Production Model Based On 5S And SLP To Improve Efficiency in A Food Industry Company

Rodrigo Kohata-Tirado, Santiago Morales-Arce
Facultad de Ingeniería y Arquitectura
Universidad de Lima
Peru
20180982@aloe.ulima.edu.pe, 20181234@aloe.ulima.edu.pe

Martín Fidel Collao-Díaz
Research Professor
Facultad de Ingeniería y Arquitectura
Universidad de Lima
Perú
mcollao@ulima.edu.pe

Abstract

The manufacturing sector is one of the most influential sectors in a country's economy, as it determines its current status and growth. Within this, the food and beverage industry is one of the biggest ones, representing a large part of the sector in Peru. Hence, the purpose of this research will be to improve the efficiency of one company in the food and beverage industry. Through the tools of Systematic Layout Planning and 5S, belonging to the Lean Manufacturing methodology, measures were proposed in order to achieve the objective. The first consists of generating proposals for plant distribution that allow optimizing times and reducing distances. Through the ARENA software, this tool could be simulated, obtaining promising results. As for the 5S, this will allow to keep the work areas clean and organized, managing to improve the flow of materials and the work environment. This research succeeded to increase the efficiency of the company's plant, demonstrating the effectiveness of these tools. In this way, this paper will serve for future research on Lean Manufacturing tools applied in the food and beverage industry.

Keywords
Lean Manufacturing, 5S, Systematic Layout Planning, Efficiency, Food Industry.

1. Introduction
The manufacturing sector is a fundamental pillar for the growth of a country, both economically and competitively (Legarda-Zaragueta et al. 2014). This industry is a measuring tool to determine the economic situation of a country, besides being capable to identify the general economic behavior (Prospecta 2014). For this reason, a key to the manufacturing sector is plant efficiency, since it seeks to make the most of resources and create a relationship between the objective and the results obtained. In other words, good results are sought with the least effort (Chapman 2006). Likewise, the food and beverage sector generates a large part of the production and employment in industrialized countries (Organización Internacional del Trabajo 2022). In the case of Peru, this industry contributed 3.7% to GDP in 2019, which represented 26.2% of the manufacturing sector. In addition, it generated around 417,000 jobs (Sociedad Nacional de Industrias 2020). Regarding production, this obtained a percentage variation of 7.4% in 2021 compared to 2020, which shows a great growth in the production of the sector in the span of a year (Instituto de Estudios Económicos y Sociales - Sociedad Nacional de Industrias 2021). This growing industry means that companies must be more efficient, as they must make the most of their resources in order to meet demand. However, this is not a reality, since only 36% of manufacturing companies belonging to the food industry in a country with similar conditions to Peru seek to improve processes and solve efficiency problems (Chinchillas 2010).

The reviewed literature indicates different causes for which efficiency can fail in a manufacturing company. The most common are excess waste, high cycle times, idle capacity, high unproductive time, the useful life of the machinery, among others. In this way, these are common indicators to determine the efficiency of production processes (Cuggia-Jiménez et al. 2020). This problem has been dealt with in different investigations where different engineering tools were used to face it and obtain better results. Case studies such as the improvement of the production line of a color industry showed that increasing efficiency allowed the reduction of the company's production time from 8.5 days to 6 days and the value of added time from 68 minutes to 37 minutes using engineering tools such as VSM and Lean Manufacturing (Rohani 2015). Another case showed a 22.5% reduction in setup times for different machines, as well as a 26% reduction in unproductive times when using Lean Manufacturing (Aucasime-González et al. 2020). Lastly, research at a food industry company in the UK was able to reduce changeover time by 30% and production costs by 10% by using SMED and Lean Manufacturing. This demonstrated that using these tools can be more efficient and economically sustainable when carrying out manufacturing operations (Garcia-Garcia 2022).

Having identified this problem, plant efficiency in the food and beverage industries is a really important issue. For this reason, a case study will be carried out that deals directly with this problem. The numbers that the company has are not optimal in terms of plant efficiency, particularly in the Mayonnaise product, causing losses such as the cost of lost opportunity or a large increase in the unit cost of its production. It was identified that unproductive time was one of the main causes that generated this problem. Thus, based on the success stories found in literature review, a solution was developed to address the aforementioned problem, through an improvement model using the 5S and SLP engineering tools. This research not only seeks to benefit the company under study, but also to contribute to the scientific community. Despite the fact that there is a large amount of research in which Lean Manufacturing tools are applied, there are very few studies in which these kinds of methods are used to directly address efficiency problems in the food and beverage industry.

In the same way, the lack of studies of the food and beverage industry in Latin America dealing with this problem encourages research of this nature, such as the present investigation.

1.1 Objectives

1.1.1 General Objective

Increase the plant efficiency of the mayonnaise production line of a company in the food industry in Peru.

1.1.2 Specific Objective

Establish the effectiveness and usefulness of these Lean Manufacturing tools in the food industry.

2. Literature Review

In order to correctly understand the bases and topics covered in this research, a review of the literature was carried out where knowledge was obtained and relationships were shown between the different concepts that would allow a better understanding of these, through the use of criticism and previous studies on the subject. Likewise, the literature review will provide both a context and a justification for the research to be carried out clearly.

