

Process Improvement to Increase Productivity in a Food Processing Company Using Work Standardization and SLP

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Abstract

This research was conducted at a company in Lima, Peru, dedicated to processing and distributing animal products and other imported inputs. The study focuses on the fish line, specifically salmon. The initial diagnosis of the production process revealed a lack of standardized procedures and a plant layout that did not favor workflow. These conditions resulted in long cycle times, high effort, and low productivity (26.41 kg/h-h) compared with another food processing company. The study aimed to develop and evaluate an improvement model to increase productivity, reduce cycle times, and minimize operator effort. To achieve this, work standardization and Systematic Layout Planning (SLP) were applied. The proposed improvements were evaluated using a validated Arena simulation model. Based on the simulated baseline and improved scenarios, productivity increased by 16.48%, while cycle time and operator effort were reduced by 14.84% and 5.59%, respectively. These results demonstrate the effectiveness of the proposed approach in the industrial environment analyzed.

Keywords

Productivity, standardized work, Systematic Layout Planning, processed food sector, cycle time.

1. Introduction

Globally, the processed meat and seafood sector has grown by 3.73% between 2024 and 2025, driven by increased demand for industrialized products (Euromonitor International 2026). In Peru, the food processing industry is a significant component of the country's economy, accounting for nearly 27% of GDP in 2024 (USDA Foreign Agricultural Service 2025). However, this increase is not accompanied by improvements in productivity; a study conducted in Latin America by Ferrer et al. (2022) shows that, over more than a decade, productivity growth in the region was barely 0.6% despite sustained growth in the sector. Given this scenario, the importance of improving productivity in food processing plants is highlighted to ensure an adequate response to the sector's increasing demand.

The present study was conducted in a food processing company located in Lima, Peru. This plant is dedicated to processing and distributing animal-based raw materials, such as fish and meat, as well as producing sauces. Among its operations, the fish production line is the most significant, with salmon in the highest demand. Therefore, the focus of this research is centered on the processing of this specific unit.

The initial analysis of the operational performance of the salmon line evidenced a productivity of 26.41 kg/man-hour. Meanwhile, in the study by Farah et al. (2024) at another Peruvian company in the food processing sector, this indicator was 34.83 kg/man-hour. Upon comparing the two values, a 31.88% technical gap was identified.

In view of this situation, and considering the evidence reported in the literature review on the effectiveness of engineering tools in improving productive performance, the present study proposes the design and implementation of improvement alternatives through work standardization and Systematic Layout Planning (SLP).

1.1 Objectives

The main objective of this research is to increase the company's productivity by applying work standardization and SLP. Meanwhile, the specific objectives of the project are as follows:

- Develop the background and state of the art on engineering tools for improving productivity in production processes.
- Perform the initial diagnosis of the company by analyzing current processes, identifying operational inefficiencies, measuring process times, and evaluating productivity indicators.
- Validate the effectiveness of the proposed methodologies through the analysis of process performance indicators.

2. Literature Review

Regarding work standardization, Santos et al. (2023) state that it involves the detailed documentation of tasks and work sequences that operators must repeatedly follow to ensure operational consistency and minimize process variability. Based on this approach, the most efficient work methods can be established to achieve higher quality standards while reducing operational costs. Likewise, Socconini (2021) highlights that work standardization enables safer and more efficient operations, shortens the learning curve for operators, and facilitates the implementation of continuous improvement initiatives.

Several studies have demonstrated the effectiveness of work standardization in improving production process indicators across different industrial sectors. For instance, Contreras et al. (2024) reported that implementing work standardization in an agro-industrial company, along with other Lean methodology tools, eliminated the main waste and sources of dirt while improving processing times by 10%. Along the same lines, Damian et al. (2023) found that work standardization reduced cycle time by 23.83% and, when combined with additional Lean tools, increased productivity by 26.92%.

Comparable results have also been reported in other manufacturing environments. Alva et al. (2023) showed that integrating work standardization with Systematic Layout Planning (SLP) and other industrial engineering tools resulted in a 36.62% improvement in productivity at an agro-industrial company. Likewise, Mundaca et al. (2023) observed that implementing work standardization at a metallurgical company reduced cycle time by 15.61%, demonstrating its effectiveness in enhancing operational efficiency across various industrial sectors.

