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Original Article

Minimization of Product Distribution Delays through An Integration Model of Lean Manufacturing Tools and A3 Report - Case Study

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Abstract *- Latin american and caribbean Gross Domestic Product (GDP) is about 70% of manufacturing. Product supply is vital for mass consumption enterprises due to population consumption. Improving value chain logistics maximizes business opportunities. Hygiene products sell well. Pallet shortages impede delivery. This study proposes a model that integrates the lean six sigma framework, the lean manufacturing principles, and the A3 report as communication and monitoring tools to ensure improvement success. Increased pallets supply sped product delivery. The integrated model uses the design for Six Sigma and standardized work tools to design the new process and the A3 report methodology to show the importance of the problem, the countermeasures proposed for immediate implementation, and the indicators for monitoring and controlling the improvement project. Performance increased pallet availability by 92%. The new process of pallet repairs increased efficiency to 95%. This study sets the stage for future research and may help other firms with comparable difficulties.*

Keywords *- Redesign of process, Standardized work, Lean thinking, DFSS, A3 report, PDCA.*

1. Introduction

In recent years, operational delays have become a fundamental problem for the manufacturing industry. Companies aim to optimize waiting times in industrial processes, which leads to an integral mapping, substituting activities that do not generate value, or redesigning said method. It is essential to maintain low manufacturing costs within a controlled environment governed by safety and quality standards but also under the rigour of the expected productivity indicators to ensure economic profitability for industrial companies [1].

In Latin America and the Caribbean, the manufacturing sector's contribution represents more than 70% of the value added on average. For this reason, the industry is considered a primary source of work since it creates more than 10% of employment [2].

In the case of Peru, according to data from the Ministry of Production, the manufacturing sector grew by 3% in 2021 compared to 2019. The comparison is made against that year since it was a pre-pandemic period, and there is a more significant similarity in the global context. This growth is due, to a large extent, to the results obtained in consumer goods (+17.3%) and intermediate goods (+30.7%). In both cases, industrial exports and domestic demand were the main reasons. All this led to the contribution to the GDP of this sector moving to 13% [3].

For this study, we will take the case of a transnational mass-produced company with operations in Lima and primarily responsible for the supply of personal hygiene products for domestic and industrial use, which has been observing, in its latest production reports, a deficit in the times to manage the delivery of orders on time. Mostly, this is due to internal problems within the warehouse area, where precisely the insufficiency of pallets to locate the goods was evidenced, this being a material that suppliers supply and that, on occasions, the failure to deliver sufficient pallets has led to operational delays that have a direct impact on two crucial factors for the company: supply time and volume. These factors maximize the productivity of the process and, therefore, increase efficiency.

It should be noted that in internal material handling processes, one of the considerations left out is using materials or tools to facilitate the handling and protection of products; in this case, those, such as pallets, usually do not have a role. It is essential for some companies, and in scenarios where high production volumes are handled, it has been possible to show that their absence has represented a delay in the transfer of goods, especially within industrial environments.

Recollecting success stories on the same casuistry worldwide, an implementation of the lean manufacturing approach and mapping analysis was found in a manufacturing company in Bangladesh. As a result of the said implementation, the Key Performance Indicator (KPI) Delivery time was reduced by 7.1%, managing to solve the main problem of delays in the delivery of its products [4].

A similar scenario was observed in the case of a manufacturing company, where Standardized Work (SW) was implemented to analyze, identify, improve, and control processes. Thanks to this, it was possible to optimize them, eliminating the activities that did not generate value. The result of this implementation was positive; productivity increased by 6.5% [5]

Although we found enough information on lean manufacturing and standardized work, the proposal to work additionally involves implementing design for Six Sigma. This scenario means that our search sources on previous studies are scarce. This is exacerbated in the case of manufacturing companies, the sector to which this study is directed.

This academic article has been divided into the following sections to promote the proposal: State of the art, including a discussion of the problem's history as it relates to various authors' approaches and instruments. Contribution in which the theoretical and proposed foundations are explained with their respective indicators. Validation in which the outcomes are described before the intervention, the execution of pilot programs, Conclusions, and Discussion.

2. Literature Review

2.1. Lean Thinking

The lean philosophy method is to achieve more with less, systematically reduce activities that do not generate value, and eliminate waste to provide value to the customer [6]. It was designed and implemented for the first time in the Japanese automobile manufacturing industry within the Toyota Production System (TPS) to redesign and improve processes differently. This thought mentions five principles to generate value from the consumer's perspective: (1) identify value, (2) map the value flow, (3) create flow, (4) establish attraction, and (5) seek perfection [7].

It is applied based on process flow analysis and value stream mapping: visualize and quantify. A success story was carried out in a pharmaceutical company in Indonesia, where the problem was evident in the increase in the operation costs in the distribution of products. The tool's implementation focused on reducing certain activities and improving the efficiency of the supply chain, resulting in a 40% reduction in total delivery time and, consequently, increasing productivity by 200%, creating a competitive advantage [6].

2.2. Standardized Work (SW)

When we talk about standardized work, we refer to a tool that aims to standardize any process to manufacture the product most efficiently. It is essential to analyze those activities within a said process that do not generate value to eliminate them; this helps reduce process failures, redesigning it and improving the cycle times of each activity within the new process. If we refer to this point, it is necessary to mention the production rate. This must be given concerning the market demand for said product, which increases productivity as the primary goal [8].

This typology has been applied in different industries, such as manufacturing. The authors used it in a Peruvian furniture factory, achieving a 6.5% productivity growth as a final goal in that workshop [9]. Other authors applied it in the consolidated cargo sector. They used this typology of standardized work to facilitate the activities within the company's process, significantly reducing order cycle time by 19.95% and, for large orders, by 20.26% [10].

