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Implementation of the 5s Method Using a Kaizen Approach to Improve Efficiency in a SME in the Metalworking Sector

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Abstract

The productivity of companies in the metalworking sector plays a fundamental role in maintaining competitiveness and operational efficiency. However, many small and medium-sized enterprises face productivity issues due to inefficient processes, lack of standardized procedures, and inadequate organization of the workspace. These problems lead to longer processing times, low operator performance, and operational inefficiencies that negatively affect production performance. In this regard, it is important to identify the main causes of these issues in order to implement improvement strategies that optimize production processes. This research proposes the implementation of continuous improvement tools, particularly the Kaizen methodology, focused on process standardization, waste reduction, and workplace organization. The main objective of this study is to improve operational efficiency and productivity in a metalworking company through the application of standardized procedures and continuous improvement practices. The results obtained after implementation demonstrate the effectiveness of the proposal, achieving a 9.9% reduction in operator utilization and a decrease of 1.10 hours in processing time, in addition to improving workspace organization, which allows these improvements to be replicated in other areas of the company.

Keywords
Productivity, 5S, Kaiezen

1. Introduction
The metalworking sector in Peru plays a fundamental role in the national economy due to its contribution to industrial development and manufacturing activities. This sector encompasses a wide range of production processes that primarily use products derived from the steel industry and non-ferrous metals throughout the production chain, including the manufacturing of machinery, vehicles, and household appliances. Currently, there are more than 167,000 metalworking companies in the country, which contribute approximately 1.7% to the national Gross Domestic Product (GDP) and represent around 15.66% of the manufacturing GDP, demonstrating its importance as one of the main drivers of industrial growth (BCR, 2020).

Between 2015 and 2019, the Peruvian metalworking sector experienced moderate but sustained growth, with an average annual rate of 0.4%. However, the COVID-19 pandemic significantly affected the sector, causing an 18% reduction in the production of intermediate goods and a 45% decline in the manufacturing of capital goods between February 2020 and January 2021, due to the slowdown in related sectors such as construction and the automotive industry. Despite these difficulties, the Peruvian government included the metalworking sector in the first phase of its economic reactivation plan, promoting initiatives aimed at access to financing, technological modernization, and training in efficient production methods, with the objective of strengthening the sector's recovery and sustainable development (BCR, 2020; PRODUCE, 2021).

In companies within the metalworking sector dedicated to the manufacturing of industrial machinery, such as screening equipment, problems related to low productivity often arise, mainly caused by disorganization in work areas, lack of cleanliness, and the absence of standardized processes. These deficiencies directly affect operator performance, increasing production times, process errors, and operational costs. According to Charaja Jesús (2020), in a study conducted in a company in the metalworking sector, it was identified that disorder in work areas and lack of cleanliness were among the main causes of low productivity and reduced operational efficiency. Similarly, Navarro et al. (2018) found that in informal MSEs in the carpentry and metalworking sectors, the main limitations to improving productive performance and advancing toward formalization were low levels of workforce training, lack of access to technology, and difficulties related to the tax regime. These conditions show that low productivity in many manufacturing companies is associated with limited worker training and the absence of continuous improvement practices. In response to this issue, various studies have highlighted the importance of implementing continuous improvement methodologies such as Kaizen and associated tools like 5S, aimed at improving work organization, eliminating waste, and optimizing production processes. The implementation of 5S within a Kaizen approach makes it possible to achieve time savings in production, optimize workspace, and improve organizational management, helping to transform disorganized companies into more efficient and cleaner organizations (Talapatra, 2022).

1.1 Objectives

This research aims to demonstrate that the implementation of a continuous improvement model based on the Kaizen methodology can contribute to increasing productivity in a company in the metalworking sector dedicated to the manufacturing of screening machines. To achieve this, the application of the 5S methodology is proposed in order to improve order, cleanliness, and organization in the work area, reducing activities that do not add value to the production process. Likewise, the application of Kaizen principles will allow for process optimization, activity standardization, and improved operational efficiency within the manufacturing process.

