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Tesis

Proffer for the Implementation of the SLP Method and Automation in a Poultry Plant for Process Optimization

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Proffer for the implementation of the SLP method and automation in a poultry plant for process optimization

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Abstract.
This research analyzes the distribution of a poultry plant, with defined processes and established areas. However, it has been proven that the poultry production process can optimize its processes by redistributing it, applying the SLP (Systematic Layout Planning) methodology. In addition, the purpose is to take the process to a second level of improvement with process automation. Initially, the plant plans were analyzing in detail, these allowed us to visualize which areas should be improved. Then, the DAP (Process Activity Diagram) was analyzed, where the activities are identified for the plant process. Thereafter, the SLP method is applied, which is essential for the redistribution of the plant. Once a more efficient plant has been obtained, productivity is analyzed using a distance and load matrix. Furthermore, the idea of automation in important processes is shown in a cost and time table. Finally, a DAP is developed that gives validity to this proposal.

Keywords: SLP, automation, plant, poultry, optimization, implementation.

1 Introduction

Nowadays, companies increasingly face the challenges of a changing and globalized market, and they have to innovate and apply continuous improvement in their operations, an efficient and effective organizational strategy in achieving objectives is to offer good quality products in order to have a competitive advantage and not to be left behind in the market. [1]
Within the internal production strategy process that is applied in this market to achieve superior quality and competitive prices, the most important part is plant distribution. Because, essentially, it tends to avoid unnecessary expenses of labor and space, perhaps these are factors of little importance in companies in underdeveloped economies but they are very significant in industries that intend to achieve or have achieved stability. [2] In addition, there will be an impact of automation because in the national and international industrial sector, the lack of several considerations of automation projects is evident, highlighting quality improvements, increases in production, increase in repeatability and stability of manufacturing processes, reduction of physical and repetitive work, obtaining greater continuity of production

on holidays, improvement of the cost-benefit relationship, selection of the most viable technical and economic offer in terms of automation technology. [3] In this case, a proposal for the implementation of plant distribution is presented for the best use of the spaces in the poultry plant, improving the distribution of areas, identifying process delays between areas, increasing profits and reducing times of processes.

2 Literature review

Muther, mentions that by spending time planning the design before installation we can significantly reduce economic losses and time delays. A bad design requires future reorganization, which is time-consuming and expensive. For this reason, industries develop different methods and algorithms in order to have adequate planning and design. [2] There are different planning techniques to develop a new design or improve the current design, such as Systematic Design Planning (SLP), Paired Exchange Method (PEM), Graph Based Theory (GBT), Dimensionless Block Diagram (DBD), Total Closeness Classification (TCR), etc. [4] In this case, the SLP application and implementation of automation will be proposed, because this poultry industry needs to produce variety of products and increase its capacity to compete in the constantly growing market. Therefore, this study focuses on the proposal of a new plant design to increase production capacity and implementation of automation for process optimization in a poultry company. The author describes to us that the Systematic Layout Planning (SLP) method designed by Richard Muther in 1968, allows us to solve plant design problems, uses quantitative data, so we can design an effective layout in order to increase productivity, reduce costs and spaces. [5]

2.1 Systematic Layout Planning (SLP)

2.1.1 Characteristics

SLP is a methodological application developed by Muther, which indicates eleven steps to follow. With this application it is possible to find many solutions for the layout of a plant. [6] Chien, classified these steps of SLP into four parts which are: data register, product processes, output results and evaluation process. [7] It is important to mention that he also modified SLP to use this procedure in different shapes and hexagons.

2.1.2 Steps

In this research, the SLP technique has been implemented, which consists of the following six steps [8]:

a) Identify and diagram the relationships between resources, obstacles and the environment based on the flow of material and service.
b) Establish and document space requirements and supplies needed for each resource.

c) Draw a relationship graph to create a graphical representation. The nodes in the graph represent the resources and the edges the relationships. Different types of edges can be used to visualize different relationships.
d) Create space relationship arrangements based on the space requirements of resources, obstacles, and the environment.
e) Evaluate the alternatives considering the importance of the different criteria used in the evaluation.
f) Detail the selected layout and make small adjustments to guarantee the correct operation, so the effective automation can be implemented in the selected areas.