2.1 Production Models to increase efficiency in the Food Industry

Food manufacturing companies are of the utmost importance for the growth and stability of a country. In the same way, this is a sector that is very competitive, so it is essential to elements that allow you to stand out. One of these fundamental elements is efficiency. This enables long-term economic growth and better performance as a company. One method that has been found to be effective in dealing with this problem is the implementation of Lean Manufacturing tools. These address the problems that lead to low efficiency, such as unproductive time, high cycle time, and unnecessary travel (Lopes et al. 2015). This methodology is widely applied in other sectors, demonstrating great results and dealing with problems such as constant machine breakdowns and the lost time generated as a result (Aucasime-Gonzales et al. 2020). However, the food industry is behind in the implementation of these tools, since they are not usually applied much in this industry, despite their effective results (Proença et al. 2022).

On the other hand, it was verified that the implementation of Lean Manufacturing tools does manage to improve efficiency in various studies applied in the food sector (Proença et al. 2022). Nonetheless, the commitment of the company's employees to face the Lean methodology was found to be decisive, since the correct implementation of these tools depends on them (Aucasime-Gonzales et al. 2020). In the same way, the lack of commitment and interest of the operators to apply these tools led to the failure of a previous attempt to implement them, further highlighting the significant role that they have in this improvement process (Lopes et al 2015).

2.2 5S Applications in the Food Industry

Organizations have to stay competitive in a changing environment through practices focused on process improvement to avoid the generation of waste and increased costs (Veres et al. 2018). There are some barriers that companies face in order to carry out good practices and achieve this improvement, such as the competitive environment, lack of knowledge, gaps between management and operational areas, poor communication between areas, and the inability to modernize and be able to apply new tools (Singh et al. 2014). A commonly used tool to apply these good practices is the 5S methodology. This tool allows you to focus on optimizing the work area by cleaning and organizing it, to make it much more efficient (Veres et al. 2018). This methodology consists of five aspects, which refer to Japanese concepts that must be carried out. For this, certain questions are carried out that allow to understand the current situation of the different processes and their environment. Once the situation is understood, certain activities can be proposed treating each "S", achieving the improvement of the work area (Velastegui et al. 2020).

Defective products and waste generate large costs for companies, therefore, by using the 5S methodology, these losses can be reduced (Chávez, 2019). In the same manner, it can improve performance, efficiency and productivity, as well as reduce operating costs, unproductive times (Leon-Enrique et al. 2022), and improve safety and health standards (Zocca et al. 2019).

2.3 SLP Applications in the Food Industry

It is important for companies in the food industry to be able to reduce their costs and expenses in order to be sustainable and globally competitive in a demanding market. That is why it is necessary to have a correctly distributed company that allows a fluid production process and flow, since it will contribute to both the economic and environmental sustainability of companies (Gómez et al. 2018). The best way to reduce possible losses according to Muther (developer of the SLP method) is to engage in correct layout planning before installation. However, since it is not always possible to do this, systematic design planning (SLP) is used (Radhwan et al. 2019). This method allows to obtain plant layout alternatives by analyzing the flows of materials, people and equipment, as well as the interaction between spaces and the relationship between these aspects (Ali Naqvi et al. 2016). Furthermore, the SLP method seeks to reduce the distances traveled by personnel and the flow of materials in order to increase the efficiency and productivity of the company, as well as reduce unproductive times, processing time, bottlenecks and waste of the products. This allows obtaining quality products at the lowest possible cost (Ojaghi et al. 2015).

Implementing the SLP method improves plant design and material flows, resulting in fewer distances traveled either between machines or between work areas, improving the efficiency, productivity and income of companies (Amit et al. 2012). It can also lead to better supervision of personnel and gives the possibility of expanding the plant in the future (Haekal and Adi 2020). In order to obtain positive results, it will be necessary to analyze indicators such as distance traveled, time traveled, travel costs, use of resources, waiting times, number of machines, space requirements, among others (Wiyaratn et al. 2013).

2.4 5S and SLP Production Models in the Food Industry

Production models based on Lean Manufacturing tools often bring great benefits to the manufacturing industry (Kennedy et al. 2013). These mainly seek to increase efficiency. However, these tools also manage to reduce waste, in terms of time, and create value through these reductions (Durakovic et al. 2018). Likewise, this generates a reduction in costs and manages to increase competitiveness (Ruiz et al. 2019). On the other hand, the food industry involves very tough competition among the participating companies, as they are increasingly facing challenges that threaten their efficiency and profitability (Kennedy et al. 2013). Thus, this methodology is a very viable solution to face these problems, optimize processes and be more efficient (Zamalloa et al. 2022). The main tools used that are most effective are 5S and SLP, which must be worked with a VSM to obtain a more complete analysis and better results (De Steur et al. 2016).