2.3. Design for Six Sigma (DFSS)

The Sig Sigma methodology is established as a tool with which production processes can maximize their quality standards. The premise of using this tool is to replace problem-solving with early problem identification. There are two types of implementations used in Six Sigma: Define, Measure, Analyze, Improve, Control (DMAIC) for Quality Improvement and Define, Measure, Analyze, Design, Verify (DMADV) for process design. Most industries apply DMAIC for product quality improvement and DMADV for new method design to design a new process. In this case, the application of this tool is directed toward the use of the DMADV typology. This implemented a series of steps structured according to inputs and outputs. The inputs are the actions performed on each item, and the result is the effect these actions will have [11].

As a first step, it is proposed to define the model from a vision of the work team and the establishment of objectives. Identify is the second step, where the product's qualities, the critical parts of the process and the analysis of techniques will be determined. Subsequently, Measure is considered. In it, we involve the measurement of vital and general factors. Next is Design. Here, the new process is formulated and defined, substituting or eliminating activities that do not generate value according to the users' needs to establish objectives and allowable tolerances and then optimize. Here, the design development will occur by constantly evaluating the new production method.

This guarantees the improvement of the critical points concerning quality and productivity. Lastly, Verify. In this step, the process's capacity will be reviewed considering the users' evaluation, and the new process will be established [12]. This tool was applied in the automotive sector to manufacture a spare part that complies with the Six Sigma standards to satisfy the clients with the quality of the products in terms of the performance of the features. The quality is fundamental in the fabrication process. Thanks to the application of DFSS, it was possible to considerably reduce the number of defects in the pieces by 4.83%, reaching the target level and leading to significant profit results [8].

2.4. A3 Report and Cycle PDCA

The A3 report method originates from one of the branches of Lean management, whose approach is attributed to a better approach to the tools and principles that are demanded to reinforce service and quality levels and contribute to eliminating waste during industrial processes [13]. The primary objective of this tool consists of detecting rework or waste in the production chain, allowing the compilation of essential information about a specific problem or a set of issues in the chain, which can be perceptible in short periods. Time can be recorded utilizing an A3 paper format of commonly known dimensions of 297x420 mm and 11.69x16.54 in. In terms of its execution, it is based on the Plan-Do-Check-Act (PDCA) cycle [14, 15].

Compliance with six general sections has been recommended, which include context, current condition, condition to be achieved, root-cause analysis, implementation plan and audit [16]. We mention the A3 problem-solving model that achieves method optimization and is aligned with maximizing results concerning the proposed objectives. Outline and make visible in summary ten steps (problem, background, current condition, goal, root cause, objective condition, countermeasures, implementation plan, test, and follow-up), which serves as a guide for implementing or improving industrial processes. Such is the case of the motorcycle manufacturing industry in the machining sector. The process improvement resulted in a reduced 70.4% preparation time (setup) of the machines; thanks to its development, the company will not see the need to add a third production shift [17].

The PDCA cycle is based on the philosophy developed by Edwards Deming in 1930, where the principal concepts associated with quality were established, which were later incorporated into international standards such as ISO 9001. Its primary use was for quality control oriented to the manufacture of products. Still, exponentially, its extension was projected towards a method that allowed the development of significant improvements in processes at any level, becoming a logical cycle that allows for improving the flow of activities or operations of PDCA [18, 19].

3. Methodology

Gathering existing academic and research information is essential as an initial part of the proposal approach. An analysis of the casuistic of each study was carried out to obtain tools of proven success that are aligned with the problems presented in this study. According to this analysis, we can understand that specific methodologies will optimize the result for the various components of the problem. According to what has been compiled, lead manufacturing and its derivatives are the most convenient method in the time optimization indicator. In addition, it is a tool to facilitate visibility in various industrial processes.

Table 1. Comparative matrix of the components of the proposal model vs Literature review

Articles \ Components	Component 1: Reduction of Delivery Time	Component 2: Process Improvement or Design	Component 3: Productivity
Pérez-Pucheta, C. E., Olivares- Benitez, E., Minor-Popocatl, H.,Pacheco-García, P. F., & Pérez-Pucheta, M. F. (2019).	Lean Manufacturing A3 Report		
Mor, R. S., Bhardwaj, A.,Singh, S., & Sachdeva, A. (2019).		SW	SW
Arredondo-Soto, K. C., Blanco-Fernández, J., Miranda- Ackerman, M. A., Solis- Quinteros, M. M., Realyvásquez-Vargas, A., & García-Alcaraz, J. L. (2021).		Lean Manufacturing Practical Process Improvement (PPI)	PDCA Lean
Shojaie, A. A., & Kahedi, E.(2018).		DFF (ICOV)	
Rossini, M., Audino, F., Costa,F., Cifone, F. D., Kundu, K., &Staudacher, A. P. (2019).	Lean Manufacturing A3 Report	Kaizen	PDCA Lean
Proposed Tools for the Integrated Model	**A3 Report**	**SW & DFSS (DMADV)**	**PDCA**

Regarding the improvement and redesign of processes, it is decided to use the SW, the DFSS methodology, and the PDCA cycle to improve productivity. As a starting point, a comparative analysis of collected cases is carried out to arrive at the proposal of this article. Table 1 shows the study of the proposed tools for forming the integrated model.