Furthermore, several authors have highlighted the benefits of combining work standardization with complementary improvement methodologies. Torres et al. (2023) highlighted that an integrated approach combining work standardization and SLP resulted in an 18% increase in productivity. Similarly, Mor et al. (2019) found that process standardization saved 31.6 seconds per production cycle, representing a 6.77% reduction compared to the original cycle time. In the food processing industry, Huarcaya and Platero (2023) estimated that process standardization increased productivity by 40.58%, further confirming the effectiveness of this approach in improving production performance.

In terms of Systematic Layout Planning, this methodology enables optimization of the plant layout, reducing unnecessary travel distances and operational effort, thereby directly improving process productivity (Díaz and Noriega 2018). Building on this, Pavletich et al. (2023) emphasize that an inadequate facility layout can lead to various operational problems within the plant, including underutilized spaces, unnecessary movement and transportation, low productivity, and long lead times.

According to Achmad and Santoso (2025), the implementation of SLP follows a structured planning process that involves evaluating product and production requirements, identifying the relationships among work areas, and comparing alternative facility layouts to select the most appropriate one. Because of its systematic and flexible nature, this methodology has been successfully applied in manufacturing companies of different sizes and industrial sectors.

Numerous studies have demonstrated significant operational improvements following the implementation of SLP. For example, Pacheco et al. (2022) achieved a 10.85% increase in productivity, accompanied by a 34.58% reduction in travel distance and a 26.26% decrease in cycle time. Similarly, Cordova et al. (2022) found that integrating SLP with Lean Manufacturing tools reduced operator effort by up to 62% and decreased non-productive time associated with unnecessary movement and tool searching.

Comparable results have also been observed in different industrial contexts. Bernardo et al. (2023) reported a 40.6% reduction in workers' physical effort after implementing SLP in a shoe repair company. Likewise, Ramos et al. (2023) found that applying SLP in a frozen mango processing and exporting company reduced the total travel distance by 31 meters. Moreover, when SLP was combined with work standardization and other improvement tools, productivity increased by 23%, demonstrating the complementary benefits of integrating multiple industrial engineering methodologies. In addition, Singla and Sharma (2023) reported a 10.17% increase in productivity after implementing SLP in a manufacturing company, further supporting the effectiveness of this methodology in improving production performance.

3. Methods

The study was developed using a quantitative approach, as it is based on measuring and analyzing indicators associated with the performance of the salmon production process. It also has an applied type, as it is oriented towards solving a real company problem through a planned intervention in the production process, based on the measurement and analysis of numerical data.

In the first stage, it conducted an initial diagnosis of the sector's situation and identified a technical gap. It was determined that the plant under study had a productivity value below the reference benchmark. To identify the root causes of the low productivity in the process, an Ishikawa diagram was utilized. From this, it was identified that the main causes were the absence of process standardization, the lack of formal documentation to guide activity execution, and a workspace layout that did not support material flow, leading to unnecessary travel.

In the second stage, based on the diagnostic results, a review of the state of the art was conducted to identify tools to address the previously identified root causes. Based on the reviewed literature, SLP and work standardization tools were selected to develop the solution proposal, given their frequent use in studies focused on productivity improvement and their effectiveness in reducing process variability.

The third stage consisted of applying the proposed tools. To implement work standardization, a Flow Process Chart was developed, and a time study was conducted for salmon processing activities. To determine the representative number of observations required for the study, the finite population sample size was calculated using the following equation.

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

Where n represents the required sample size, N is the population size corresponding to 692 salmon, Z is the critical value associated with a 95% confidence level, p is the inclusion ratio (95%), q is the complement of p (5%) and E is the margin of error (5%). Based on these parameters, the sample size was 66 salmon selected through non-probability convenience sampling based on product availability and physical condition. With this information, the standard procedures for the process were designed, and, based on them, a manual was developed that defines the sequence to follow and the standard times for each activity.

On its part, the SLP component was implemented in accordance with the procedures and guidelines outlined by Díaz and Noriega (2018). First, the initial situation was analyzed through multiple visits to the production plant and by measuring the distances between the work areas. With this information, the flow diagram was developed, and the Guerchet method was applied to estimate the minimum required area for each station. Additionally, the activity relationship analysis was conducted using proximity codes and technical criteria. Subsequently, the initial effort matrix was calculated based on the collected data. Based on this diagnosis, a new plant layout was designed. Finally, the new effort matrix was calculated to quantify the improvement and demonstrate increased productivity.

The details of the proposed model and the application stages of both tools are presented in Figure 1.

