Model based on SLP and work study to increase productivity in a bakery SME in Peru

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ABSTRACT

During the last decade, SMEs of bakery products in Peru have presented high production costs due to the empiricism in carrying out activities generating times that do not add value to the process, which directly influence low productivity. Furthermore, this sector has potential growth that must be exploited using innovative methods to achieve greater competitiveness. Furthermore, there is little evidence in the scenario of bakery SMEs that seek to reduce travel times in the process and improve methods in the production area. This article presents a model that integrates the SLP methodology and work study with the aim of increasing productivity in a bakery SME by optimizing the resources used and generating significant cost savings. The model was validated in a Peruvian bakery, where productivity was improved from 1.22 to 1.45.

Keywords: Productivity, Work study, Manufacturing, SLP, Layout, Bakery

INTRODUCTION

Globally, manufacturing companies are focused on making high-quality products due to global competition. These organizations are constantly looking for innovative practices or techniques to lower the cost of manufacturing the product, in-creasing quality and production in the shortest time (Randhawa and Ahuja, 2018).

It is important to increase the productivity of a company since, with this, it contributes to the economic growth of a country, which is generally measured by the increase in production or gross domestic product (GDP) (Duran, Cetindere and Aksu, 2015).

Currently, we live in such a competitive and globalized world where companies aim for maximum cost reduction. Unfortunately, in pursuit of this search, they begin to use low-quality supplies and materials, reduce the number of operating personnel and do not invest in technology, when the solution is very close and that is, seek methods and tools that allow the process to continuously im-prove. Today, SMEs put so much effort in increasing the capacity of the production line to meet the needs of the market. To do this, they first have to improve the productivity of the production line. Too, High labor force costs were found to be associated with non-value-adding activities, for example the materials handling process in most SME facilities involves employees spending a great deal of time and effort sorting parts and perform manual tasks, resulting in increased production time and production costs (Yazdi, Azizi and Hashemipour, 2018).

Investigating the final finished product that will be the object of study, it was found that bread is a staple food consumed worldwide that is found in various cultures, is available to all socioeconomic levels and represents one of the largest markets (Pantidi, Selinas, Flintham, Baurley and T. Rodden, 2017). Currently, bread consumers are more aware and have an interest in fiber-based products, so the bakery industry varies in the inputs to produce different types of bread (Ad, Levent and Çol, 2019).

Between 2001 and 2010, the world market for bakery products showed a growth of 3.9%, this is due to the fact that composite flour products have gained fame and is constantly increasing since it has both economic and nutritional benefits. If historical data is analyzed, in 2006 the global sales volume of bread was 122 million tons while in 2011 it was 125 million tons (Engindeniz and Bolatova, 2019).

This research focuses on Peru, specifically in the bakery and pastry sector where greater emphasis should be placed on improving the method of operation, material flow and productivity. This action must go hand in hand with achieving the minimum waste of resources without affecting the quality of the product and using the resources properly in order to satisfy the daily demand of the client.

Applying the Systematic Layout Planning (SLP) methodology and study of work in

this industry would be an antidote to all forms of waste of resources in the production of the final product.

STATE OF THE ART

Productivity

Productivity is a value that indicates the relationship between outputs and inputs (Suryoputro, Wildani and Sari, 2018). Today, the mechanism for acquiring productivity data can vary considerably and depend on the accuracy of the information required and available resources (Eriksson and Lindroos, 2014). Traditionally, manual time studies are carried out in which productivity is evaluated on the basis of stopwatches or other portable data loggers to measure cycle and element times (Olivera, Visser, Acuna and Morgenroth, 2016).

Productivity has generally been defined as the relationship between the extent of production and the unit of all the resources used to produce this product. This includes an effective relationship to measure performance by outputs that are a product of the use of the method, result of the method, product prices, work-in-process inventory levels, and lead time. The improvement of productivity through the technique of the study of work is necessary to increase profits and achieve an adequate use of the labor of an industry (Prasad Bagri, G. and Raushan, 2015).