3.1. Proposed Model

The model proposes integrating the lean six sigma framework, lean manufacturing principles, and the A3 report to reduce operational delays in the distribution process and increase productivity. For the development of the model, the analysis of the problem is treated as the first component to identify the root causes. This is achieved by applying diagnostic tools such as the Pareto diagram, Ishikawa diagram, and problem tree. The leading cause was the low pallet availability, which generated operational delays in the pallet distribution process. The second component tries to apply the redesign of the process through 5 phases: (1) define the causes that generate the delays in the delivery of products; focus on the VOC, guaranteeing quality and satisfaction by improving delivery times; (2) measuring through indicators of time, units and productivity, (3) analyzing thoroughly through tools that help in visual search for find the cause of the root problem, (4) design new methods through standardized work eliminating activities that do not generate value to the process. Finally, (5) verify through the evaluation of the indicators by comparing the results pre-and post-implementation of the improvement.

As a third component, it is used using A3 Report; this tool is beneficial and allows us to visualize the progress through the PDVA method for continuous improvement. For this new process, the standardized work methodology is applied to define and eliminate those activities from the entire process that do not add value. Finally, the instruments and tools of the model components are aligned and focused, creating synergies with the objectives mentioned above. Lastly, for the proposal to be consistent in the long term and to continue to improve the efficiency of pallet stock management. In Figure 1, the proposed model is shown in a summarized way. Next, the implementation process of the proposed integrated model was developed to have a reference for its immediate application in the case study, as shown in Figure 2.

3.2. Model Indicators

The necessary indicators that align with the elements of the proposed method are detailed below.

- Availability of pallets: Quantity of pallets required by the company concerning the quantity of available pallet stock, expressed as a percentage.

$$\text{Pallets Availability}(\%) = \frac{\text{Quantity of pallets required}}{\text{Quantity of available pallets stock}} \times 100$$

- Efficiency: Installed capacity refers to the actual repair of pallets. Concerning the available ability, this capacity is expressed as a percentage.

$$\text{Efficiency}\ (\%) = \frac{\text{Installed Capacity}}{\text{Available Capacity}} \times 100$$

- Productivity: The proportional inverse concerning the unit cost of pallet repair in the initial and final scenario, expressed in Pallets/PEN.

$$\text{Productivity} = \frac{\text{Number of pallets repaired in a month}}{\text{Total cost of pallet repair shop}}$$

- In addition, the differential delta value: The difference between the final and initial productivity with respect to the initial productivity, expressed as a percentage.

$$\%\Delta P = \frac{\text{Pfinal - Pinitial}}{\text{Pintial}} \times 100$$

- Unit cost per pallet repaired: The total sum of all costs necessary for repair in both scenarios (internal and external).

$$UC = \frac{\text{Labour Costs + Material Costs + Tooling Costs + Indirect Costs}}{\text{Total pallets repaired}}$$

