparative analysis shows that implementing the 5S methodology reduced unproductive time by 70.91%. This means that, in each production cycle, the operator now has an additional 149.73 seconds that were previously lost to non-value-added activities. This time recovery directly impacts operational efficiency, eliminating interruptions in the continuous flow and reducing employee fatigue by minimizing physical movement.

In addition to the time reduction, the checklist was reapplied to audit the maturity level of the 5S methodology after the intervention. Table 7 presents the detailed results, showing significant progress in each area.

Table 7
Final 5S checklist results (Post-implementation)

No.	ELEMENT TO BE EVALUATED	Points (0-3)	Observations / Evidence
1. SEIRI (Sorting)			
1.1	Unnecessary materials, equipment, and documents have been identified and removed.	3	Area completely cleared, only the shift remains.
1.2	The materials in use are clearly differentiated from those that are not in use.	3	Supplies in use under the table; stock in separate warehouse.
1.3	Work areas are free of objects that do not add value.	3	Tables without outside tools or trash.
1.4	There is a procedure in place for disposing of obsolete materials.	3	A "Clearance" criterion was established at the start of the shift.
1.5	Inventory control is in place to prevent unnecessary accumulation.	3	Stock defined in bins (1 bag system).
1.6	Waste is properly managed and segregated.	3	Trash cans relocated near the cutting area.
2. SEITON (Order)			
2.1	Every tool, piece of equipment, or material has a designated place.	3	Assignment of specific bins for each part number.
2.2	The corridors are signposted and free of obstructions.	3	Clear corridors, platforms removed from passageways.
2.3	The storage areas have visible and understandable signage.	3	Light blue labels on all containers.
2.4	The equipment and tools are organized for quick access.	3	Materials under the station within easy reach.
2.5	Color coding or labels are used to identify materials.	3	Standardized use of blue labels with code and photo.
2.6	The documents have an organized and accessible filing system.	3	Folders by station.
3. SEISO (Cleaning)			
3.1	The work area is kept clean at all times.	3	The standard is maintained during operation.
3.2	Sources of dirt (leaks, spills, dust) are identified and controlled.	3	Control of shingle waste using nearby bins.
3.3	There are scheduled daily and weekly cleaning routines.	3	5-minute cleaning routine.
3.4	There are designated personnel responsible for cleaning activities.	3	Roles defined by workstation.
3.5	Cleaning equipment is available and in good condition.	2	Basic equipment is available, but is currently being upgraded.
3.6	The floor, furniture, shelves and production/warehouse areas are kept clean.	3	Floors and racks free of dust and clippings.
3.7	Equipment and tools are cleaned before	2	Cleaning is mostly done at the end of the

	and after use.		shift.
4. SEIKETSU (Standardization)			
4.1	Clear rules have been established to maintain classification, order, and cleanliness.	3	There are visual instructions at the stations.
4.2	There are written procedures or visual instructions.	3	"Standard Procedure" available.
4.3	Safety procedures are integrated into the 5S standards.	3	Part of the training (order = security).
4.4	The signs, labels, or visual boards are up to date.	3	Aerial signs, labels installed and visible.
4.5	Periodic internal 5S audits are conducted.	2	The role of random reviews by supervisors was initiated.
4.6	There are performance indicators related to order and cleanliness.	2	Visual monitoring is in place, but the graphical metrics need to be formalized.
5. SHITSUKE (Discipline)			
5.1	The staff consistently follow the established rules.	2	The staff mostly respect the new standards.
5.2	The staff demonstrate habits of order and cleanliness without needing reminders.	2	Noticeable improvement, although it requires occasional supervision.
5.3	There is a 5S training program for all workers.	3	100% of staff trained (See attendance lists).
5.4	Supervision includes review of 5S compliance.	3	Supervisors conduct daily verification tours.
5.5	Employee participation in improvement proposals is encouraged.	3	Active participation in the rearrangement of bins.
5.6	Public recognition is given to achievements in the implementation of 5S.	2	Positive verbal feedback to compliant operators.

Comparing these results with the initial diagnosis (Table 3) reveals that the area progressed from critical compliance (average of 0.6 in Order) to an outstanding level (3.0). The implementation of labels and the definition of specific locations directly addressed the root cause of waste. Furthermore, formal training increased the Discipline score, establishing a cultural foundation for continuous improvement.

Finally, the risk conditions were reassessed using the safety diagnostic tool. Table 8 shows how order and standardization positively impacted risk prevention and regulatory compliance.