2.2 Automation

Automation corresponds to the need to minimize human intervention in production processes, that is, save labor effort. [9] Therefore, the authors tell that a traditional automation line can increase productivity approximately ten times more than its usual production. [4] Furthermore, professionals confirm that automation is more hygienic, efficient, and environmentally friendly. Which allows having a system of several activities, in the same place, where there are specialized machines that carry out cutting operations and repetitive activities. [9]

2.3 SLP and automation applied to industrial plants

The SLP application and the implementation of automation provide different benefits for the poultry industry such as: Increased efficiency and quality, this automation can do repetitive activities., which maintain industry requirements more effectively, reducing production times and operating costs. Furthermore, through the use of SLP, spaces are optimized so that the available space in the plant is more utilized. In industry, automation can also reduce the human production errors, improving food safety and product quality.

3 Methodology

Initially, the plant plans were analyzing in detail, considering the distribution of the areas, between main and other services. This with the objective of understanding the operation of the company. Then, using a DAP (Process Activity Diagram), the existing activities of the production chain are analyzed, and it evaluate their operational efficiency. Subsequently, it is identified which activities are the most important, between critical and non-critical. This is important to prioritize them when is time to redistribute the plant, and also allows them to know if they are suitable for the implementation of automation. Once the evaluation is completed, the SLP method is applied; it has a series of steps, which were detailed previously. This application allows the redistribution of the plant, with a better distribution of areas and optimization of activities. In order to verify if this methodology worked and was useful, an improved DAP of the new proposal is carried out. Which achieves the objective of reduction the unnecessary activities, as well as downtime. Finally, within the objectives of this research, there is the proposal of automation in certain activities of the company, which can be more efficient when implemented with new machinery, bringing with it benefits such as increased productivity and reduction of human errors. The following Figure 1 shows the steps of the methodology of this research, presented in a flow chart.

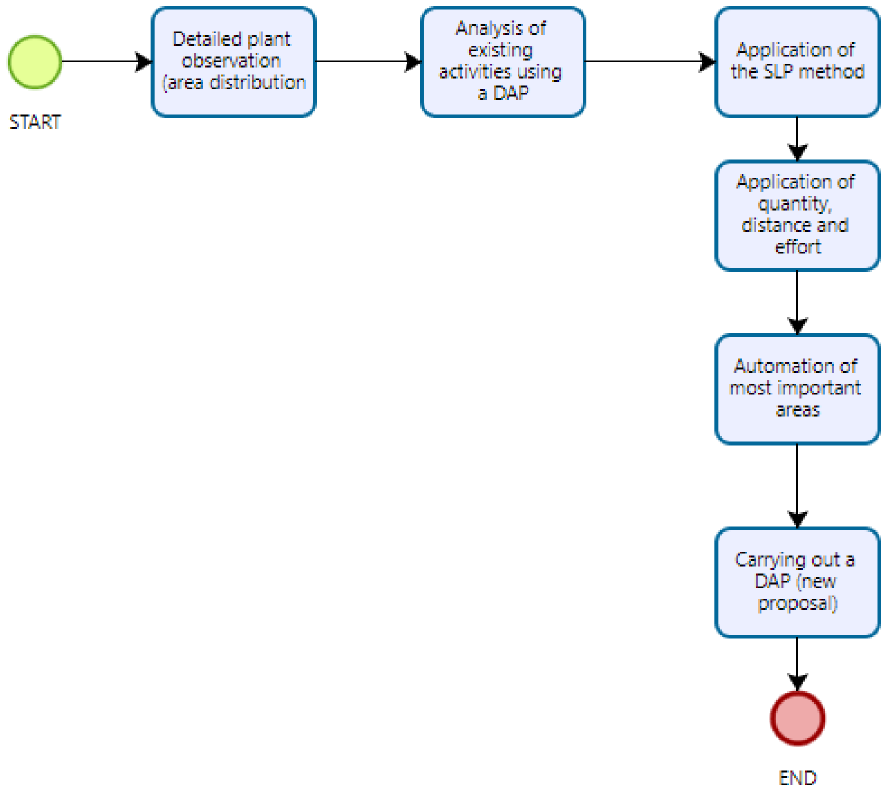


Fig. 1. Methodology flow chart. Own elaboration.