2. Literature Review

2.1 5s in the commercial sector

The 5S methodology aims to optimize the work environment through five principles: sort, set in order, shine, standardize, and sustain, allowing the elimination of waste and improving operational efficiency within organizations (Shahriar, 2022). This tool contributes to the organization of the workspace, the standardization of activities, and the reduction of non-productive time, which facilitates the development of production processes. Likewise, various studies highlight that the application of 5S strengthens an organizational culture oriented toward continuous improvement and worker commitment to order and discipline in operations (Guillen et al., 2018; Neyra et al., 2019).

Empirical evidence shows that the implementation of 5S generates significant improvements in productivity and process performance. Senthil Kumar et al. (2022) demonstrated that the application of this methodology improved operator comfort, increased efficiency in their activities, and reduced the number of defective products, which directly contributed to increased productivity in the area. Similarly, Islam et al. (2022) reported an 18% reduction in material search time and a 20.4% reduction in total process time, mainly due to the elimination of waste associated with unnecessary movements and waiting times. Likewise, Espinoza-Camino et al. (2020) identified improvements of over 70% in logistics and material handling processes after the implementation of 5S, showing significant optimization in operational times. In the same vein, Campos (2022) states that the implementation of this methodology improved order fulfillment levels and reduced the time of key activities within the company, demonstrating that the application of organization and standardization tools positively impacts organizational productivity.

2.2 Kaizen method in the commercial sector

The Kaizen methodology, based on the philosophy of continuous improvement, is oriented toward the progressive optimization of production processes through the implementation of constant and sustainable improvements. In the metallurgical sector, where operations such as machining, casting, and component assembly predominate, this methodology makes it possible to identify inefficiencies, reduce waste, and improve the quality of the final product. Its application encourages the active participation of workers in process improvement, promoting standardization, operational control, and the efficient use of resources. Likewise, various studies highlight that Kaizen strengthens organizational culture in industrial environments, fostering staff commitment, operational discipline, and continuous improvement as part of daily management (Sichinsambwe et al., 2023; Sahmi & El Abbadi, 2024).

Empirical evidence shows that the implementation of Kaizen generates measurable results in process performance within the metallurgical sector. Kareska (2024) demonstrated that the application of Kaizen events made it possible to reduce cycle times in production processes, achieving a significant increase in productivity and an improvement in operational efficiency through the elimination of non-value-added activities. Similarly, Upadhyay (2025) reported a considerable reduction in material waste and non-productive time, which resulted in the optimization of operating costs and better utilization of resources in industrial plants. Likewise, Gebremeskel (2025) identified improvements in work performance and organizational efficiency following the implementation of Kaizen, showing greater worker participation and a reduction in errors in production processes. On the other hand, Kumar et al. (2022) demonstrated that the integration of Kaizen in metalworking manufacturing environments made it possible to reduce production defects, improve the quality of the final product, and optimize operating times, generating sustained increases in productivity. These results show that the application of Kaizen not only improves operational efficiency but also directly impacts quality, costs, and the overall performance of companies in the metallurgical sector.

3. Methods

This study is developed under a case study approach, as it analyzes a specific company in the metallurgical sector, which presents production processes associated with machining, assembly, and material transformation. For the development of the research, a combination of methodological tools is used to evaluate the current performance of the organization and propose improvements aimed at increasing operational efficiency.

The proposed model considers as input the low levels of productivity and efficiency in production processes, while as output a significant improvement in these indicators is expected through the application of the Kaizen methodology. In this sense, the methodological proposal is structured into three stages: diagnosis of the current situation, design of the intervention, and implementation of improvements, as shown in Figure 1.

In the first stage, a diagnosis of the company's current situation was carried out using various analysis tools. Key performance indicators were evaluated in order to measure process performance in terms of productivity, operation times, and quality. Likewise, the Pareto diagram was applied to identify the most relevant causes affecting the performance of the production system. Additionally, the Ishikawa diagram made it possible to determine the root causes of the identified problems, while the problem tree facilitated the understanding of the relationship between causes and their effects. From this analysis, issues such as high operation times, the presence of non-value-added activities, deficiencies in the organization of workstations, and the absence of process standardization were identified—factors that directly impact low productivity.

In the second stage, once the main causes of the problem were identified, improvement alternatives were selected, opting for the Kaizen methodology as the central axis of the intervention. This approach is based on continuous improvement through small changes, promoting staff participation, waste elimination, and the standardization of operational activities. Unlike other approaches, the proposal is oriented toward generating sustainable improvements over time through the progressive optimization of processes.