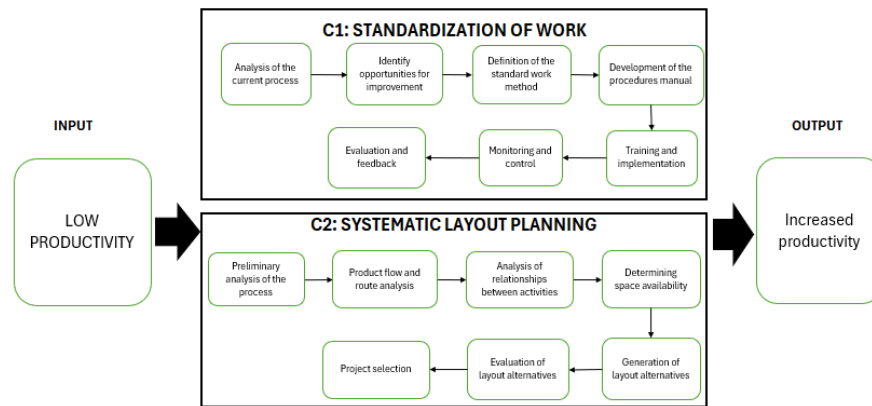


Figure 1. Macro design of the proposed solution

4. Data Collection

To develop the work standardization proposal, data were collected through multiple visits to the production plant. During these visits, the salmon processing operations were directly observed at different production stages, and the processing time of each activity was measured according to the activities identified in the Process Analysis Diagram (PAD). High variability was observed in the data due to a lack of task homogenization. Based on the time study, the average cycle time was 59.46 minutes, and the initial productivity was 26.41 kg/man-hour.

The development of SLP began with the analysis of the company's initial scenario. To this end, the layout of the production area was developed, as shown in the following image. Figure 2 corresponds to the travel chart based on the initial plant layout prior to the solution proposal. It presents the travel paths of the fish production line. The abbreviations used in Figure 2 are as follows: MC = Machine, WM = Weighing Machine, and BK = Boiler.

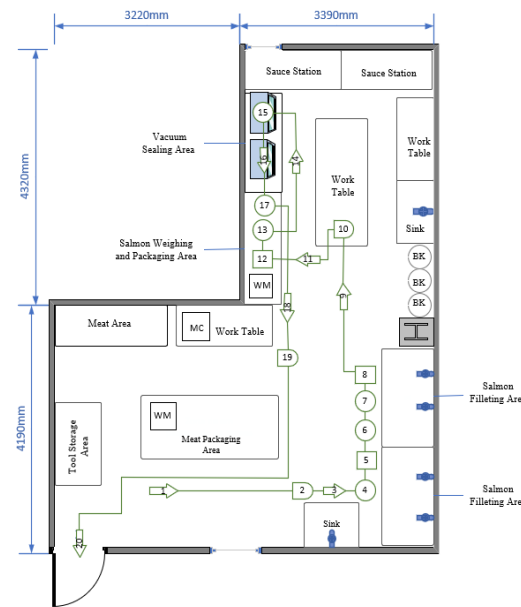


Figure 2. Route diagram of the initial situation in millimeters

Regarding SLP, an activity relationship chart was developed to identify relationships among the functional areas within the production plant (Figure 3). This analysis made it possible to determine the desired closeness between

workstations based on their operational requirements. The resulting closeness relationships served as the basis for developing the proposed facility layout.