4 Results

4.1 DAP Identification

The DAP, also known as the Process Activity Diagram, is a detailed chart, usually centered on a product component or worker, that represents a variety of elements such as actions, reviews, movements, pauses, storage, schedules, distances, materials, and transportation methods, among others. This diagram enables a detailed analysis of the process. [10] Therefore, we can visualize the company's current DAP below (see Figure 2).

(DAP)		Operator/material/equipment			
Diagram Nº:	Sheet Nº:	Resumen			
Object:		Activity	Current	Proposed	Economy
		Operation	11		
		Transport	12		
Activity:		Standby	1		
In-plant poultry processing		Inspection	1		
		Storage	2		
Method:	Current	Distance (m)			
Location:		Time (min-male)			
Operator:	Card Number:	Cost:			
		Labor			
Composed by:	Date:	Material			
Approved by:	Date:	Total			

Description	Dist. (m)	Time (min)	○	⇨	D	□	▽	Observation
Receipt of chicken jabas	6	15					●	Approximately 62 jabas with 12 chickens each
Transfer of jabas to the scale	0	6		●				With 6 operators
Weighing of jabas	0	48	●					
Transportation of jabas to the settling area	4	6		●				For broiler selection and quality control
Chicken Laying	0	30	●					
Transfer to the stunner	4	6		●				
Chicken stunning	0	18	●					It is carried out by means of an electrical stunning machine.
Chicken slaughtering	0	22	●					Chickens are slaughtered manually by 4 operators.
Transfer to bleeding table	2	6		●				
Waiting for chick bleeding	0	18			●			
Transfer to the blanching kettle	4	4		●				
Chicken scalding	0	32	●					First scalding
Transfer to the peeling table	4	6		●				
Chicken peeling		20	●					
Final peeling inspection	0	22				●		Manual verification
Transfer to the blanching kettle	4	6		●				
Chicken scalding	0	18	●					Second blanching (disinfection)
Transfer to cooling vat	3	0		●				
Chickens cooling	0	25	●					
Transfer to cutting table	2	15		●				
Cutting of limbs	0	30	●					Manual cutting
Transfer to evisceration table	2	15		●				
Gutting of chickens	0	40	●					Manual gutting
Transfer of peeled chickens to vats	2	6		●				
Washing and disinfection of chickens	0	40	●					
Transfer to cold storage in jabas	8	6		●				Capacity of 15 peeled chickens
Final product storage	0	15					●	For subsequent packaging and distribution
Total	45	475	11	12	1	1	2	

Fig. 2. This DAP (Process Activity Diagram) is the current version managed by the company. It identifies unnecessary transfers and very traditional operations that do not contribute to productivity.

4.2 SLP Application

The main part of plant layout planning is design planning, which focuses mainly on the allocation and layout of functional areas and machines with the objective of optimizing the material flow. [11] Therefore, the application of SLP in the observed plant is presented below (see Figure 3).