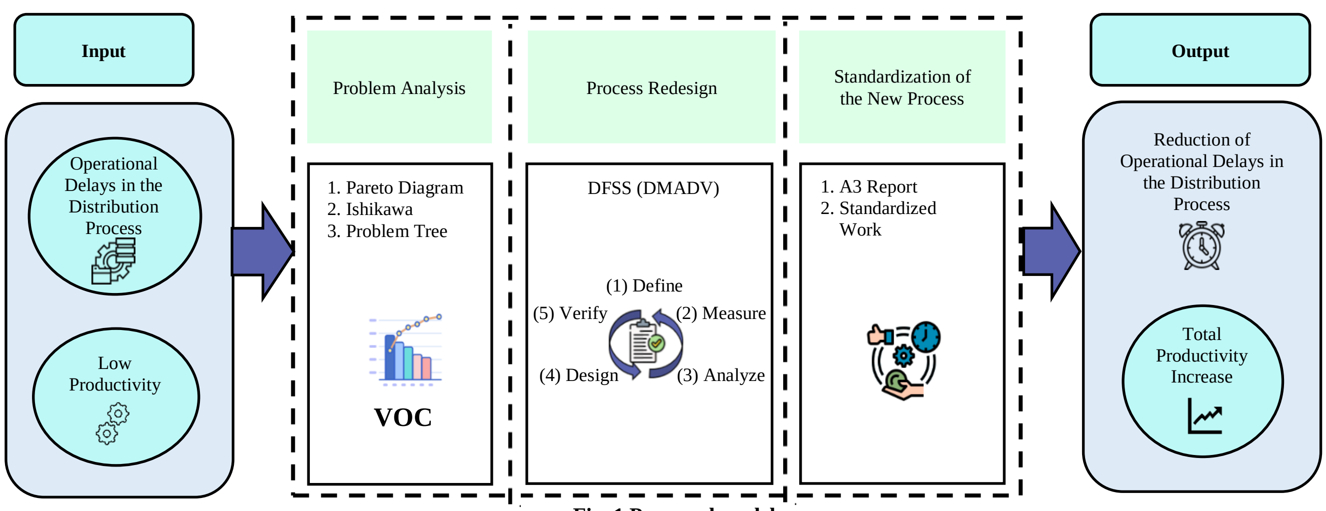

Fig. 1 Proposed model

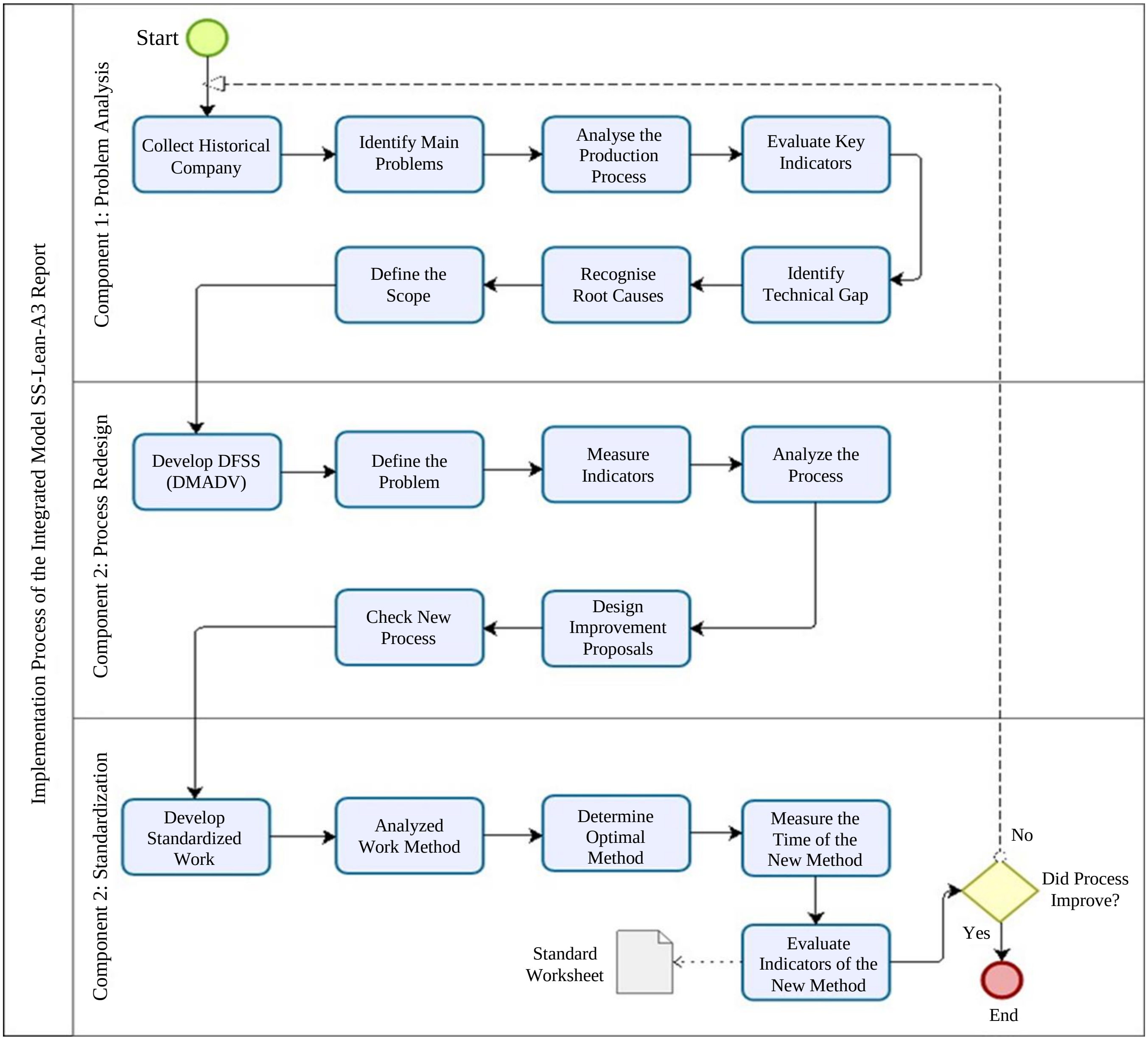

Fig. 2 The flow of the proposed method

4. Results

4.1. Validation Scenario

The validation scenario was developed in a case study in a company that belongs to the mass consumption sector, which is responsible for developing personal hygiene and cleaning products, providing solutions for the care of people the main person in charge of the supply of said products for domestic and industrial use. For the validation of the proposed model, all the tools offered in the model were implemented to solve the problem.

4.2. Initial Diagnosis

After analyzing the inefficiency of the product distribution process, a bottleneck linked to the stock of available pallets was found. Many pallets end up damaged in the logistics process due to constant use. These damaged pallets were sent to an external provider that provided the repair service, who could only supply a minimum number of pallets, in addition to delay in the delivery.

In the study case, three distribution lines must be supplied with an available stock of pallets that reaches 49% in the first scenario, which, compared to the indicator necessary for optimal distribution of 94%, needs to be more. Therefore, it is necessary to analyze those factors that impact the problem. The non-compliance of external suppliers, the delays in delivering the pallets, and the insufficient stock of pallets due to inadequate personnel to repair more pallets due to increased demand for the products since the need to distribute more products requires a more significant number of pallets improved. For these reasons, it was necessary to implement a project by the same company to repair damaged pallets. Figure 3 shows the problem tree that summarizes the diagnosis.