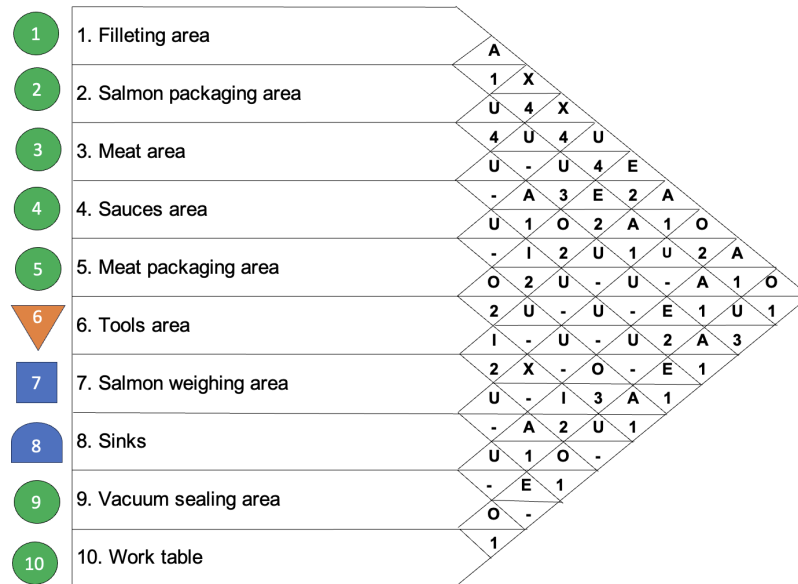


Figure 3. Activity relationship diagram

The relationship chart was developed considering the following closeness ratings: A (Absolutely Necessary), E (Especially Important), I (Important), O (Ordinary), U (Unimportant), and X (Undesirable). These ratings were according to four technical criteria: product flow between work areas (1), shared use of equipment or materials (2), operational communication or information exchange (3), and cross-contamination prevention requirements (4).

A weight matrix (kg) was developed based on the amount of fish transported between workstations. Likewise, a distance matrix (m) was constructed considering the distances traveled by operators during the production process. These matrices were then combined to obtain the effort matrix (kg-m), yielding a total of 1,632.65 kg-m.

For the development of the effort matrix corresponding to the initial situation in Table 1, the areas involved in the process were defined as follows: Zone A corresponds to the filleting area, Zone B to the work table, and Zone C groups the weighing and packaging activities, as these are carried out at the same work table; likewise, areas A.MP and A.PT represent the raw material and finished product warehouses, which are located outside the production area.

Table 1. Effort matrix of the initial situation (kg-m)

	A.MP	A	B	C	A. PT	Total
A. MP	X	940.8				940.80
A		X	186.49			186.49
B			X	67.72		67.72
C				X	437.64	437.64
A. PT					X	1,632.65

5. Results and Discussion

5.1 Numerical and Graphical Results

The design of the new work method proceeded by developing the procedures manual shown in Figure 4, which standardizes the cutting, filleting, and packaging activities in the salmon process. This manual will be structured according to the sequence of operations defined in the Flow Process Chart and will include descriptions of the steps to follow, the tools used, the assigned times, and the necessary instructions.