Finally, in the third stage, the results obtained after the implementation of the methodology are evaluated by comparing the initial indicators with those achieved afterward. This makes it possible to determine the impact of the applied improvements in terms of productivity, reduction of non-productive time, and operational efficiency. Based on this, Figure 1 presents the proposed model for the development of the research.

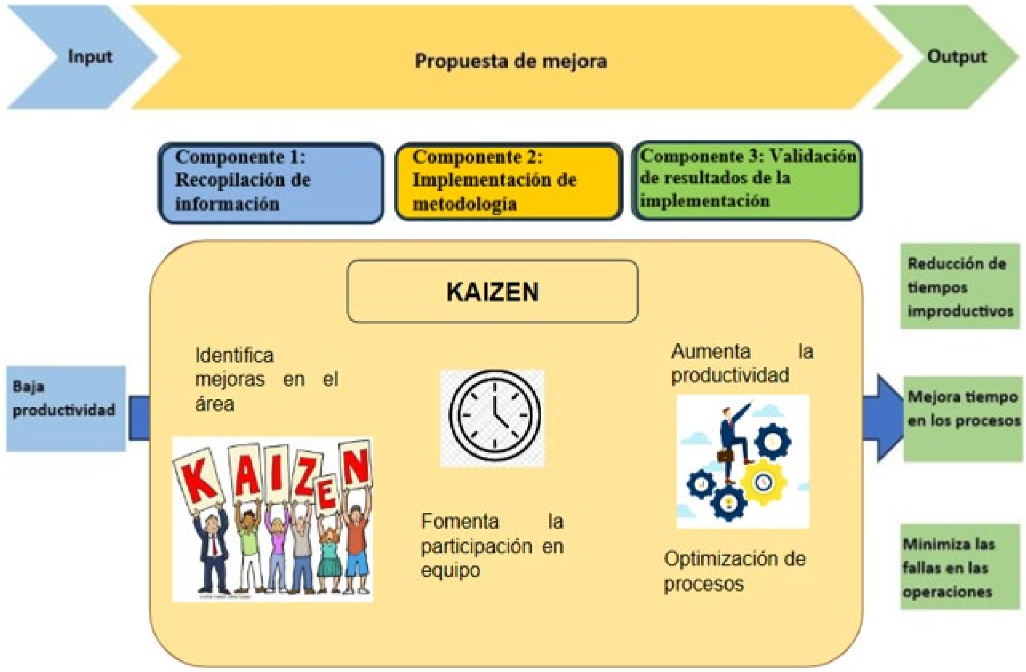

Figure 1. Proposed model

4. Data collection

Data collection was based on obtaining and analyzing information from various sources in order to evaluate the current situation of the company in the metallurgical sector. First, a literature review (articles, books, and technical documents) was conducted, which supported the application of the Kaizen methodology and the 5S tool.

Likewise, interviews were conducted with operational staff and supervisors, along with structured surveys, to identify the main deficiencies in production processes, as well as the level of organization and operational performance.

Additionally, an analysis of key indicators was carried out, which made it possible to evaluate productivity, process times, and quality. Based on this, the Pareto diagram was used to prioritize the most critical problems, followed by the Ishikawa diagram to identify their root causes, and the problem tree to structure the relationship between causes and effects.

Finally, based on the collected information, the feasibility of implementing the Kaizen methodology together with the 5S tool was determined, aimed at improving organization, reducing waste, and optimizing production processes. Figure 2 shows the procedure followed in this stage.