Nevertheless, despite the fact that the food industry does not have many studies implementing these tools, the Lean Manufacturing methodology can be applied in several industries (Durakovic et al. 2018). These managed to increase the income and profitability of companies (Ruiz et al. 2019). In order to apply them effectively, it is necessary to encourage the participation of workers during implementation, in addition to being in constant supervision (Zamalloa et al. 2022). Finally, it must be taken into consideration that the greatest threat when applying this methodology is the lack of understanding of it, so it must be known in depth and have a literary review that allows having a background about these tools (Durakovic et al. 2018).

3. Methods

For the realization of this production model, a guide based on previously analyzed papers on methods to treat plant efficiency in a manufacturing company was taken into consideration, in order to increase it, through Lean Manufacturing tools. These articles displayed different solutions that can be applied to treat various causes, such as time reduction and area organization. In addition, these papers contain different proposals that set certain guidelines to achieve this study. These guidelines guided the solution of different problems that various investigations share with this study, so the relationship between these and their authors is found in Table 1.

Table 1. Guidelines table

Author	Organization of the workspace	Cleaning of the workspace	Time reduction	Plant layout
Lopes et al. (2015)	5S	5S	-	-
Cháves et al. (2019)	5S	5S	5S	
Amit et al. (2012)	SLP	-	SLP	SLP
Kennedy et al. (2013)	5S	5S	5S	-

In the same way, the literature review showed a considerable number of studies in which Lean Manufacturing tools are applied to solve efficiency problems in different areas. However, there is a shortage of study articles in which these techniques are implemented to address this problem in the food and beverage manufacturing industry, as stipulated by Lopes et al. (2015). Therefore, this research seeks to create a production model that is consistent with this problem and this specific area, serving as a guide for future research and for different companies in this area.

According to the review of these papers, a production model based on the application of 5S and SLP is proposed to increase the plant efficiency of a company in the food industry. This model consists of 4 components: diagnosis, planning, implementation and evaluation of results. These components are adjusted to the company's work methodology and its production model. Moreover, these are in accordance with the analysis carried out on the situation in which the company finds itself and focused on the improvement that is sought to be implemented to face the problem that is to be solved. Figure 1 details each of these components, which will be explained below.

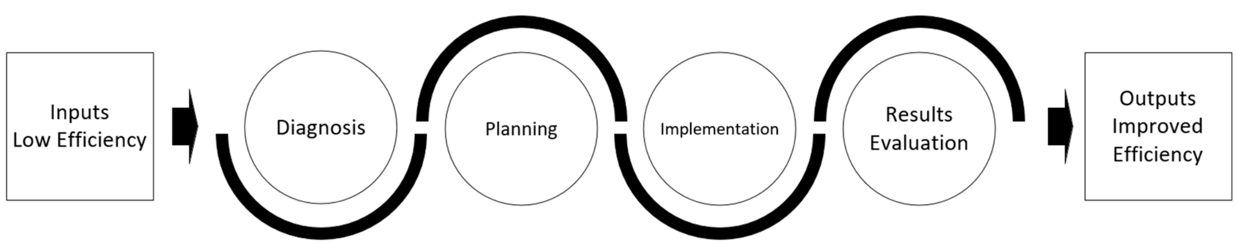

Figure 1. Production model

3.1 Diagnosis

In this component, the company's processes, flows and data will be investigated in order to find the causes that generate this problem. In the same way, the indicators and times of each part of the product manufacturing process will be analyzed, in order to reduce them and implement an improvement. For this phase, an Ishikawa diagram will be used to visualize in a graphic, clear and detailed way the reasons why there is a low plant efficiency. Moreover, a problem tree diagram will be made in order to determine the importance and frequency with which each cause occurs. Through the analysis of these diagrams and the data provided by the company, a tree of objectives will be developed. This will allow to establish a series of solutions for each problem.

3.2 Planning
At this stage, a schedule of activities will be made. This will be a guide to calculate the implementation times of each solution. In the same way, the territory will be prepared to be able to apply the tools. First, the 5S verification form will be done. This will allow to know to what extent the implementation of this tool will be necessary. Likewise, the current distribution of the machines and components that the company owns will be analyzed in order to carry out possible simulations of distribution alternatives, using the SLP technique. Finally, the concept of Lean Manufacturing and the benefits that it brings to efficiency and the work environment will be communicated to the work team. It is sought that all are aligned for the correct execution of the Lean Manufacturing philosophy.

3.3 Implementation
It will start with the implementation of the 5S. Based on the audit carried out in the planning stage, the problems that exist will be identified in order to devise an applicable solution. Thus, each of the S will be investigated to achieve a neater, more organized and, above all, efficient work area. For this, it will be necessary to instruct the work team and attain their total commitment to this improvement. Finally, to implement the SLP tool, various simulations will be executed in order to create possible alternatives that will be compared to evaluate their efficiency ratio, selecting the one with the highest value. All this will be carried out through the Arena simulation software.

3.4 Results Evaluation
Finally, this component includes the monitoring and control of the implemented tools. A monitoring plan is established to assess that the techniques are being used correctly. On the subject of 5S, there will be a constant weekly follow-up, which will be in charge by the plant supervisor. Regarding the SLP, the distances traveled, waiting times, transfer distances and material flow times will be timed. With the new information collected, an exhaustive analysis will be carried out with the main indicators and their respective percentages. These will be compared with the initial situation to determine the impact of the implemented measures and verify that the established objective has been met.