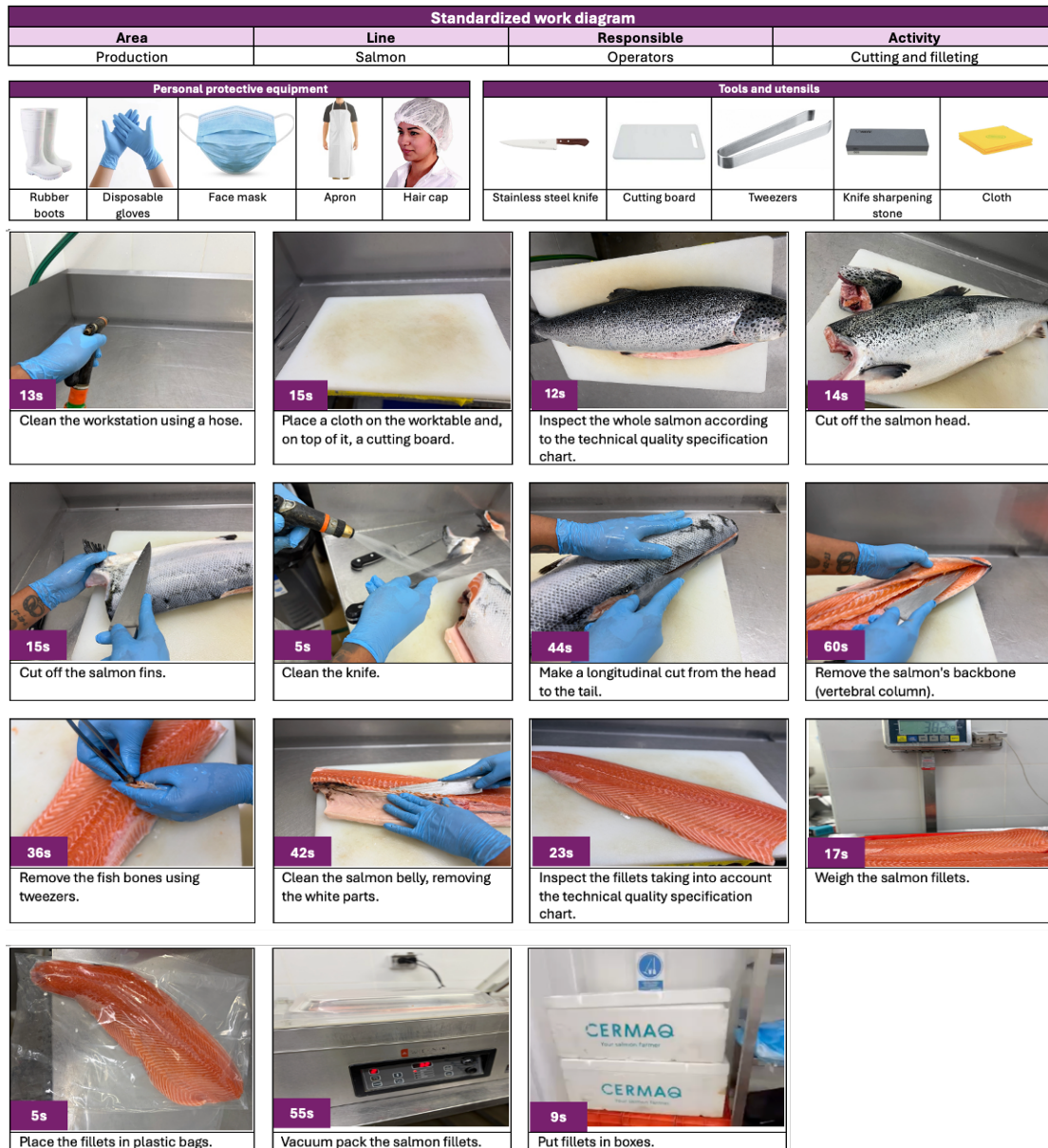


Figure 4. Standardized Work Diagram

The initial and final inspections are performed on the whole salmon and the salmon fillet, respectively; that is, at the beginning of the filleting process and during the pre-packaging inspection. Therefore, the following technical specification charts (Table 2 and Table 3) were developed, listing the quality parameters to be evaluated to ensure product safety.

All attributes in Tables 2 and 3 must be inspected individually due to their criticality. Since the product is intended for human consumption, it is paramount to ensure the quality and good condition of each piece processed within the plant.

Table 2. Salmon technical specifications

Product characteristics	Type of characteristic		Technical standard or specification	Control method	Inspection technique	AQL
	Variable / Attribute	Criticality level	V.N. $\pm$ Tol (for variables)			
Odor	Attribute	Critical	Fresh, mild, characteristic sea scent	Sensory	100%	0
Eyes	Attribute	Critical	Clear, bright, and bulging. Black and shiny pupil	Sensory	100%	0
Appearance	Attribute	Critical	Shiny skin, no discoloration, and moist	Sensory	100%	0
Texture	Attribute	Critical	Firm flesh quickly regains its original shape	Sensory	100%	0
Scales	Attribute	Critical	Well-adhered	Sensory	100%	0
Gills	Attribute	Critical	Deep red or pink color, and must be moist	Sensory	100%	0
Abdomen	Attribute	Critical	Must not be swollen	Sensory	100%	0

Table 3. Technical specifications of the salmon fillet

Product characteristics	Type of characteristic		Technical standard or specification	Control method	Inspection technique	AQL
	Variable / Attribute	Criticality level	V.N. $\pm$ Tol (for variables)			
Color	Attribute	Critical	Uniform pink or light orange	Sensory	100%	0
Odor	Attribute	Critical	Fresh and mild	Sensory	100%	0
Appearance	Attribute	Critical	White lines along the fillet. No spots or discoloration.	Sensory	100%	0
Texture	Attribute	Critical	Firm and elastic flesh: must return quickly to its original shape	Sensory	100%	0

Regarding SLP, and based on the relationship analysis, a new facility layout was proposed to reduce operators' travel distances and improve workflow continuity. One of the main modifications was the removal of the sink located next to the filleting area. Since fish washing is performed with wall-mounted hoses, the sink at this station was unnecessary and limited space for operator circulation and movement. Additionally, it was considered that the sauce area should

not be located near the filleting zone, as these processes are incompatible. In the proposal, the work table located next to the vacuum sealing area in the initial situation was redefined as a packaging area, thereby separating the weighing and packaging activities that were previously performed at the same station and exhibited operational overlap. The proposed plant layout is shown in Figure 5.