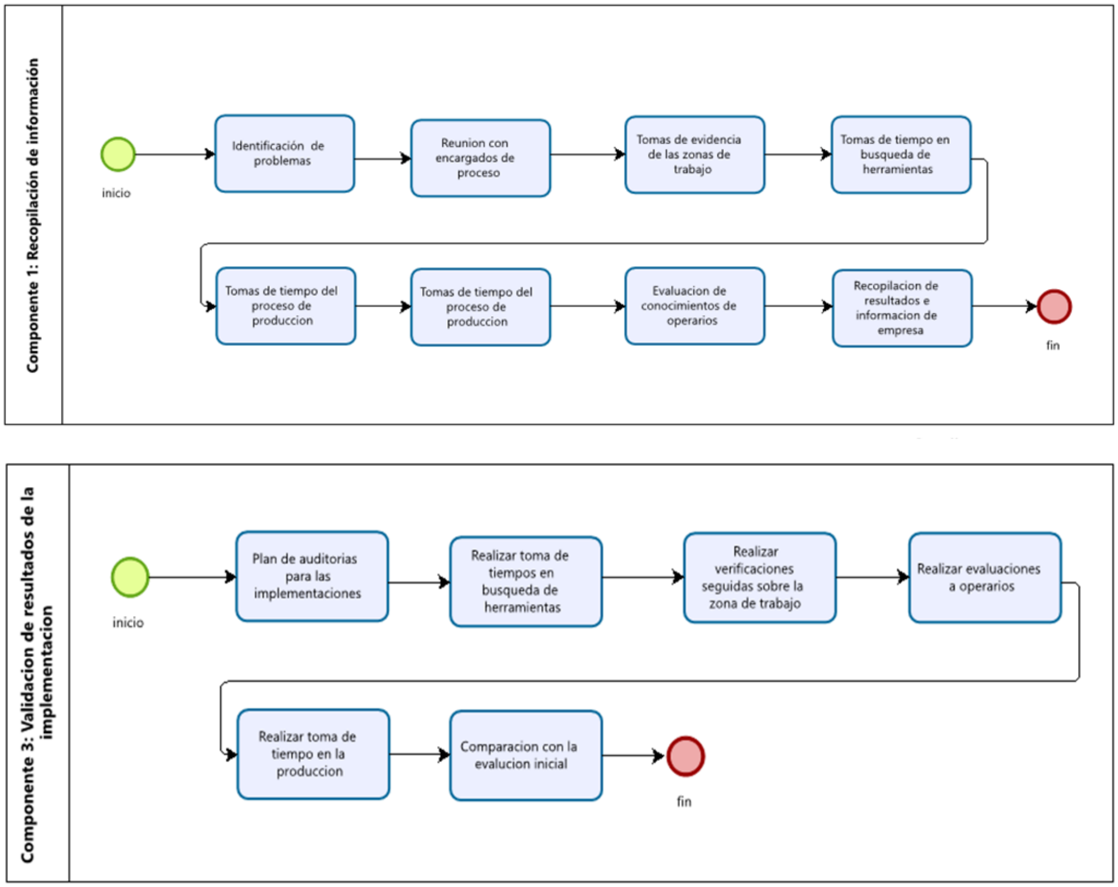

Figure 2. Diagram of the results

4.1. Implementation of 5S, ABC Method and Systematic Layout Planning

This phase is focused on the application of the selected improvement tools based on the main problems identified in the screening machine manufacturing process. In this regard, the Kaizen methodology is established as the central axis, complemented by the 5S tool, with the aim of increasing operational efficiency and reducing non-productive time. In the case study, the company presents deficiencies related to the disorganization of workstations, lack of standardization of activities, and inadequate management of tools and materials, which leads to production delays, unnecessary movements, and low productivity.

In order to evaluate the current state of the production system, a time study was conducted to determine the standard time for each activity in the process. For this purpose, factors such as rest times, operator fatigue, and working conditions were considered. It is important to note that the measurements were carried out with operators who had approximately two years of experience in the company, ensuring that the obtained times reflect representative and reliable performance. Data collection was carried out over a one-week period with operators who had greater experience in the screening machine manufacturing process, covering activities such as cutting, machining, assembly, welding, inspection, and finishing, whose results are presented in Table 1 as baseline times prior to the implementation of improvements.

Table 1. Sample times

	Corte	Inspecci ón Corte	Tornead o	Taladrado	Fresado	Roscado	Grabado de series	Tratamiento térmico	Rectificado
Toma 1	5.01	2.07	12.54	15.05	18.51	10.47	5.3	66.07	10.45
Toma 2	5.38	2.21	16.37	7.02	18.43	6.23	4.14	59	9.54

Toma 3	6.13	2.54	15.25	10.58	21.1	8.2	5.642	60.28	8.24
Toma 4	6.03	2.37	18	14.7	18.55	14.28	4.43	65.16	7.54
Toma 5	6.52	2.35	9.44	17.26	24.23	12.2	4.32	60.04	9.54
Toma 6	5.54	3.58	13.12	15.45	23.34	12.03	4.22	56.54	9.3
Toma 7	5.39	3.02	14.15	9.16	19.36	13.15	5.21	57.23	9.5
Toma 8	5.5	1.54	18.52	17.38	17.18	8.5	5.09	56.32	6.07
Toma 9	5.51	0.57	13.24	7.52	21.3	8.19	4.43	60.2	11.01