It is specified that productivity is the performance of the factors used in pro-duction, and it can be determined as the relationship between the production obtained in a given period and the amount of resources used to obtain it (Kang, Zhao, Li and Horst, 2016).

Work study

The objective of the study of the work is to examine the method associated with the activity that is being simplified or modifying the tactics of the operation of unnecessary work or the wasteful use of resources and setting a standard time for the development of the activity (Singh and Yadav, 2020). Also, by using re-sources efficiently, the study of work helps the company to reduce production costs and time of certain activity, necessarily examining the time of each element.

In the manufacturing industry, the application of time study and method study is widely used. Also, reducing the operation time in production leads to better productivity in the system. Thus, the study of work is especially linked to productivity. It is most often used to increase the quantity produced from a given quantity of resources without adding investment capital on a large scale (Singh and H. Yadav, 2016).

The study of work is the systematic examination of the methods of carrying out activities such as effective use of resources and allows establishing performance standards for the activities carried out. It is used to simplify the way a job is done and improve the production method. On the one hand, the method study examines the existing methodology and looks for any improved techniques or designs resulting in the most efficient use of material, plant, equipment and labor. On the other hand, time study is a work measurement technique that consists of calculating the operation time on an assembly line with the help of a stopwatch (Pancholi, 2018).

In 2017 research, they viewed work study as an important tool to increase productivity in the leather products industry, identified the bottleneck, and reduced a considerable amount of work content with the new improved method. Applying the study of methods and the measurement of work in the production line for women's handbags in the Surma industry, productivity improved by 12.71% (Moktadir, Ahmed, Tuj Zohra and Sultana, 2017).

According to a study carried out in a cotton manufacturing company, unnecessary delays in the operation were identified, work study techniques were applied in the bottleneck operation, assembly, and cycle time was reduced by 40.08% per cart (Matani, 2019).

Systematic Layout Planning

Small and medium-sized companies have a common problem, the design and distribution of their facilities, where the flow of information is impractical. For this reason, manufacturing companies are aware that it is possible to improve their production capacity by relying on methodologies that allow them to reorder and standardize their processes (潘丽颖, 2019).

There are different alternatives and approaches used to solve the problem of the distribution of the facilities; Each procedural approach generates a different arrangement depending on the set of objectives to be achieved (Amar and Abouabdellah, 2017). For this reason, it is important to have a good design of the distribution of the facilities, since many goods or equipment will have a direct and indirect effect of the efficiency in the circulation flow of the products (Zakirah, Emeraldi, Handi, Danil and Kasih, 2018).

The main objective of this tool is to improve the flow of both materials and information together with the use of space in order to reduce the costs of movement and material handling. The method is based on a detailed analysis that allows the identification of the production process and the logistical capacity of the company in order to carry out an optimal design of the facilities (Suhardi, Juwita and Astuti, 2019).

INPUT

The proposed model is developed in the bakery and pastry products sector, specifically in the company FINARTE S.A.C, a company that has a low productivity of 1.22 compared to the productivity of the sector, which is 1.30. From the analysis carried out in the bakery SME sector, it was found that low productivity is due to the inadequate use of resources, the inadequate distribution of the production area and a deficient working method.

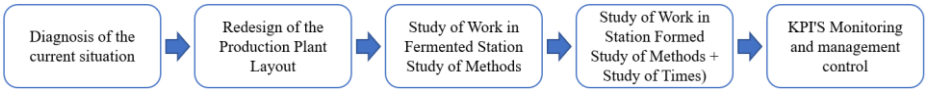

Figure 1. Design of the proposed model

In the first place, it begins by collecting data from the company to be able to carry out the current situation, with this you will know how the company is doing and you will have greater control to implement the improvement proposal. It is very important that the workers of the company are fully willing to provide in-formation or collaborate with the data collection at the time of the production of the breads of the company FINARTE S.A.C. This will allow you to compare the results of the improvement and know if the implementation was successful.