4. Data Collection
The data collection of this paper is divided into two parts, since different information is required for the application of each tool. Starting with the 5S tool, an audit was carried out to find out the state of the production plant in terms of order, cleanliness, discipline, among others. This audit was carried out through a plant inspection and a questionnaire that set the guidelines to follow in each S. Thus, the questionnaire consisted of 10 questions per section, which determined the level of Selection, Order, Cleaning, Standardization and Discipline. that the company showed according to the methodology. Once the audit was completed, the results corresponding to each aspect of the 5S were obtained. These were summarized in Table 2, which shows the total score obtained by the company.

Table 2. Initial Audit 5S

5S		Initial Score
S1 (Seire)	Selection	7
S2 (Seiton)	Order	7
S3 (Seiso)	Cleansing	8
S4 (Seiketsu)	Standardization	9
S5 (Shitsuke)	Discipline	9
Total		40

The initial situation of the company is very good, since they have very high cleanliness and quality standards to meet due to the industry in which they operate. Each S has a score out of 10, with the total of the 5S being 50. In this case, the score obtained was 40, leading to the conclusion that the system has the possibility of improving.

On the other hand, for the Systematic Layout Planning tool, it was necessary to collect the activities corresponding to the mayonnaise production process, taking into account the transport between areas and the automatic processes of the system. Likewise, the times of these activities were taken and the distances traveled between the areas were measured, as seen in Table 3. In addition, the flow of materials was studied to know the route that is carried out in order to be able to optimize it. Finally, working on a plant that has already been built, it must be taken into consideration the space limitations that each area represents.

Table 3. Process activity table

Zone A	Zone B	Time (Minutes)	Distance (Meters)
Raw material warehouse	Dosimetry	30 - 40	4
Dosimetry	Reception of raw materials	15	4
Reception of raw materials	Temporary storage	30	6
Temporary storage	Emulsion room	3-5	3
Emulsion room	Quality Control (Laboratory)	4-5	87
Quality Control (Laboratory)	Emulsion room	4-5	87
Emulsion room	Storage tanks	5-6	-
Storage tanks	Packing	-	-
Packing	Boxing	-	-
Boxing	Warehouse of finished products	3	16
Total		94 – 109	203

According to Table 3, an approximate total of 94 to 109 minutes and 203 meters traveled was obtained to carry out the activities of the production process. It should be noted that activities in which the operator intervenes were taken into consideration since there are others where the route is through pipes to make the process more automated.

Continuing with the application of the SLP, it was necessary to know the distribution of the plant and the machines it has. In this way, visual support was obtained through the layout of the plant, which can be seen in Figure 2, taking into consideration only the areas used in the mayonnaise process, in order to analyze possible proposals and determine the feasibility.

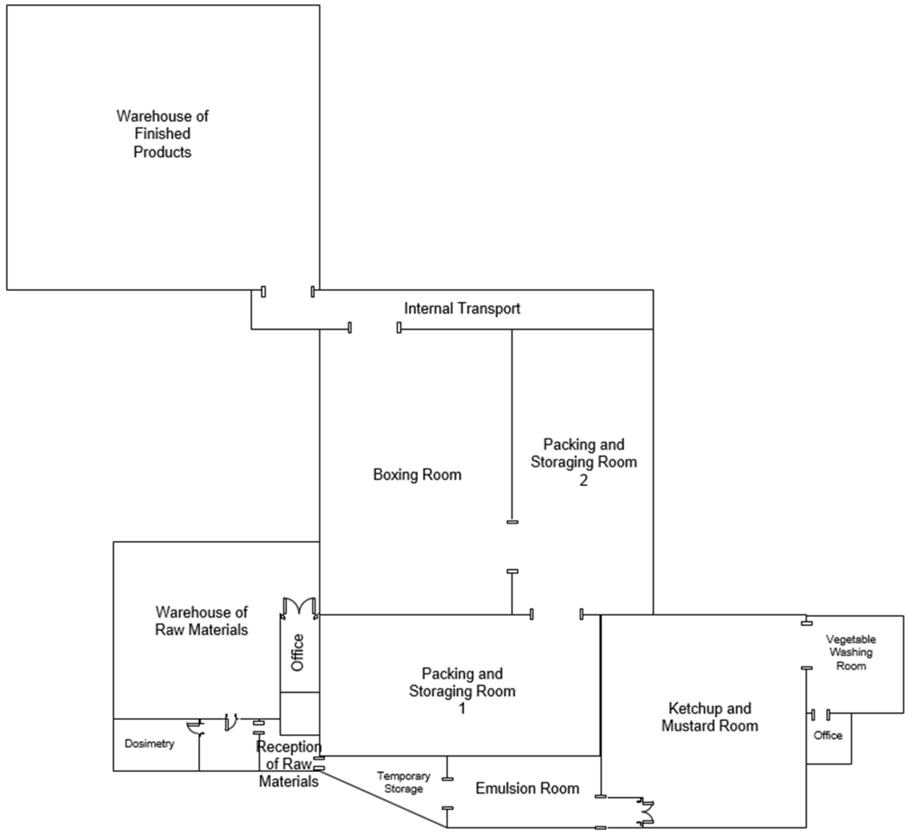

Figure 2. Initial layout of the plant

Finally, the KPIs analyzed in this initial phase of the investigation are summarized in Table 4.