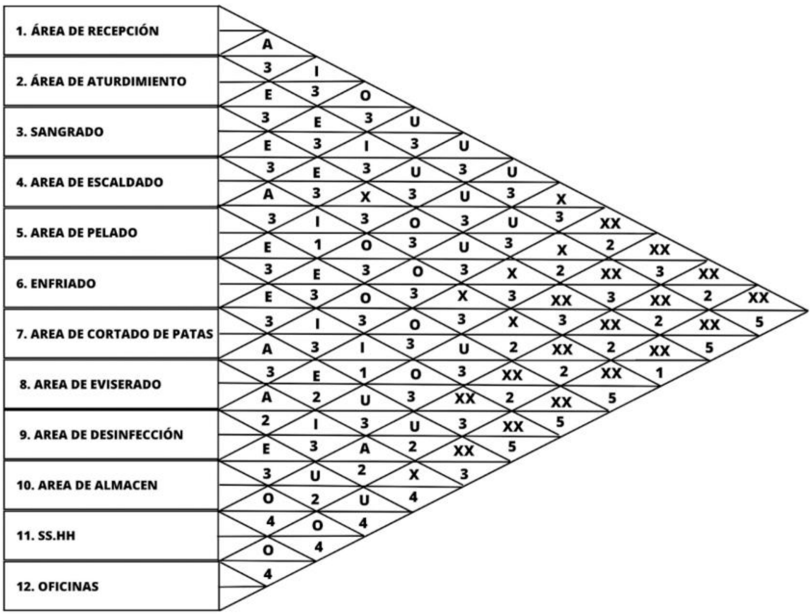


Fig. 3. Relational path diagram, belonging to the SLP methodology for the redesign of a poultry plant.

4.3 Distance, Load and Effort Matrix

Based on the analysis of the sequence of operations, evaluating the quantities to be transported and the distances to travel, the effort that these movements represent is evaluated, giving us this evaluation of the work an index to measure its productivity and propose an improvement proposal. [12]

4.3.1 Quantity Matrix

The quantity matrix is fundamental in industrial plant design because it provides a quantitative representation of the necessary resources and their location. We can see in the following Figure 4, the current Quantity Matrix of the plant under observation.

	Reception of broiler litter	Weighing of bins	Broiler Laying	Chicken stunning	Reception of broiler litter	Chick slaughtering	Waiting for chicken bleeding	Scalding of chickens	Chick peeling	Final peeling inspection	Chickens scalding	Cooling of chickens	Cutting of limbs	Gutting of chickens	Washing and sanitizing chickens
Reception of broiler litter		1500													
Weighing of bins			1500												
Broiler Laying				1500											
Chicken stunning					1500										
Chick slaughtering						1500									
Waiting for chicken bleeding							1500								
Scalding of chickens								1500							
Chick peeling									1500						
Final peeling inspection										1500					
Chickens scalding											1500				
Cooling of chickens												1500			
Cutting of limbs													1500		
Gutting of chickens														1500	
Washing and sanitizing chickens															15000
Final product storage															

Fig. 4. The production that the poultry company has in all areas, a quantity of 15,000 chickens monthly, can be identified with the quantity matrix.

4.3.2 Distance Matrix

The distance matrix is an important tool in plant design because it helps engineers and planners make informed decisions about the layout of equipment, work areas, and material flows to achieve an efficient, safe, and profitable plant. By evaluating and minimizing distances between key points, significant benefits can be realized in terms of operational efficiency and productivity. This is represented in the following figure (see Fig. 5).

	Reception of broiler litter	Weighing of bins	Broiler Laying	Chicken stunning	Reception of broiler litter	Chick slaughtering	Waiting for chicken bleeding	Scalding of chickens	Chick peeling	Final peeling inspection	Chickens scalding	Cooling of chickens	Cutting of limbs	Gutting of chickens	Washing and sanitizing chickens
Reception of broiler litter		6													
Weighing of bins			4												
Broiler Laying				4											
Chicken stunning					0										
Chick slaughtering						2									
Waiting for chicken bleeding							4								
Scalding of chickens								4							
Chick peeling									0						
Final peeling inspection										4					
Chickens scalding											3				
Cooling of chickens												2			
Cutting of limbs													2		
Gutting of chickens														2	
Washing and sanitizing chickens															8
Final product storage															

Fig. 5. In the following figure we can identify the distance matrix between areas of the poultry company.