Table 8
Results of the final security assessment (Post-implementation)

No.	SECURITY CRITERIA	Points (0-3)	Observations
A. Signage and Order			
A.1	Visible safety signs (evacuation routes, exits, risk zones).	3	Improved visibility by removing visual obstacles.
A.2	Fire extinguishers are clearly marked and easily accessible.	3	Free access guaranteed by clearing of corridors.
A.3	Emergency exits free of obstructions.	3	Corridors and evacuation routes completely clear.
A.4	Safety instructions visible at strategic points.	3	They remain visible at strategic points.
B. Physical Space Conditions			
B.1	Adequate lighting in all areas.	2	General lighting is maintained; tidiness helps to avoid shadows.
B.2	Sufficient natural or artificial ventilation.	2	No structural changes, acceptable condition.
B.3	Floor in good condition, without cracks, unevenness or spills.	3	Clean floors free of cable debris.
B.4	Delimited and safe transit spaces.	3	Yellow lines visible and respected.

C. Equipment and Tools			
C.1	Tools in good condition, with no visible damage.	3	Tools classified and in good condition.
C.2	Machines with installed safety guards.	3	Operational security devices.
C.3	Electrical equipment with current maintenance.	3	No exposed cables in walkways.
C.4	There are no loose cables or makeshift installations.	3	Organized cabling in the stations.
D. Materials Handling			
D.1	Materials stored in a stable and secure manner.	3	Bins secured in racks or under tables, with no risk of falling.
D.3	Storage areas with load limits respected.	3	overstock was eliminated, correct stacking height.
D.4	Suitable containers for waste and recyclable materials.	3	Containers relocated and sufficient for scrap .
E. Personnel Safety			
E.1	Proper use of personal protective equipment (helmet, gloves, goggles, boots).	3	Active monitoring of the use of gloves and safety glasses.
E.2	A first aid kit is available.	1	The request was processed; physical installation in the area is pending.
E.3	The workers have received training in safety and emergencies.	3	Trained personnel (See evidence in Figures 9 and 10).
E.4	There is a record of evacuation or emergency drills.	3	The civil protection program is being followed.

The most notable improvement is reflected in section D Material Handling, which went from a poor rating to full compliance (3.0). By eliminating excess inventory and assigning specific containers, the risk of injuries from overexertion or falling objects was drastically reduced.

Furthermore, in section E, Personnel Safety, the training provided closed a critical gap by ensuring that employees are aware of the risks involved in their work. Although the first-aid kit is still undergoing administrative processing, the reduction of risks at the source (order and cleanliness) has created a safer environment.

The results validate the effectiveness of the implemented improvement actions. The systematic application of the 5S methodology transformed the area's operating conditions, achieving a 70.91% reduction in unproductive time per cycle.

Furthermore, the final audits show an increase in the level of compliance with the standards of order and cleanliness, going from critical conditions to outstanding levels (3.0) in the Sorting and Order phases, the safety risks associated with the handling of materials were mitigated, creating a safer and more efficient work environment.

Conclusions and Recommendations

This project addresses the operational efficiency problems identified in the company's study area, where disorganization and inadequate material distribution were generating unnecessary movements and delays in the production flow. The objective was to develop and implement improvement actions based on the 5S methodology under a Lean Manufacturing approach, to optimize space organization and significantly reduce unproductive time (Muda).

The methodology employed was applied and quantitative, structured around a continuous improvement design. It began with a diagnosis of the current situation using time studies and checklists, followed by the implementation of the Sorting (Seiri), Setting in Order (Seiton), and Cleaning (Seiso) phases. Subsequently, Standardization (Seiketsu) and Discipline (Shitsuke) mechanisms were established, supported by staff training and the implementation of visual aids to ensure the sustainability of the changes.

The results obtained validate the effectiveness of the intervention. A 70.91% reduction in unproductive time per cycle was achieved, decreasing from 211.16 to 61.43 seconds, which impacts the line's productive capacity. Final audits demonstrated a substantial increase in compliance with order and cleanliness standards, reaching an outstanding level and mitigating the safety risks associated with materials handling.

It is concluded that the systematic application of the 5S methodology not only transformed the physical environment but also fostered a culture of operational discipline. The strategic relocation of supplies and the elimination of unnecessary items proved to be effective and low-cost solutions for maximizing efficiency and improving workplace ergonomics. The organization is recommended to maintain the audit program and replicate this model in other production areas to standardize operational excellence.

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