Table 4. KPIs initial phase

KPI	Initial State
Efficiency	44%
Transfer Time (Minutes)	94 – 109
Distance Traveled (Meters)	203
5S Score	40

5. Results and Discussion

After analyzing the current situation of the company through the figures and tables previously seen, the implementation of the proposals for the 5S tool began. Based on the initial audit, it was determined that the improvement situations for the Selection area lie in the obstruction of the work area due to crates, residual cleaning water and in the organization and labeling of work tools. First, a space was delimited within the work area to leave the crates after use. Also, a container that is under the machines was considered for when they proceed to clean them. Finally, a color code for the crates was implemented, where only a specific object can be stored depending on the color. For the Order area, a focus was given to the shelves. In this way, a code was made to the shelves to easily find the tools. Finally, to address the Cleanup area, a waste zone was designated within the work area.

For the implementation of SLP, an analysis of the current layout was carried out in order to propose a new one through a diagram and a relational table. By working on an already built plant, the warehouses were immovable, since these are the largest areas of the company. Once the respective analysis was done and an improvement plan was proposed, it was tested through a simulation in the ARENA Software. The results obtained were satisfactory, demonstrating a great improvement compared to the current situation and making clear the feasibility of the proposed proposal.

5.1 Numerical Results

Starting with the implementation of the 5S, once the improvement proposals were applied, two more audits were carried out. These were done in order to evaluate the process and verify if the implemented measures were being followed, where the following results were obtained for each audit completed, summarized in Table 5.

Table 5. 5S Audit Final Score

5S		Audit 1	Audit 2	Audit 3
S1 (Seire)	Selection	7	9	10
S2 (Seiton)	Order	7	9	9
S3 (Seiso)	Cleansing	8	8	10
S4 (Seiketsu)	Standardization	9	9	9
S5 (Shitsuke)	Discipline	9	9	9
Total		40	44	47

After implementing the proposed proposals, through new subsequent audits, it was possible to improve the work environment, allowing the operators to carry out their work in a more orderly, clean and organized way so that they can be more efficient in their daily activities.

On the other hand, in the SLP, with the development of the simulation it was possible to obtain the results of the proposed plant layout. By simulating the proposed improvement model and comparing it with the current situation, statistically significant differences can be seen with 95% confidence, as shown in Table 6. The simulation yielded the confidence intervals for the selected indicators. Thus, the improvement model manages to increase the number of Doy Packs produced, of boxes produced and drastically reduce transfer times.

Table 6. Indicators comparison

Indicators	Current situation	Improvement model
Doy Packs produced	3706.56	[6235.27 ; 6248.19]
Boxes produced (12 units/box)	308.88	[518.56 ; 519.7]
Transfer Time (Minutes)	94 - 109	[34.66 ; 36.80]

Compared to the current situation, some transfer activities were eliminated and the times in the remaining transfer activities were reduced. Thus, the simulation showed an increase in the efficiency of the plant, managing to produce more by reducing the distances traveled by the operators. Finally, the applications of the Lean Manufacturing tools were effective, managing to improve the KPIs initially proposed, represented in Table 7.

Table 7. KPIs Comparison

	As is	To be	Results
Efficiency	44%	89.68%	74.03%
Transfer Time (Minutes)	94 - 109	38 - 46	34.66 - 36.80
Distance Traveled (Meters)	203	-	31
5S Score	40	45	47

The objective of the research was to increase the efficiency of the company's plant, since this was well below the standard efficiency of the sector, which is 89.68% (Molina and Castro 2015). Efficiency was increased by 30%. Despite not reaching the standard efficiency of the sector, notable results were obtained, also reducing transfer times and meters traveled.

5.2 Graphical Results

Regarding the implementation of the improvement proposals for the 5S tool, as previously mentioned, a color code format was created that was applied to the crates. With this, it was sought to guarantee an order and a visual aid that allows the operators to easily identify which items are in the crate. The implemented format can be seen in Figure 3.

Color	Content	Maximum Quantity
	Mayonnaise Base	3 items
	Chili Base	3 items
	Ketchup Base	3 items
	"Mayoqueso" Base	3 items
	Fruit Pulp	3 items

Figure 3. Color code format

In the same way, a code was made to the shelves in order to facilitate the search for tools or required supplies. In addition, the maximum storage quantities were indicated so as not to compromise the shelf and so that it does not suffer possible damage. This format can be seen in Figure 4.

Enumeration	Category	Maximum Weight
1	Assorted Items	50 kg
2	Mix Containers	50 kg
3	Containers	50 kg
4	Temporary Storage of Supplies	50 kg
5	Temporary Storage of Supplies	50 kg
6	Utensils	50 kg
7	Liquid Supplies	50 kg
8	Fragile Supplies	50 kg
9	Large Volumen Liquid Supplies	50 kg

Figure 4. Code Shelves Format

Finally, for the SLP, the following layout plan was proposed to improve plant efficiency, seen in Figure 5. It was considered to bring the quality laboratory closer to the emulsion room, in order to reduce distance traveled. In the same way, the emulsion room was extended due to the removal of temporary storage. Finally, determine that the reception of raw materials area is only for that activity.