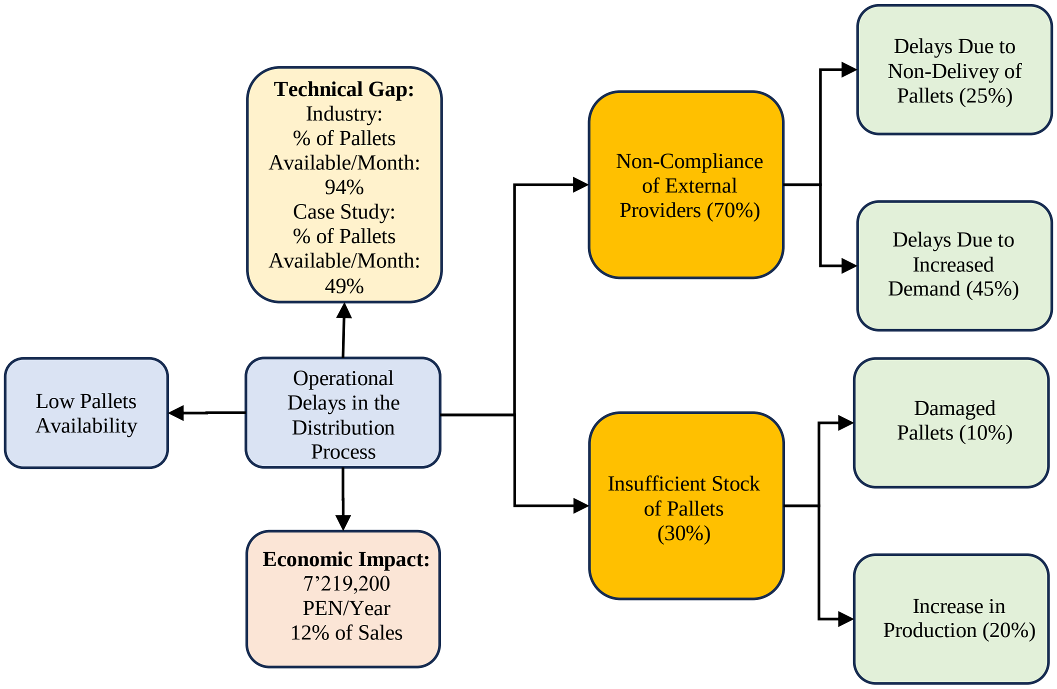

Fig. 3 Problem tree

Finally, Table 2 shows the main indicators of the research problem solved.

Table 2. Dashboard with current case study indicators

Indicators	As Is
Pallet availability (%)	49
Efficiency (%)	N/A
Productivity (pallet/PEN)	0.026
Unit cost per pallet repaired (PEN)	37.50

4.3. Validation Diagnosis

The validation of the proposed model was carried out by implementing all the tools of the improvement proposal. At the beginning of the improvement, the DSFF was deployed, obtaining the following results:

4.3.1. First Phase: Define

Remember that the main problem is operational delays in the product distribution process. In this first phase, the objective is to define the causes using the VOC tool. This useful tool allows us to describe customer feedback about their experiences, allowing us to discover the customer's critical requirements and the process. Thanks to the application of the VOC, it is understood that to avoid delays, it is necessary to comply with the pallet stock requirement. According to the logistics operations area, a minimum of 800 available pallets per week is needed to supply the distribution lines. In the pre-implementation scenario, only 442 weekly pallets were known that the external supplier provided. Figure 4 shows the development of the VOC.

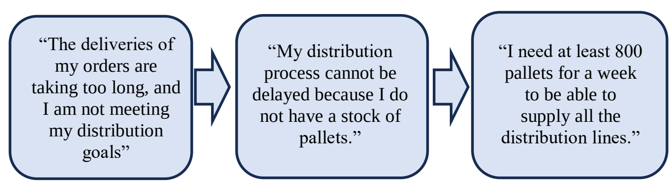

Fig. 4 Voice of the customer (VOC)

For this reason, an action plan was taken regarding the implementation of an internal pallet repair workshop in the mass production plant to be able to supply the requested quantity per week since, as mentioned above, the external supplier that repaired the pallets did not meet the delivery deadlines or the amount requested.

4.3.2. Second Phase: Measure

The main results indicators of the initial scenario, which is the outsourcing service, were evaluated, obtaining the following results:

Availability Indicator: The company requires 800 pallets to continue the normal product distribution process. In this scenario, only 416 available pallets were supplied by the external supplier to provide the distribution lines. Resulting in a 49% availability of pallets, generating problems in meeting and delivering orders to different customers on time.

Unit cost: The outsourcing service repaired each pallet for 37.50 PEN, including all costs such as inputs, raw materials, and personal labour. It was costly since they fixed more than 400 pallet batches per week.

4.3.3. Third Phase: Analyze

The problem of operational delays negatively impacted distribution by being unable to supply pallets to all lines. An analysis was carried out, considering the result of the indicators showing the high degree of criticality in the availability of pallets and the low productivity. As for efficiency, it depends on the availability of pallet stock, the leading cause of the problem. This breach was due to the third-party supplier's delay in delivering repaired pallets. In addition to the delay, the number of pallets they were improving needed to be increased to supply all the distribution lines. When carrying out the outsourcing repair service, there needed to be more control and supervision, which generated uncertainties regarding the quality of the materials, the difference between the pallets left for repair, and those that returned to the plant. Another negative factor was reflected in the repair costs of the pallet repair service; 37.50 PEN/pallet was considered very high since the volume of pallets to be repaired could have been better. Thanks to this analysis, it was decided to implement an insourcing pallet repair shop. In Figure 5, the Ishikawa Diagram is shown, which allows us to find the causes.