In this sense, after performing the corresponding calculations, it was determined that the current standard time for the total activities of the screening machine manufacturing process is 7.81 hours, considering in each of them the time the operator spends moving between different workstations. It is important to note that these data were obtained from measurements carried out on operators with approximately two years of experience in the company, which ensures the representativeness of the results. Based on this, it was identified that the total process time is high, revealing inefficiencies related to disorganization, search times, and a non-optimized work sequence.
Once the time study was completed, the selected improvement tools were implemented:

• **5S Methodology:** its application was evaluated through a 5S audit, based on the criteria of sort, set in order, shine, standardize, and sustain. In the initial assessment, a low level of compliance was obtained, indicating a disorganized environment with the presence of waste. After its implementation, a significant improvement in the audit score was recorded, reflected in better arrangement of tools, reduced search times, and greater visual control at workstations. Likewise, a reduction in non-productive times was observed, directly contributing to process efficiency.

• **Kaizen Methodology:** its impact was measured through performance indicators such as process time and productivity, comparing values before and after implementation. Through the application of continuous improvements, elimination of non-value-added activities, and standardization of operations, it was possible to optimize the work sequence and reduce unnecessary times. As a result, an improvement in the flow of the production process and an increase in operational efficiency were observed, demonstrating the effectiveness of the methodology in reducing waste and achieving sustained performance improvement.

The following presents the results obtained from the current scenario of the screening machine manufacturing process. To measure the level of productivity, a production sampling was carried out over a period of 26 working days, considering the average number of units produced during that interval. Likewise, to determine the level of defective products, quality control records from the production area were used, in which screening machines that did not meet the established technical specifications were identified.

- **Effectiveness level (%):** (Actual production / Expected production) × 100 = (24 / 32) × 100 = 75.00%
- **Time efficiency level (%):** (Expected time / Actual time) × 100 = (7 / 7.81) × 100 = 89.63%
- **Productivity level (%):** Effectiveness × Efficiency = 75.00% × 89.63% = 67.22%
- **Average cycle time per screening machine: 7.81 hours**
- **Time gap (%): ((Actual time – Expected time) / Expected time) × 100 =** ((7.81 – 7) / 7) × 100 = 11.57%

5. Results and discussion

Based on the initial evaluation of the 5S methodology, a compliance level of 52% was obtained, which revealed opportunities for improvement in the organization of the area. From this diagnosis, a one-month pilot test was developed aimed at optimizing working conditions and strengthening operational efficiency. During this period, non-value-added elements were identified through the use of sorting tags that allowed materials to be grouped and differentiated; these were completed by the area supervisor and placed in visible locations to facilitate control (Figure 3), in

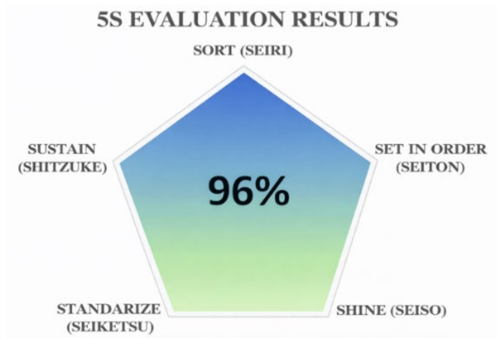

Figure 3. 5S final audit results

addition to establishing a monitoring record to document the actions carried out.
Subsequently, a cleaning program was implemented with the active participation of workers under supervision, where recurring issues and their causes were identified, allowing the definition of corrective measures to improve order and cleanliness. This was complemented by the implementation of a 5S visual control board, which facilitated continuous monitoring of progress and compliance with activities, encouraging team participation.

Finally, staff commitment was reinforced through discipline and individual responsibility to ensure the sustainability of the improvements, achieving an increase in the compliance level up to 96% in the final audit, reflecting a significant improvement in the organization and efficiency of the área.