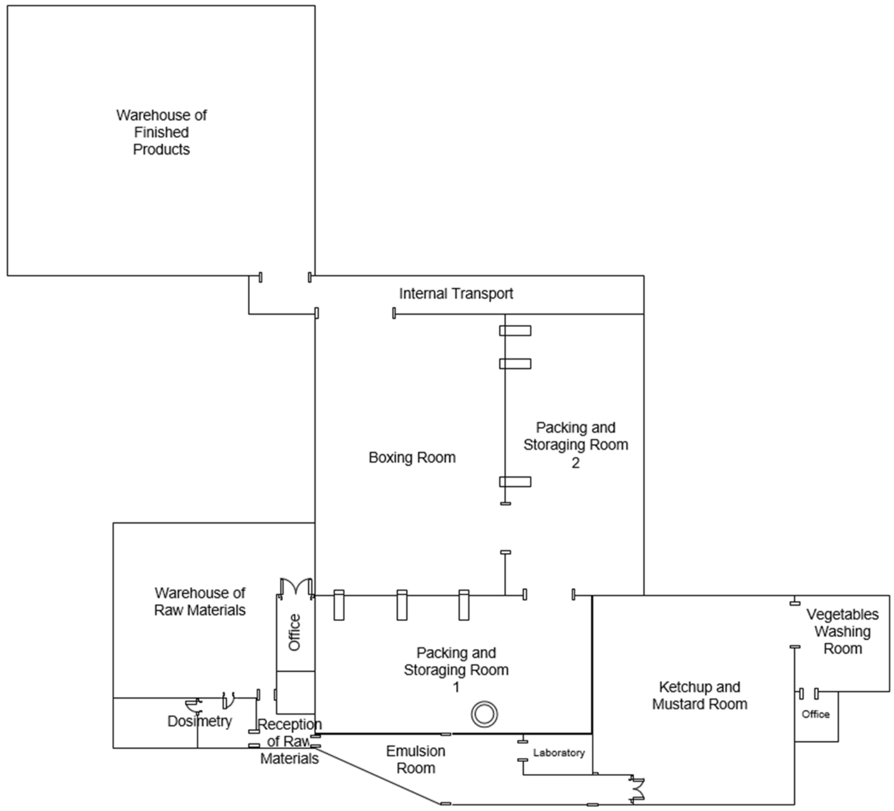

Figure 5. Proposed layout plan

With the proposed layout plan, the new times of the activities were calculated and the ARENA Software was used to create a simulation model that allows to appreciate the improvements, shown in Figure 6.

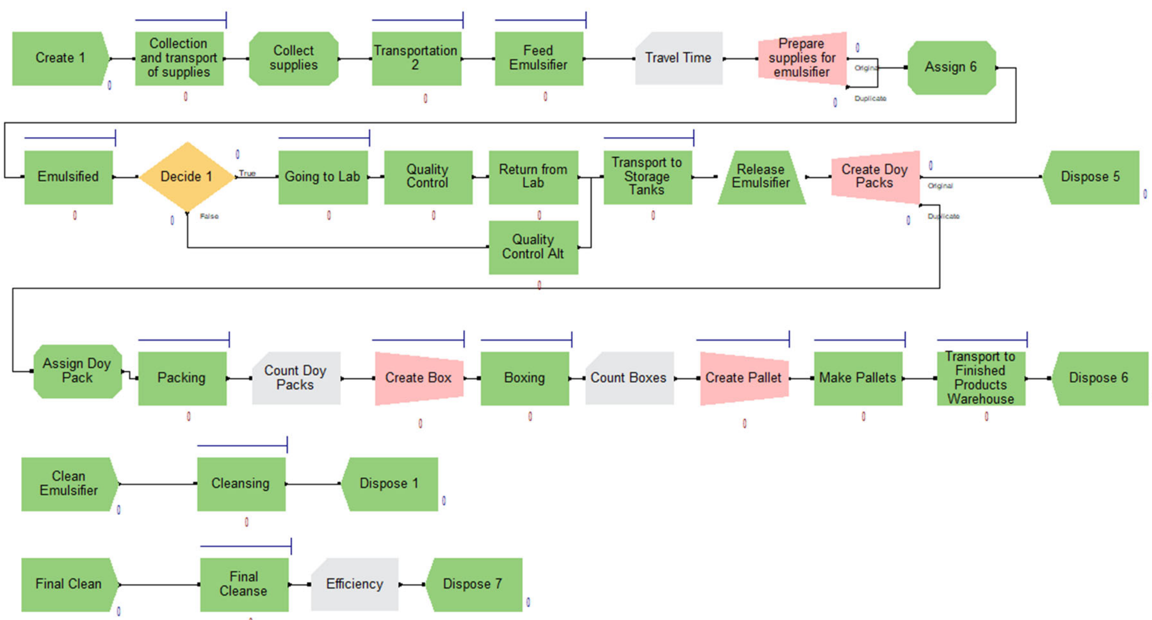

Figure 6. Improvement model in Arena Software.