4.3.3 Effort Matrix

The effort matrix is an important management tool in plant design that helps companies understand and manage the distribution of workloads and resources in their facilities. This facilitates decision making, efficiency optimization and resource planning to ensure efficient and profitable plant operation. Therefore, the effort matrix identified in the company is shown in the following Figure 6.

	Reception of broiler litter	Weighing of bins	Broiler Laying	Chicken stunning	Reception of broiler litter	Chick slaughtering	Waiting for chicken bleeding	Scalding of chickens	Chick peeling	Final peeling inspection	Chickens scalding	Cooling of chickens	Cutting of limbs	Gutting of chickens	Washing and sanitizing chickens	TOTAL
Reception of broiler litter		90000														90000
Weighing of bins			60000													60000
Broiler Laying				60000												60000
Chicken stunning					0											0
Chick slaughtering						30000										3000
Waiting for chicken bleeding							60000									6000
Scalding of chickens								60000								6000
Chick peeling									0							0
Final peeling inspection										60000						60000
Chickens scalding											45000					45000
Cooling of chickens												30000				30000
Cutting of limbs													30000			30000
Gutting of chickens														3000		30000
Washing and sanitizing chickens															120000	12000
Final product storage																0
15000/615000=0.0244																615000

Fig. 6. In the following figure we can identify the effort of each area and at the same time it is the result of the quantity produced between the resource having the productivity.

4.4 Distance, Load and effort proposed Matrix

The matrix analysis technique identifies critical points in the plant layout and allows the planner to concentrate his effort on the points that offer the greatest probability of introducing an improvement. However, it is not a means of determining the optimal arrangement, but rather of evaluating different possible arrangements on a quantitative and comparative basis. For this reason, it constitutes a valuable technique. [12]

4.4.1 Proposed quantity matrix

The proposed quantity matrix demonstrated a notable increase in products, being fundamental in the design of an industrial plant by providing a quantitative representation of the necessary resources and their location in the current diagram. In the following Figure 7, we can see the proposed quantity matrix for the redistribution of the plant under investigation.

	Reception of broiler litter	Weighing of bins	Broiler Laying	Chicken stunning	Reception of broiler litter	Chick slaughtering	Waiting for chicken bleeding	Scalding of chickens	Chick peeling	Cooling of chickens	Cutting of limbs	Gutting of chickens	Washing and sanitizing chickens	Cooling of chickens
Reception of broiler litter		37500												
Weighing of bins			37500											
Broiler Laying				37500										
Chicken stunning					37500									
Chick slaughtering						37500								
Waiting for chicken bleeding							37500							
Scalding of chickens								37500						
Chick peeling									37500					
Final peeling inspection										37500				
Cutting of limbs											37500			
Gutting of chickens												37500		
Washing and sanitizing chickens													37500	
Final product storage														37500
Cutting of limbs														

Fig. 7. The proposed quantity matrix can be identified for the production that the poultry company has in all areas with a quantity of 37,500 chickens monthly.

4.4.2 Proposed Distance Matrix

The proposed distance matrix minimized the distances between key points, significant benefits can be obtained in terms of operational efficiency and productivity. We can visualize the aforementioned in the following Figure 8.

	Reception of broiler litter	Weighing of bins	Broiler Laying	Chicken stunning	Reception of broiler litter	Chick slaughtering	Waiting for chicken bleeding	Scalding of chickens	Chick peeling	Cooling of chickens	Cutting of limbs	Gutting of chickens	Washing and sanitizing chickens	Cooling of chickens
Reception of broiler litter		6												
Weighing of bins			0											
Broiler Laying				4										
Chicken stunning					0									
Chick slaughtering						2								
Waiting for chicken bleeding							4							
Scalding of chickens								4						
Chick peeling									0					
Final peeling inspection										3				
Cutting of limbs											0			
Gutting of chickens												0		
Washing and sanitizing chickens													2	
Final product storage														8
Cutting of limbs														

Fig. 8. In the figure we can identify the distance matrix proposed between the areas of the poultry company.