After the pilot implementation of the 5S methodology, an As-Is model was developed in Arena software to simulate the number of orders fulfilled during a workday, considering the operation times obtained from the company. A total of 37 replications of the model were performed, taking into account the stations required for production and the elimination of tool-searching times, which in the initial scenario accounted for approximately 25 minutes per workday. The activities were fitted using exponential and uniform distributions with the Input Analyzer software, and the main entities in the model were the sieves, while operators were represented as resources assigned to each activity.

From the simulation, key performance indicators were obtained, including total production time, operator utilization, and the utilization of the cutting machine and the drill. These results made it possible to objectively evaluate the impact of the 5S implementation on the efficiency of the production process, demonstrating a reduction in idle times and an optimization of resource usage, thereby providing valuable information for decision-making in operational management (Table 2).

Table 2. Current scenario indicators

Simulation indicators	Values obtained
Tiempo Total	7.81 horas
Utilización del Operador	97.53 %
Utilización del Taladro	70.75 %
Utilización de la Máquina de Corte	4.94 %

For the implementation of the 5S and Kaizen methodologies, the process began with the classification and organization of tools, which made it possible to improve visual control of the operation, reduce errors, and decrease the amount of defective production, as well as minimize time lost searching for tools, which was reduced from 25 minutes to 0 minutes. In the Quality Control subprocess, the percentage of parts subjected to inspection decreased from 30% to 20%, while the percentage of approved parts increased to 90%, demonstrating greater reliability. After the implementation of 5S, the time dedicated to searching for tools, which was previously 25 minutes, was reduced to 0 minutes, completely eliminating this time waste.

The comparative graphs between the As-Is and To-Be scenarios show clear improvements in efficiency and resource utilization. The average time required to complete the processes decreased from 7.81 to 6.71 hours, reflecting an improvement in production speed, although not statistically significant. Operator utilization decreased from 97.53% to 87.63%, indicating a more balanced and sustainable workload distribution, with confirmed statistical significance. Drill utilization decreased from 70.75% to 60.75%, and cutting machine utilization slightly decreased from 4.94% to 4.24%, suggesting better task allocation and optimization of operational flow. Taken together, the implementation of 5S and Kaizen contributed to a more efficient, agile, and balanced process, both in terms of production times and human resource management (Table 3).

Table 3. Improved scenario indicators

Simulation indicators	Values obtained
Tiempo Total	6.71 horas
Utilización del Operador	87.63 %
Utilización del Taladro	60.75 %
Utilización de la Máquina de Corte	4.24 %

Figure 4 below shows the simulation diagram used in Arena to obtain the desired results.

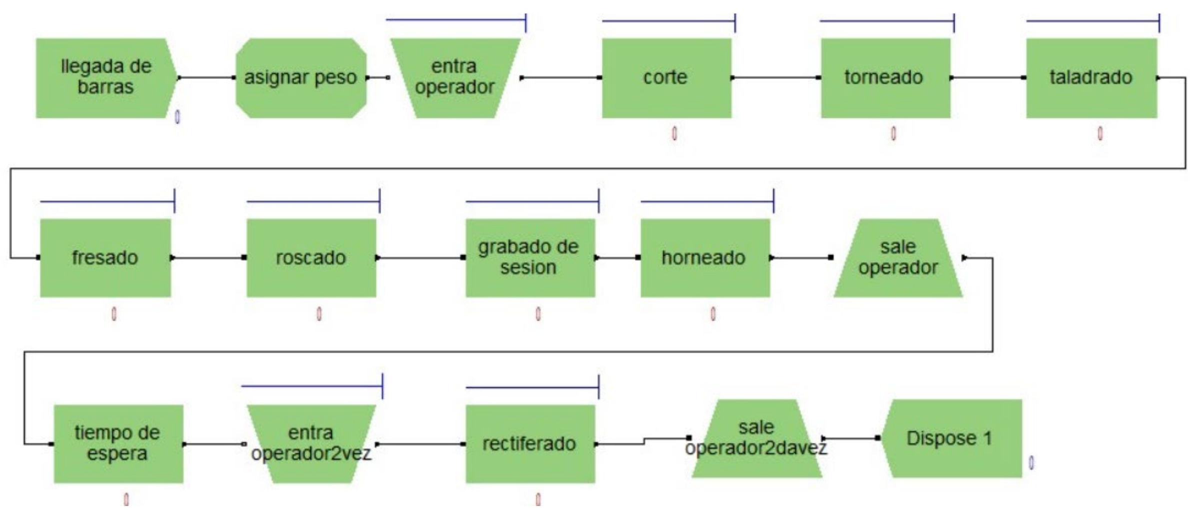

Figure 4. Graphical representation of the improved model

5.1. Numerical Results

The indicators obtained after the pilot application are presented below, considering that the productivity level and production time are based on an average of 26 working days:

- **Effectiveness level (%): (Actual production / Expected production) × 100 =** (26 / 32) × 100 = 81.25%
- **Time efficiency level (%): (Expected time / Actual time) × 100 = (7 / 7.81) × 100 =** 89.63%
- **Productivity level (%): Effectiveness × Efficiency = 81.25% × 89.63% =** 72.80%
- **Average cycle time per sieve:** 6.71 hours
- **Time gap (%): ((Actual time – Expected time) / Expected time) × 100 = ((7.81 – 7) / 7) × 100 =** 11.57%.

5.2. Graphical Result

Through the application of the tools we were able to obtain the following graphic results in Figure 5:

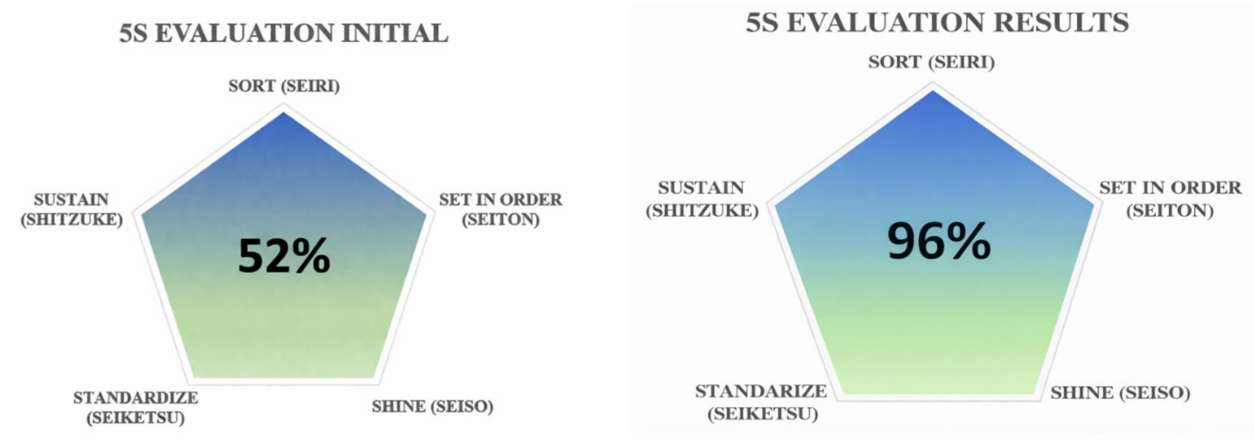

Figure 5. 5S Audit Comparison before and after

5.3 Validation

A 26-day pilot test was conducted to validate the proposed model, using updated data after the implementation of both tools, which made it possible to recalculate the indicators. Table 4 presents the simulation results before and after the improvement.

Table 4. Comparison of indicators between scenarios

Indicator	Initial Situation	Improved Situation
Total Time	7.81 horas	6.71 horas
Operator Utilization	97.53 %	87.63 %
Drill Utilization	70.75 %	60.75 %
Cutting Machine Utilization	4.94 %	4.24 %

The final results indicate that the stated objective was achieved, showing improvements across all indicators, and if the model continues to be applied, there is still room for further optimization.

6. Conclusion

The implementation of the model in the metalworking company reduced the total production time from 7.81 to 6.71 hours and decreased operator utilization from 97.53% to 87.63%, while also optimizing drill utilization from 70.75% to 60.75% and cutting machine utilization from 4.94% to 4.24%. The standardization of processes and the organization of work areas eliminated non-value-added activities, improving operational efficiency and production flow.

These results confirm that the model is effective, replicable, and contributes to a more organized and productive work environment. Furthermore, it is evident that by maintaining the application of these practices, there is still room to further improve the company’s efficiency and productivity by reducing non-productive time and optimizing the use of key resources.

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