6. Conclusion

In conclusion, the implementation of the 5S and SLP tools proved to be effective in the company. Although the industry standard efficiency was not reached, it was managed to increase by 30%, which is still significantly positive. On the other hand, the application of 5S provided an improvement in the work environment, facilitating the tasks of the operators and guaranteeing cleanliness and order in the work areas. Thus, the proposed objectives and the correct development of the investigation were achieved. In this way, this study can be useful for companies in the food industry.

References

Ali Naqvi, S. A., Fahad, M., Atir, M., Zubair, M. and Shehzad, M., Productivity improvement of a manufacturing facility using systematic layout planning, *Cogent Engineering*, vol. 3, no. 1, 2016.

Amit, N., Suhadak, N., Johari, N. and Kassim, I., Using simulation to solve facility layout for food industry at XYZ Company, *2012 IEEE Symposium on Humanities, Science and Engineering Research*, pp. 647-652, Kuala Lumpur, Malaysia, June 24-27, 2012.

Aucasime-Gonzales, P., Tremolada-Cruz, S., Chavez-Soriano, P., Dominguez, F. and Raymundo, C., Waste Elimination Model Based on Lean Manufacturing and Lean Maintenance to Increase Efficiency in the Manufacturing Industry, *IOP Conference Series: Materials Science and Engineering*, Washington, USA, September 25-27, 2020.

Chapman, S., *Planificación y Control de la Producción*, 1st Edition, Pearson, 2006.

Chávez, J., Altamirano, E., Osorio, F. and Raymundo, C., Modelo esbelto de gestión de producción para la reducción de desperdicios en PYMES del sector alimentos procesados, *AHFE International Conference on Advanced Production Management and Process Control*, pp. 53-62, Washington D.C, USA, July 24-28, 2019.

Chinchillas, J., Perfil Industrial de la Manufactura Mexicana, Available: http://repositoriodigital.ipn.mx/handle/123456789/15569, August 29, 2022.

Cuggia-Jiménez, C., Orozco-Acosta, E. and Mendoza-Galvis, D., Lean manufacturing: a systematic review in the food industry, *Informacion Tecnologica*, vol. 31, no. 5, pp. 163-172, 2020.

De Steur, H., Wesana, J., Dora, M. K., Pearce, D. and Gellynck, X., Applying Value Stream Mapping to reduce food losses and wastes in supply chains: A systematic review, *Waste Management*, vol. 58, pp. 359-368, 2016.

Durakovic, B., Demir, R., Abat, K. and Emek, C., Lean manufacturing: Trends and implementation issues, *Periodicals of Engineering and Natural Sciences*, vol. 6, no. 1, pp. 130-139, 2018.

Garcia-Garcia, G., Singh, Y. and Jagtap, S., Optimising Changeover through Lean-Manufacturing Principles: A Case Study in a Food Factory, *Sustainability (Switzerland)*, vol. 14, no. 14, 2022.

Gómez, J., Tascón, A. and Ayuga, F., Systematic layout planning of wineries: The case of Rioja region (Spain), *Journal of Agricultural Engineering*, vol. 49, no. 1, pp. 34-41, 2018.

Haekal, J. and Adi, D., Planning Of Production Facilities Layouts In Home Industry With The Systematic Layout Planning Method, *International Journal of Innovative Science, Engineering & Technology*, vol. 7, no. 10, pp. 147-153, 2020.

Instituto de Estudios Económicos y Sociales - Sociedad Nacional de Industrias, Reporte Macroeconómico Coyuntura Industrial, *Lima: Sociedad Nacional de Industrias*, 2021.

Kennedy, I., Plunkett, A. and Haider, J., Implementation of lean principles in a food manufacturing company, *23rd International Conference on Flexible Automation & Intelligent Manufacturing*, pp. 1579-1590, 2013.

Legarda-Zaragueta, A., Hidalgo-Nuchera, A. and Blazquez-Lidoy, J., The Importance Of The Manufacturing Industry On Growth And Competitiveness Of A Country, *DYNA*, vol. 89, no. 4, pp. 377-381, 2014.

Leon-Enrique, E., Torres-Calvo, V., Collao-Díaz, M. and Flores-Perez, A., Improvement model applying SLP and 5S to increase productivity of storaging process in a SME automotive sector in Peru, *The 3rd International Conference on Industrial Engineering and Industrial Management*, pp. 219-225, Barcelona, Spain, January 12 – 14, 2022.

Lopes, R. B., Freitas, F. and Sousa, I., Application of Lean Manufacturing Tools in the Food and Beverage Industries, *Journal of Technology Management & Innovation*, vol. 10, no. 3, pp. 120-130, 2015.

Molina, A. and Castro, G., Análisis de eficiencia del sector industrial manufacturero en cinco países suramericanos, 1995-2008, *Civilizar. Ciencias Sociales y Humanas*, vol. 15, no. 29, pp. 93-112, 2015.