Second, once the information has been collected, we proceed to redesign the layout of the distribution plant, putting into practice the System Layout Planning tools. The application of this tool brings great benefits to the company such as the reduction of travel times, which is reflected in costs and this directly affects productivity.

First, the travel distance in the current layout of the company will be analyzed in order to determine the distance between the workstations that have some relationship.

Next, the current relational diagram of spaces will be elaborated to know the proximity of the stations and examine the flow of materials. With this information obtained, the proposed relational diagram of spaces will be developed, taking into account the proximity that the stations must present to reduce the distances and travel times that are reflected in cost overruns.

Then, the new layout will be developed, assessing the proximity between stations, aiming to have a minimum number of intersections along the route, so that in the new layout the stations are strategically located following the flow of the production process.

Afterwards, a comparative table will be made of the current and proposed distance of travel in meters to quantify the reduction that will be achieved.

Third, it is understood to carry out a study of methods in the fermentation station in

order to devise the most practical, economical and effective method, through the contributions of the participants, evaluating options to establish a new fermentation method comparing the cost-effectiveness relationship between the new method and the current one. The final action for this phase is to maintain the new fermentation method, controlling its correct application and implementing standardized procedures to avoid returning to the use of the previous method.

Fourth, a study of the work will be carried out in the formed station since it is the manual operation with the longest processing time. On the one hand, there is the study of methods which will be used to change the way in which this operation is carried out. For this, how the training work is being carried out, its purpose, the place in which it is carried out, the sequence in which it is carried out, the person and the methods used will be critically examined. Immediately, the most practical, economical and effective method will be devised through the contributions of the participants, evaluating options to establish a new forming method comparing the cost-effectiveness ratio. On the other hand, the time study will be carried out in the forming activity to establish a standard time and represent the improvement of the method study.

Finally, a control of these changes must be kept in order to be able to evaluate them and for this reason it is necessary to establish indicators for the proposed improvement. These indicators will be presented below.

Indicator	Formula
Percentage reduction in travel time	$\frac{Initial\ Transfer\ Time - Final\ Transfer\ Time}{Initial\ Transfer\ Time} \times 100$
Percentage of travel distance reduction	$\frac{Initial\ Transfer\ Distance - Final\ Transfer\ Distance}{Initial\ Transfer\ Distance} \times 100$
Percentage of Reduction of Fermentation time	$\frac{Initial\ Fermentation\ Time - Final\ Fermentation\ Time}{Initial\ Fermentation\ Time} \times 100$
Percentage of Reduction of movements in the station Formed	$\frac{\#\ Starting\ Moves\ -\ \#\ Finishing\ Moves}{\#\ Starting\ Moves} \times 100$
Percentage reduction in forming time	$\frac{Initial\ Forming\ Time - Final\ Forming\ Time}{Initial\ Forming\ Time} \times 100$

VALIDATION

To validate the proposed model, a pilot test was carried out at the company FINARTE S.A.C

When evaluating the case study company, a poor productivity was observed compared to the sector in Peru. This problem was evidenced by the aforementioned and its fundamental causes were long transfer routes and the deficient method of forming and fermenting.

With the implementation of Systematic Layout Planning, it was possible to re-duce the cost, distance and travel time by S /. 7,428.00 soles, 33 meters and 12.5 min respectively. Likewise, the number of batches of bread per day, number of breads per year, annual income and productivity increased by 2.03 batches, 111143 breads, S /. 22,228.50 soles and 9% respectively (See Table 2).

After implementing the second phase, study of methods in the fermentation station, the fermentation time was decreased by 20 min. Also, the number of batches per day, number of breads per year, annual income and productivity in-creased by 4.33 batches, 237,250 breads, S /. 47450.00 soles and 7% respectively (See Table 3).

At the end of the implementation of the third phase, study of the work in the formed station, the number of movements was reduced, the forming time in 6 movements and 38.83 minutes respectively. Likewise, the number of batches per day, number of loaves per year, annual income and productivity increased in 8.41 batches, 460,448 loaves, S/. 92089.50 soles and 12% respectively (See Ta-ble 4).