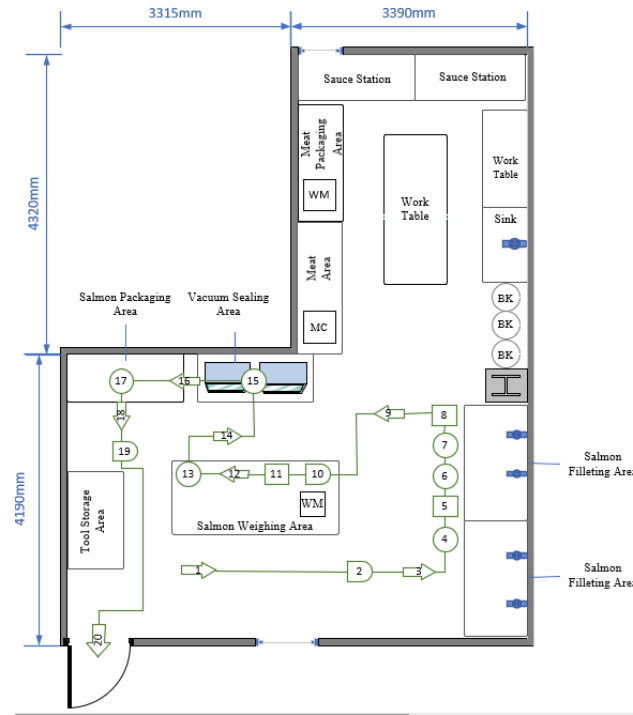


Figure 5. Solution proposal route diagram

The validation of the SLP tool was conducted by developing the effort matrix. The weight matrix was developed based on the estimated batch of fish entering the production process. As the salmon advanced through each workstation, the recorded weight was adjusted to reflect the reduction in mass resulting from successive processing operations. In contrast, the distance values varied relative to the current scenario due to the new workstation layout. Table 4 presents the effort matrix (in kg-m) for the proposed solution, yielding a final total of 1,541.42 kg-m. Areas A.MP, A, and A.PT remain the same, while Zone D represents the new weighing area and Zone E is the new fish packaging area.

Table 4. Effort matrix of the proposed solution (kg-m)

	A.MP	A	D	E	A. PT	Total
A. MP	X	934.92				934.92
A		X	145.34			145.34
D			X	60.48		60.48
E				X	400.68	400.68
A. PT					X	1,541.42

By comparing the effort in the initial situation with that of the proposed solution, a 5.59% reduction in total effort was calculated due to shorter distances between workstations.

5.2 Proposed Improvements

To validate the results of implementing process standardization at the plant, a simulation model was developed in Arena software. This model, shown in Figure 6, represents the entire cutting, filleting, and packaging process that the salmon go through, following the exact same steps detailed in the previously presented process standardization manual.

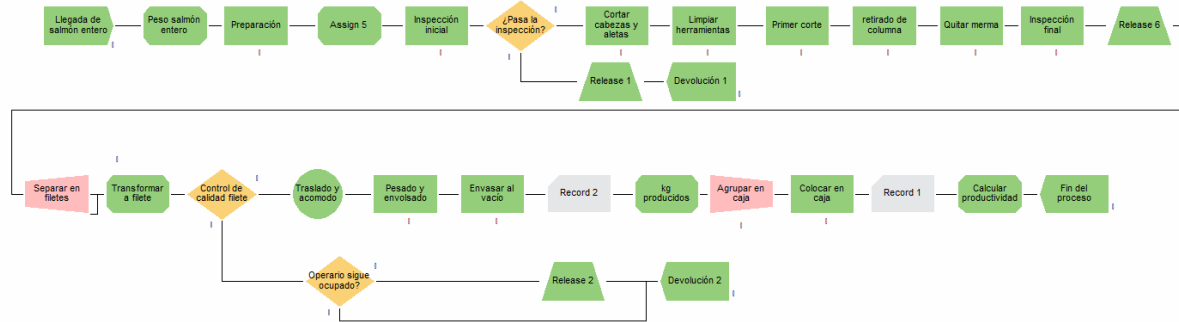


Figure 6. Simulation model of the proposed solution in Arena

The application of work standardization in this case study aimed to reduce and standardize the duration of each activity within the process, rather than adding or eliminating steps. This approach eliminated variations in work methods among operators, resulting in shorter processing times while preserving the original process flow. Consequently, the Arena simulation model maintained the same process logic, entities, resources, and activities as the current system, with the only modification being the updated processing times obtained after implementing work standardization.