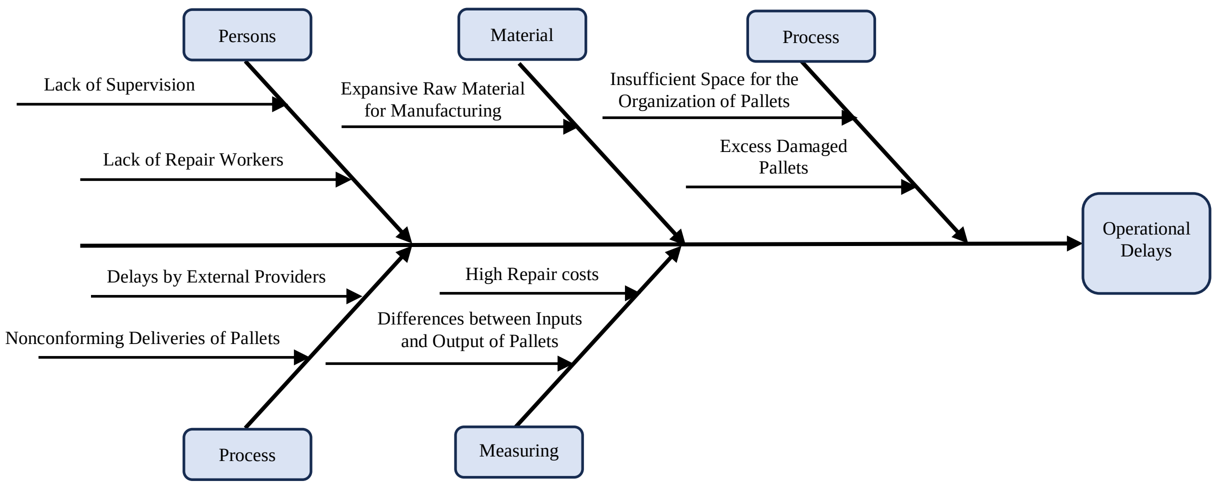

Fig. 5 Ishikawa diagram

4.3.4. Fourth Phase: Design

The proposal to implement an In-House pallet repair workshop aims to optimize the delivery of these for the distribution of the products. In this penultimate stage, the workshop's design is carried out, considering the optimization of spaces for an optimal repair process. To determine this point, it is established that the process consists of 4 activities, explained below.

- Segregation Process: This activity seeks to select pallets in optimal conditions to be repaired according to quality standards. Pallets that are very worn are considered low; that is to say, they are discarded.
- Cannibalization Process: In this process, the operator oversees removing those parts of the pallet that he needs to replace.
- Assembly and Nailing Process: This activity aims to replace empty spaces on the pallet with Material in good condition and then assemble it through the nailing process.
- Quality Control: In this last process, 100% revision of each pallet is sought; you should not find any wood in bad condition. If this happens, the rework is applied, and the pallet returns to the assembly and nailing process.

Next, in Figure 6, the process is summarized through a block diagram.

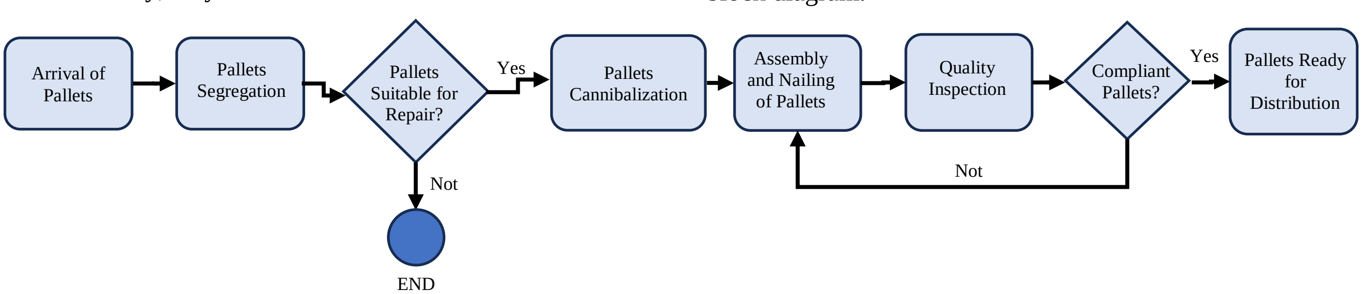

Fig. 6 Pallets repair process

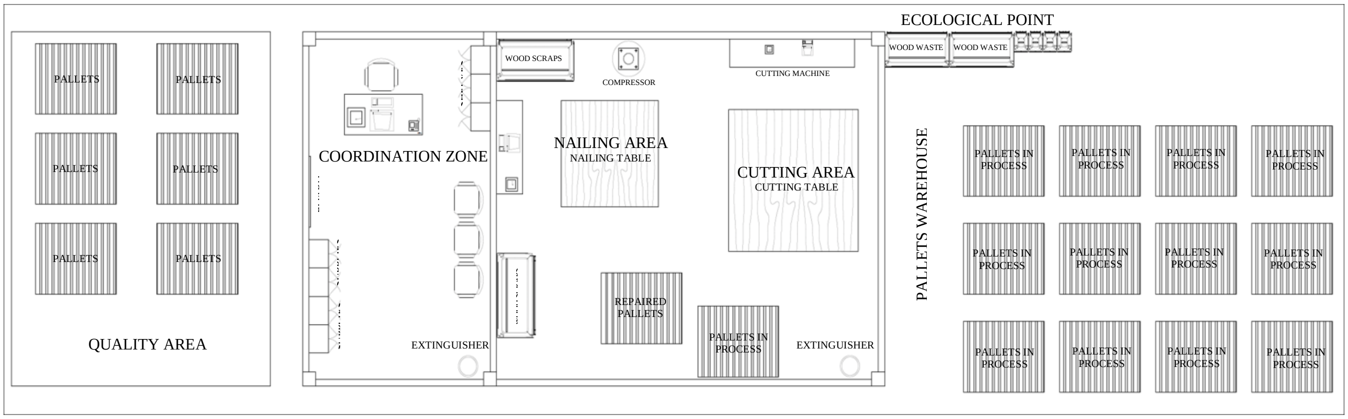

Fig. 7 The layout of the new pallet repair process

The layout developed for the internalization of the pallet repair process is shown in Figure 7. For the design and development of the work method of the pallet repair process, the lean tool standardized work was used to establish the optimal strategy and the conditions of space and furniture for optimal productivity in this new repair process.

Here, it was possible to define the optimal number of operators, 3, and the most efficient sequence with the required space and tools. All this implementation process is summarized with the standard worksheet used for training, monitoring, and control of this new process. Appendix 1 shows this artifact.

A fundamental tool for this improvement process was the A3 report tool, which engaged all project personnel and the company's senior management. With this tool, it was possible to show the importance of the problem and the countermeasures proposed for its immediate implementation and the monitoring and control indicators of the improvement project. Achieving in this way a successful result within the deadlines established in the project. Appendix 2 shows the A3 report used to execute this process improvement project.