Ojaghi, Y., Khademi, A., Yusof, N., Renani, N. and Hassan, S, Production layout optimization for small and medium scale food industry. *12th Global Conference on Sustainable Manufacturing*, pp. 247-251, September 22, 2014.

Organización Internacional del Trabajo, Available:https://www.ilo.org/global/industries-and-sectors/food-drink-tobacco/lang--

es/index.htm#:~:text=El%20sector%20de%20la%20alimentaci%C3%B3n,personas%20en%20todo%20el%20 mundo, Accessed on August 12, 2022.
Proença, A., Gaspar, P. and Lima, T, Lean optimization techniques for improvement of production flows and logistics management: The case study of a fruits distribution center, *Processes*, vol.10, 2022.
Prospecta, Available: https://www.prospecta.mx/pdf/2415.pdf, Accessed on August 27, 2022.
Radhwan, H., Shayfull, Z., Farizuan, M., Effendi, M. and Irfan, A, Redesign of bahulu production layout to improve the efficiency of process flow, *5th International Conference on Green Design and Manufacture 2019*, Kota Bandung, Indonesia, July 30, 2019.
Rohani, J. and Zahraee, S., Production line analysis via value stream mapping: A lean manufacturing process of color industry, *2nd International Materials, Industrial, and Manufacturing Engineering Conference*, pp. 6-10, February 4-6, 2015.
Ruiz, S., Simón, A., Sotelo, F. and Raymundo, C., Optimized plant distribution and 5S model that allows SMEs to increase productivity in textiles, *17th LACCEI International Multi-Conference for Engineering, Education, and Technology*, Montego Bay, Jamaica, July 24-26, 2019.
Sa'udah, N., Amit, N. and Ali, M., Facility layout for SME food industry via value stream mapping and simulation, *International Accounting and Business Conference 2015*, pp. 797-802, 2015.
Singh, J., Rastogi, V. and Sharma, R, Implementation of 5S practices: A review, *Uncertain Supply Chain Management*, vol. 2, no. 3, pp. 155-162, 2014.
Sociedad Nacional de Industrias, Propuestas Sectoriales para Reactivar: Perú Agenda 2031- Para el progreso social y económico*, Lima: Sociedad Nacional de Industrias,* 2020.
Velastegui, L. and Flores, J., Calidad y Productividad: Un Análisis al Método" 5S" en la Rentabilidad para Empresas del Sector Avícola de la Provincia de Tungurahua*. Revista de Investigación, Formación y Desarrollo: Generando Productividad Institucional*, vol.8, no.2, pp. 15-31, 2020.
Veres, C., Marian, L., Moica, S. and Al-Akel, K, Case study concerning 5S method impact in an automotive company, *11th International Conference on Interdisciplinarity in Engineering*, Targu Mures, Romania, vol. 22, pp. 900-905, 2018.
Wiyaratn, W., Watanapa, A. and Kajondecha, P, Improvement plant layout based on systematic layout planning. *IACSIT International Journal of Engineering and Technology*, vol. 5, no. 1, pp. 76-79, 2013.
Zamalloa-Menacho, A., Manani-Rojas, R., Flores-Perez, A. and Collao-Diaz, M, Proposal of production model based on lean and continuous improvement to improve the productivity in SMEs of baking: An empirical investigation in peru, *3rd International Conference on Industrial Engineering and Industrial Management*, pp. 66-71, Barcelona, Spain, January 12-14, 2022.
Zocca, R., Lima, T., Gaspar, P. and Charrua-Santos, F, (2019). Kaizen approach for the systematic review of occupational safety and health procedures in food industries, *1st International Conference on Human Systems Engineering and Design: Future Trends and Applications,* pp. 722-727, Reims, France, October 25-27, 2018.

Biography

Rodrigo Kohata-Tirado is an industrial engineering student at the University of Lima, Peru. Highly interested in the areas of logistics, commercial and marketing. Constantly searching for personal and professional growth. Participated in several simulators to gather better understanding of the business world, such as The Fresh Connection – Supply Chain Simulator, The Business Strategy Game – Global Marketplace Simulator, and ERPsim – Real-time Business Simulator.

Santiago Morales-Arce is a tenth-cycle industrial engineering student at the University of Lima, Peru. Interested in the areas of project management, process optimization, consultancy and commercial. He's participated in multiples simulators being The Business Strategy Game, the one which he had an outstanding ranking globally.

Martín Collao-Diaz at ESAN University and Industrial Engineer from the University of Lima specialized in supply chain management and operations. A leader with more than 25 years of local and international experience in national and multinational companies in industrial, hydrocarbon, and mass consumption sectors. Broad experience in supply chain management (purchasing, inventory, suppliers and supply sources management, logistics: transport, distribution and warehouse management), operations (planning and control of production and maintenance), and integrated system management (ISO 9001, ISO 14001, and OHSAS 18001). Business alignment based on sales and operations planning (S&OP). Besides, continuous search for improvements in profitability based on process optimization and saving projects using tools such as Six Sigma methodology, among others, focused on being a High-performance Organization (HPO). Development of a high-performance team. Member of IEEE and CIP (College of Engineers of Peru).