Table 2: Phase 1 - Current scenario vs. Proposed scenario

	As Is	**To Be**	**Decrease**	**Increase**
Cost of transfers	S/ 16,003	S/ 8,575	S/ 7,428	
Transfer distance (m)	67.2	34.2	33	
Transfer time (min)	26.6	14.1	12.5	
Number of lots per day	13	15.03		2.03
Number of breads per year	711750	822893		111143
Annual income	S/ 142,350	S/ 164,578		S/ 22,228
Productivity	1.22	1.34		9%

Table 3: Phase 2 - Current scenario vs. Proposed scenario

	As Is	**To Be**	**Decrease**	**Increase**
Fermentation time (min)	80	60	20	
Number of batches per day	13	17.33		4.33
Number of breads per year	711750	949000		237250
Annual income	S/ 142,350	S/ 189,800		S/ 47,450
Productivity	1.22	1.31		7%

Table 4: Phase 3 - Current scenario vs. Proposed scenario

	As Is	To Be	Decrease	Increase
Number of movements	11	**5**	**6**	
Forming time (min)	75.25	**36.42**	**38.83**	
Number of batches per day	13	**21.41**		8.41
Number of breads per year	711750	**1172198**		460448
Annual income	S/ 142,350	**S/ 234,439**		S/ 92,089
Productivity	1.22	**1.38**		12%

Finally, after executing the pilot plan for the improvement proposal, it is considered that for future studies the combination of tools such as Systematic Layout Planning and work study should be valued as an improvement proposal in other sectors that work with a production line. In addition, it is suggested to develop further research in tools that support the SLP and study of the work since, despite having had excellent results in this project, there may be complementary techniques that allow improving the productivity of the production process. Finally, a study could be carried out where the combination of the proposed tools can be implemented, in such a way that it is not only suitable for companies with a pro-duction line but also for other types of workshops, discontinuous lines or assembly lines.

CONCLUSIONS

The main objective of the improvement project was to improve the productivity of the bread production process, which through the pilot plan developed had a positive result varying from 1.22 to 1.45.

The implementation of the solution model based on the Systematic Layout Planning methodology and study of the work guaranteed the reduction of excessive transfer time in the production process and obtaining the best method for the fermentation and forming stations, leading to the elimination of activities that do not add value made by production operators.

Our contribution with this project is valuable since the Systematic Layout Planning methodology and study of joint work have been used in a bakery SME. When reviewing the literature, success stories were found with the aforementioned tools used in large factories and in very few cases implemented in small companies, always being a factor that they use them independently. So, our project is a contribution to research in this matter.

The times and distances traveled in each of the activities were detailed. Based on this, it was identified that there were 13 transfers in the production process representing S / 16,003.00. When applying the improvement of Systematic Lay-out Planning it was reduced to S / 8 575.00. In addition, with the application of SLP, 12.5 minutes in transfer times were reduced for each lot, representing an additional annual income of S / 22,228.50.

With the study of methods it was observed that the fermentation had a process that had to be improved. Thus, the best method was devised which involved ac-quiring a fermentation chamber and with the approval of the owner of the business, work was done based on this, reducing from 80 minutes to 60 minutes rep-resenting a production of 4 additional batches per day being a additional annual income of S / 47 450.00.

In addition, it was observed that the forming station was the manual operation with the longest time with 75.25 minutes. Then, study of methods and study of times were applied to identify those activities that do not add value and establish a new standard time for the operation formed. The current working method was improved and the number of movements was reduced from 11 to 5 and the operation time varied from 75.25 minutes to 36.42 minutes, representing a production of 8 additional batches that, when converted to figures, generates an additional annual income of S /. 92089.50

To carry out the improvement model, a total budget of S / 24,014.20 is re-quired. It should be noted that the economic validation carried out shows that the project is profitable and viable since the following results are obtained: the net present value (NPV) is S / 62 789.00, the internal rate of return (IRR) is 102%, The benefit-cost ratio indicates that for every S / 1.00 invested there is a benefit of S / 2.61 soles and the payback period is 1 year.

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