4.3.5. Fifth Phase: Validate

Applying the proposal through the implementation of the insourcing pallet repair shop for the distribution of products in a mass consumption company made it possible to observe improvements in pallet availability, efficiency, and productivity. In addition to the savings for pallet repair. The implementation of the repair shop based on the proposed integrated model is shown below:

Figure 8 shows the workshop implemented in the case study plant. Figure 9 shows the segregation station for pallets received from the finished products warehouse. In this process, the pallets suitable for repair are classified according to the quality standards established by the finished products warehouse.


Fig. 8 Implemented workshop view


Fig. 9 Pallet segregation process

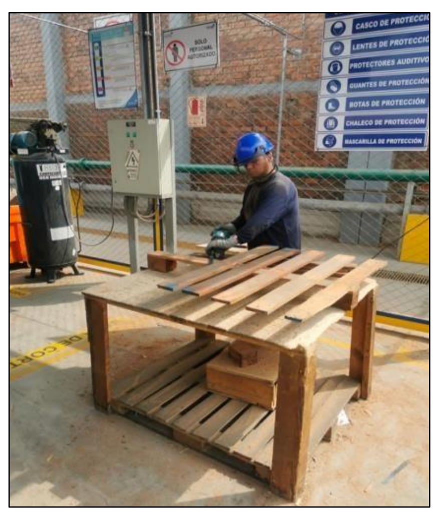
Fig. 10 Pallet cannibalization

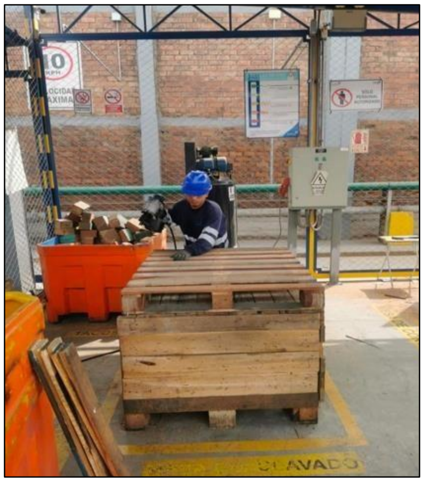

Fig. 11 Nailing and assembly process of pallets

Fig. 12 Quality process

Fig. 13 Finished pallets

Figure 10 shows the cannibalization process of suitable pallets; in this process, the damaged parts are removed, discarded and replaced by parts in optimal conditions. Then, as shown in Figure 11, the assembly and nailing process of the pallets to be repaired is carried out. Once finished, the quality control process continues, as shown in Figure 12. Finally, after the pallet quality review, all repaired pallets are stored in the distribution area assigned to the side of the workshop, as shown in Figure 13.

Next, in Table 3, the comparative analysis of the indicators of the improvement implemented versus the initial situation is observed.

Table 3. Analysis of the indicators of the improvement implemented versus the initial situation is observed

Indicator	As Is	Results	% Δ
Pallet availability (%)	49	94	92%
Efficiency (%)	-	95	-
Productivity (pallet/PEN)	0,026	0,095	165%
Unit cost per pallet repaired (PEN)	37,50	10.50	157%

5. Discussion

The decision to convert an outsourcing service into insourcing by implementing an In-House flooring repair workshop and applying standardized work to design a new process, control it and supervise it was the most optimal and effective way to solve the problem of the operational delays in the distribution of products since there was not enough stock of pallets, demonstrating growth from 49% to 94% in the availability of pallets, achieving an improvement of 92%. This working method always gives good results, significantly increasing the order rate range from 94.79% to 96.13% [10]. On the other hand, in the initial scenario, as it was an external service, the ability of the operators to repair pallets was not controlled, so the levels of efficiency were deficient, and this was reflected in the small number of pallets that they fixed and the delays in delivering these pallets. In contrast to the new scenario, it reaches up to 95% efficiency [20]. It also applied the DFSS methodology of the DMADV typology, saving 26% in one week considering the shortest term.

6. Conclusion

Implementing an integrated model that combines the Six Sigma framework, Lean Manufacturing principles, and the A3 report in a company that manufactures hygiene products yielded positive results by identifying the primary causes of the problem and proposing an integrated solution model as a mitigation measure. It is also essential to note that human value plays a crucial role in implementing these techniques, as employees' dedication to the enhancement process will be reflected within a short time frame. The state should provide programs or entities that promote and support the training of lean manufacturing models to give manufacturing companies the best facilities possible. The development of this research was aimed at increasing the availability of pallets through an effective repair process. We take five indicators that allow us to visualize the increase in the efficiency of said process.

As we mentioned before, the percentage of availability of pallets was the leading indicator of analysis. In it, we got a 92% reach. The efficiency had increased, reaching 95%. In terms of productivity, growth was substantial, reaching 165%. Another factor (and one of the most important) is the unit cost, which was reduced by less than half to 10,5 PEN.

Finally, it is convenient to indicate that the company, in the initial scenario, generated an opportunity cost for not meeting its logistical needs.

This cost was based on the volume of merchandise not transferred, which amounted to 7 219 200 PEN. In other words, implementing the project and generating considerable savings for the company allowed it to maximize its income due to the mobilization of this stagnant merchandise.

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Appendix 1 - Pallet Repair Process Standard Worksheet

In-house Pallets Repair	Time	Area	Activity	Work Team
	8 Hrs	Distribution	Repair of pallets	3 operators and 1 supervisor

Required Personal Protective Equipment (PPE)

Helmets	Glasses	Safety shoes	Gloves	Auditory protector	Dust respirator	PPE cannibalization	Vest	Face shield	PPE Segregation

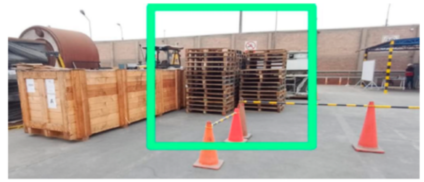
Equipment/Tools

Nail	Wood	Spare parts	Compressor	Cutting machine	Nailing machine

1

Process N° 1: Arrival at the workshop of more than 800 damaged pallets per week for subsequent repair.