4.4.3 Proposed Effort Matrix

The proposed effort matrix helps companies understand and manage the distribution of workloads and resources in their facilities. This will facilitate informed decision making, efficiency optimization and resource planning to ensure efficient and profitable plant operation.

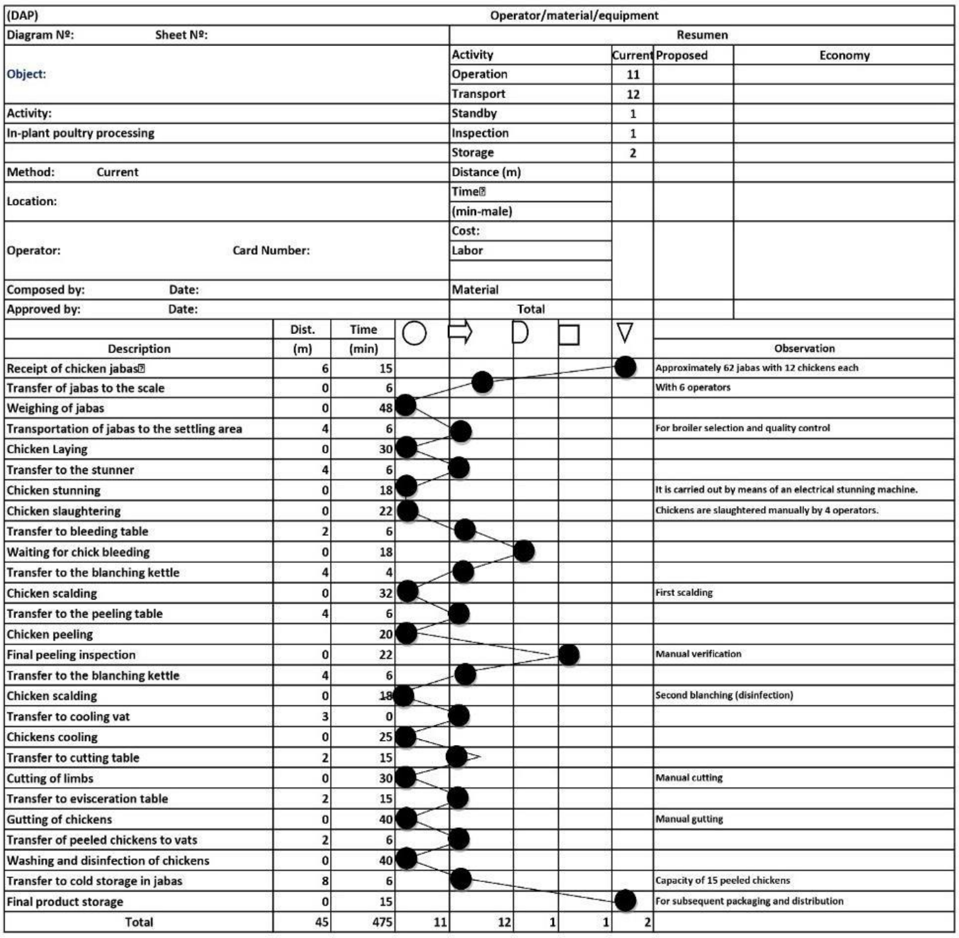
This is demonstrated in the following Figure 9 shown below.

	Reception of broiler litter	Weighing of bins	Broiler Laying	Chicken stunning	Reception of broiler litter	Chick slaughtering	Waiting for chicken bleeding	Scalding of chickens	Chick peeling	Cooling of chickens	Cutting of limbs	Gutting of chickens	Washing and sanitizing chickens	Cooling of chickens	total
Reception of broiler litter		225000													225000
Weighing of bins			0												0
Broiler Laying				150000											150000
Chicken stunning					0										0
Chick slaughtering						75000									75000
Waiting for chicken bleeding							150000								150000
Scalding of chickens								150000							150000
Chick peeling									0						0
Final peeling inspection										112500					11250
Cutting of limbs											0				0
Gutting of chickens												0			0
Washing and sanitizing chickens													75000		75000
Final product storage														300000	30000
Cutting of limbs															0
375000/61=0.0303															1237500

Fig. 9. In the figure we can identify the proposed effort matrix of each area and at the same time it is the result of the quantity produced between the resource having the productivity.