With the newly recorded times, the Arena simulation model estimated an average productivity of 31.8 kg/man-hour. This represents a 16.48% increase over the simulated productivity of 27.3 kg/man-hour. Likewise, the average simulated cycle time decreased from 54.6 to 46.5 minutes, constituting a 14.84% reduction. The results of the improved scenario are shown in Table 5.

Table 5. Comparison of performance indicators for current and improved scenarios

Indicator	Current Scenario	Improved Scenario	Unit
Productivity	[26.2-28.8]	[30.6-33.6]	Kilograms/Man-Hour
System Cycle Time	[50.3-55.5]	[42.7-47.6]	Minutes
Operator Effort	1,632.65	1,541.42	Kilograms-Meters

5.3 Validation

Figure 7 presents a comparison between the indicators of the initial situation and the proposed solution. These results were obtained after validating the Arena simulation using the Output Analyzer tool. In the initial scenario, productivity reached an average of 27.3 kg/man-hour, with a minimum of 26.2 kg/man-hour and a maximum of 28.8 kg/man-hour. After the implementation of the proposed improvements, this indicator increased to an average of 31.8 kg/man-hour, a minimum of 30.6 kg/man-hour, and a maximum of 33.6 kg/man-hour.

Similarly, the average system cycle time in the initial scenario was 54.6 minutes, with a lower limit of 50.3 minutes and an upper limit of 55.5 minutes. In contrast, the average system cycle time of the proposed solution was 46.5 minutes, with a minimum of 42.7 minutes and a maximum of 47.6 minutes.

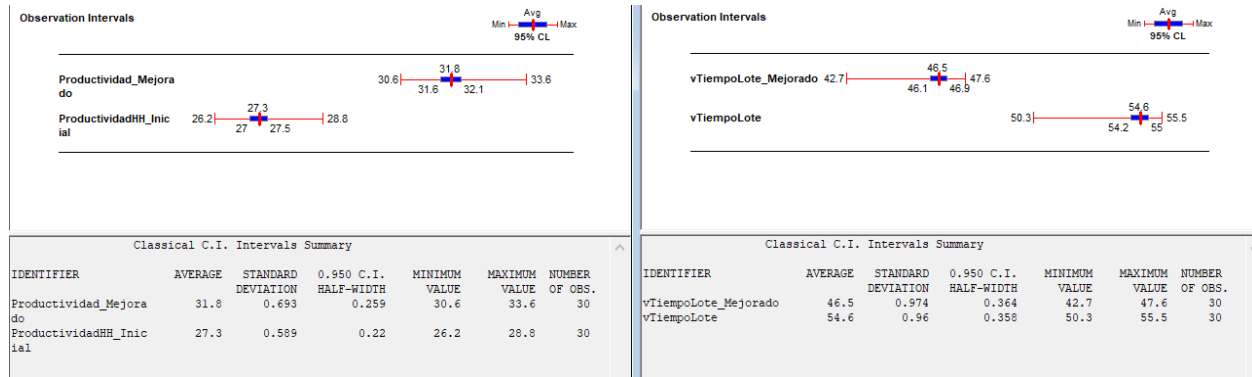


Figure 7. Output Analyzer Report

The simulation outputs from independent replications were compared using a paired t-test at the 95% confidence level. The results demonstrated that the proposed scenario produced statistically significant improvements over the current system, supporting the effectiveness of the proposed methodologies.

6. Conclusion

The implementation of work standardization and SLP tools in the production of salmon fillets has proven to be an effective strategy for improving the evaluated indicators.

The Arena simulation projected an increase in productivity from 27.3 to 31.8 kg/man-hour, representing a 16.48% improvement. The improvement is attributed to reduced variability in filleting times and better workplace organization. Furthermore, the simulation results project a 14.84% reduction in cycle time under multiple replications. In addition, after executing SLP, operator effort was reduced by 5.59%. These findings confirm the effectiveness of the proposed improvements and demonstrate the value of integrating these tools.

Throughout the study, some limitations were noted, including the scarcity of scientific literature on processes and contexts similar to those addressed in this research. Another limitation is that the study was conducted exclusively on the salmon processing line. Although this limits the scope of the findings, it also provides an opportunity for future researchers to implement and adapt the proposed methodology to other processes and product lines. Consequently, this research provides a practical framework for improving productivity in salmon filleting processes and can serve as a reference for similar food processing industries seeking to enhance their operational performance.

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