2



Process N°2: Segregate or choose the pallets that are in considerable condition, according to quality to start the repair.

3

Process N° 3: Cannibalize the selected pallets suitable for repair.

4

Process N°4: Assemble and nail the pallets, filling the spaces that need to be replaced with raw material.

5

Process °5: Review each pallet and verify if they were repaired according to quality standards.

6

Process N°6: Repaired pallets available to distribute the products.

Appendix 2 - A3 Report of the Pallets Repair Process

1. TITLE	Reduction of operational delays regarding the availability of pallets in the distribution process			Format A3 Problem Solving					
OWNER:	Supervisor	PARTICIPANTS:	3 operators	COACH:	Supervisor	STATUS:	Developing	DATE:	Jun-23

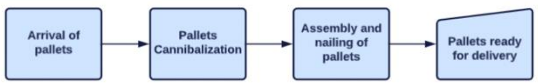
2.CONTEXT

Currently, there is a low availability of pallet stock, generating operational delays in the distribution process of hygiene and personal care products.

3.CURRENT SITUATION

After carrying out an analysis of the inefficiency of the product distribution process, a bottleneck linked to the stock of available pallets was found. Within the logistics process, a large number of pallets end up damaged due to constant use. These damaged pallets were sent to an external provider that provided the repair service, who could only supply a minimum number of pallets; in addition to delay in the delivery of the same.

In the study case, there are 3 distribution lines, which must be supplied with an available stock of pallets that reaches 49% in the first scenario, which compared to the indicator necessary for optimal distribution of 94% is not enough. Therefore, it is necessary to analyze those factors that have an impact on the problem. The non-compliance of external suppliers, the delays in delivering the pallets, the insufficient stock of pallets due to insufficient personnel to be able to repair more pallets due to the increase in demand for the products, since the need to distribute more products requires greater number of pallets repaired. For these reasons, it is necessary to implement a project by the same company to



4.GOALS

1.Eliminate or decrease operational delays in the pallet distribution process
2. Optimize the stock in the availability of pallets to supply the 3 distribution lines
3. Increase productivity

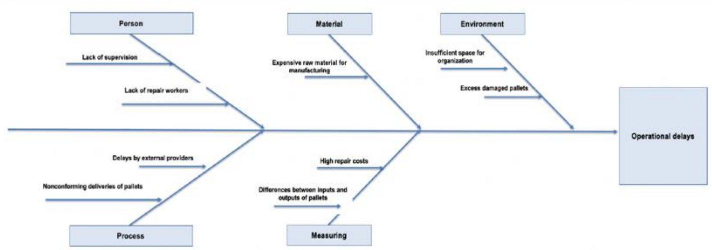
IMPROVEMENT OPPORTUNITIES

- Standardize the pallet repair process
- Significantly reduce pallet repair costs
- Optimize the distribution of pallets for the mobilization of 7,219,200 PEN

KPI's

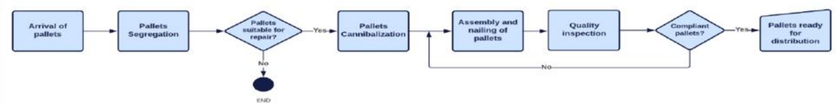
- Increase pallet availability

5.ANALYSIS OF CAUSES

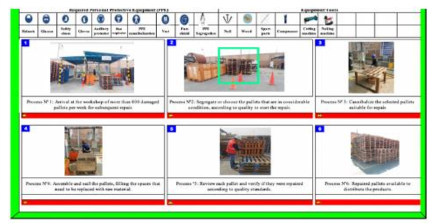


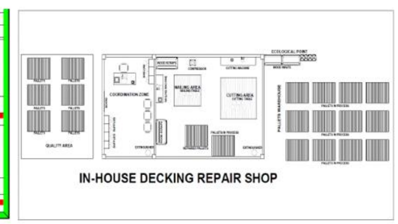
6. COUNTERMEASURES - ACTION PLAN

The proposal to implement an In-House pallet repair workshop aims to optimize the delivery of these for the distribution of the products. The process consists of 4 important activities.
1.Segregation Process: This activity seeks to select those pallets that are in optimal conditions to be repaired, according to quality standards. Pallets that are very worn are considered low; that is to say, they are discarded.
2.Cannibalization Process: In this process, the operator is in charge of removing those parts of the pallet that he needs to replace.
3.Assembly and Nailing Process: The objective in this activity is to replace empty spaces on the pallet with material in good condition, then assemble it through the nailing process.
4.Quality Control: In this last process, 100% revision of each pallet is sought; you should not find any wood in bad



The standardized worksheet is carried out in order to summarize the new insourcing pallet repair process and the new layout showing the new pallet distribution process.





7.RESULTS

INDICATOR	MODEL AS IS	MODEL TO BE	RESULT OBTAINED FROM THE IMPROVEMENT
PALLET AVAILABILITY (%)	49	94	92%
EFFICIENCY (%)	-	95	-
PRODUCTIVITY (pallet/sol)	0.026	0.095	165%
UNIT COST PER PALLET REPAIRED (PEN)	37.50	10.50	157%

8.SEGUIMIENTO

Carry out continuous audits in order to control compliance with the action plan, the audits would be scheduled but not notified. In the first place, the planning of the audit program is given, then the planning of the process. The most important part is the execution of the audit, which helps to define the corrective actions to be taken for continuous improvement.