4.5 Proposal DAP

The DAP proposal (Process Activity Diagram) is presented below in Figure 10, which reflects the changes generated by the SLP application and automation together, which bring improvements in distances and times.



(DAP)		Operator/material/equipment			
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		Operation	11		
		Transport	12		
Activity:		Standby	1		
In-plant poultry processing		Inspection	1		
		Storage	2		
Method:	Current	Distance (m)			
Location:		Time (min-male)			
Operator:	Card Number:	Cost: Labor			
Composed by:	Date:	Material			
Approved by:	Date:	Total			

Description	Dist. (m)	Time (min)	○	⇨	D	□	▽	Observation
Receipt of chicken jabas	6	15					●	Approximately 62 jabas with 12 chickens each
Transfer of jabas to the scale	0	6		●				With 6 operators
Weighing of jabas	0	48	●					
Transportation of jabas to the settling area	4	6		●				For broiler selection and quality control
Chicken Laying	0	30	●					
Transfer to the stunner	4	6		●				
Chicken stunning	0	18	●					It is carried out by means of an electrical stunning machine.
Chicken slaughtering	0	22	●					Chickens are slaughtered manually by 4 operators.
Transfer to bleeding table	2	6		●				
Waiting for chick bleeding	0	18			●			
Transfer to the blanching kettle	4	4		●				
Chicken scalding	0	32	●					First scalding
Transfer to the peeling table	4	6		●				
Chicken peeling		20	●					
Final peeling inspection	0	22				●		Manual verification
Transfer to the blanching kettle	4	6		●				
Chicken scalding	0	18	●					Second blanching (disinfection)
Transfer to cooling vat	3	0		●				
Chickens cooling	0	25	●					
Transfer to cutting table	2	15		●				
Cutting of limbs	0	30	●					Manual cutting
Transfer to evisceration table	2	15		●				
Gutting of chickens	0	40	●					Manual gutting
Transfer of peeled chickens to vats	2	6		●				
Washing and disinfection of chickens	0	40	●					
Transfer to cold storage in jabas	8	6		●				Capacity of 15 peeled chickens
Final product storage	0	15					●	For subsequent packaging and distribution
Total	45	475	11	12	1	1	2	

Fig. 10. DAP (Process Activity Diagram) Proposed version.

5 Discussion

A case of SLP application is the research called "Design performance indicators and systematic planning", where the objectives are to carry out plant layout redesign planning applying this methodology, with this you can reduce transfer times and routes. The final results of this research were to minimize the area of the production machinery and then place it in another part of the plant, with this more space was reduced that allowed the other areas to be organized. and have less displacement of operators. Finally, this application increased staff productivity and improved utilization of the production area. [13] Comparing the initial situation with the current one, productivity will be defined using the following expression: Productivity = Production / Resources Where "resources" will be represented by the effort or work generated by the transfer of material from one place to another. [12] For this case, the variation in productivity will be determined in order to evaluate the proposed alternative having an improvement of 24.24% in productivity.

6 Conclusion

In conclusion the application of SLP together with automation has the potential to significantly transform operations in a variety of industries and sectors. It offers benefits such as improved efficiency, error reduction, resource optimization and increased flexibility, which can lead to increased competitiveness and efficiency in a wide range of applications.
In addition, it is also concluded that this study demonstrates that a good plant layout and automation of critical processes improves the productivity of any company, regardless of industry or size. In this way, it avoids business dwarfism in third world countries and improves the quality of products and services.

7 Recommendation:

It is recommended to follow the detailed guidelines on how to carry out the implementation of SLP and automation together, if you want to apply this proposal in any industry. Additionally, a step-by-step implementation plan is suggested, highlighting the resources required and approximate timelines.

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