

Production Model Based on Lean Manufacturing, MRP, MPS and TPM to Reduce Losses in a MSE in the Bakery Sector

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Abstract

Currently, the bakery sector has been growing exponentially, which is why most customers are more demanding and seek higher quality products. A large percentage of bakery companies in Peru are small or medium, most of which are induced to informality. Due to this, the processes have inefficiencies in there that decrease directly to the final product, causing deficiencies of these. That is why this research is based on reducing defective products by applying the Lean Manufacturing philosophy. The tools that were applied are the 5s, improvement of order and cleanliness within the plant; followed by this, the MRP was applied to be able to manage the stock of materials and then the MPS, to be able to determine the quantity of products to be produced and at what time they should be produced. Finally, the TPM which is responsible for each operator to maintain the machines they use. This proposal was carried out through a pilot test to be able to develop each tool in a bakery MYPE. In this way, the result was obtained: The reduction of finished products from 10% to 5%, reduction of production costs.

Keywords

5S, MRP, MPS, TPM, Lean Manufacturing.

1. Introduction

Worldwide, bread is one of the most consumed products, obtaining approximate net sales of 6,630,209 worldwide. Its consumption extends to all nations of the world.

world, Russia being the leader in the ranking with figures that reach 130 kg per capita, followed by Chile, where its consumption is 90 kg per capita. In addition, the bakery sector is part of the food sector, this is one of the sectors that provides the most employment, since 1 in 5 people work in said industry. In Peru, the baking industry has presented a great demand since 2020, when the pandemic began, due to the fact that bread consumption grew by 30% compared to 2019. In addition, according to the Institute of Economic and Social Studies (2018), the per capita consumption of bread in Peru is approximately 35 kilos, with a tendency to grow 6 kilos more in the coming years. Due to this great increase in purchases in Peru by the bakery sector, different businessmen have been investing in the creation of different products (different varieties of artisan breads and with healthier ingredients) to satisfy internal demand. In different countries, including Peru, the bakery sector has been harmed due to losses or losses of the final product, which is why different companies in this sector are trying to implement innovative methods that reduce losses or losses of the final product. to increase their profitability and be competitive in the market. The identified problem can arise from different reasons such as poor execution of processes, overproduction, machine failure, among others. This would result in an increase in expenses in the company causing a reduction in profitability. There are different investigations that were carried out in order to reduce losses in companies in the bakery sector, one of those was in Colombia, where the "Romanello pastry shop" generates negative effects due to downtime, raw materials and inputs, due to this it has The objective is to increase the utility of the company by optimizing the production area by applying different tools of the Lean Manufacturing philosophy (Galvis C and Ñustes E 2014). Another example is in a company in the production sector - production of bakery products in the district of Huaraz, where its production process was very

messy, causing losses of the finished product and wastage. This caused low profitability to the company (Macedo B 2018). Finally, the Cosmos bakery has different problems, one of them is the high presence of losses in the production process, due to this, in the research it is proposed to use the standardization of processes for the growth and improvement of productivity (Contreras D 2020). Mentioned the above, it is necessary for Peruvian bakeries to be more efficient, maximizing their profitability. For this, a case study has been chosen where the problems of the sector are reflected in which we can appreciate an excess of losses and the final product that was rejected due to different waste and operations. These wastes were identified, which are due to poor execution of processes, overproduction, and machine failure, which generate monetary losses of S/.33,726 per year in the case study. To solve the previously described problem, an improvement model was developed where different tools of Lean Manufacturing 5S, TPM, Standardization of the work method are used, all previously identified under the 7-step methodology, Kaizen. The objective of this investigation is to reduce the losses and waste that are generated, applying everything mentioned above, so that in this way the company has less monetary losses. The scientific articles already reviewed contain little information on "Lean Manufacturing" work models for this type of company, that is, baking. For this reason, the need to carry out this research arises.

1.1 Objectives

The study aims to demonstrate that applying the production method based on Lean Manufacturing -5S, MRP, MPS and TPM, reduces defective products in bakeries, improves the order and cleanliness of the plant and prevents machine failures in the first place. It will be identified according to the index of defective products that exist in the company. Secondly, the tools mentioned above will be applied and a control will be taken to see if you are helping to improve the company.

2. Literature Review

2.1. Methodology 5'S

The 5s method of the lean manufacturing philosophy aims to eliminate waste, reduce materials in process, increase labour productivity, avoid accidents, optimize spaces, increase the speed of improvement. This method forms the work culture, through the planned practice of the concepts of each S.

The first S Seiri- Classification: It consists of classifying, selecting, clearing. Separate the useful from the useless in the production process of the company. The second S Seiton-Organization: In this step, each element will be assigned a suitable location and they will be identified. The third S Seiso-Cleaning: Eliminate dirt from all areas of the plant and preserve cleanliness. The fourth S Seiketsu-Standardization: In this step, operations are standardized to preserve the current situation and not be lowered. The fifth S Shitsuke-Discipline: The operators will work under all the changes of 5s that were implemented.

2.2. MRP

The MRP, Material Requirement Planning, is a system that allows the company to have a better management of its inputs, and a better control of its input stock. There are many small and medium-sized companies that place orders based on assumptions or when materials have run out. This generates little control of raw materials. Where if the materials are missing, they will cause problems in production, since it will not be possible to comply with the client's orders. On the other hand, if the materials remain for a long period in the warehouses, this will cause unnecessary storage costs and the possibility that these products become obsolete. For these reasons it is important to apply an MRP system to be able to request from suppliers the quantity of optimal materials with the aim of improving the efficiency and profitability of the company.

2.3. MPS

The master production plan or MPS is used for manufacturers who sell products to order, that means that the sales order is taken first, then the product is manufactured and then the order is delivered, it is used to improve the production of a company where it establishes quantities to produce. As you can see, the bakery sector has been increasing sustainably, which implies facing different challenges, which is why it is necessary to plan each stage of the process. In addition, as the author (Oktarini 2018) says, delays in production processes can often be experienced, or in some cases the number of customer requests for bread cannot be met. Due to this, according to (Trattner 2018), it is important

to evaluate the qualitative nature of the planning of production tasks, in this way implement a master production program (MPS) where you can see the aggregate volumes of each product to be produced and In this way, the demand for the orders can be covered more efficiently, that is, the next production, that is, the demand, can be determined. In this way, by applying the MPS, customers will be satisfied with their orders and there will no longer be delays or shortages. As different authors affirm, the application of a master production plan is essential, in order to improve the production management of bakeries, in addition to the fact that it is essential after using the MRP, planning of material requirements. On the other hand, it is important for the company to know how much to produce and when to do it, which is why the MPS will help to resolve these doubts.

2.4. TPM

The Lean-TPM model assumes the challenge of zero failures, zero incidents and zero defects to improve the efficiency of a production process, allowing to reduce costs and intermediate and final stocks, thereby improving productivity. Implementing a TPM program creates a shared responsibility across teams that encourages greater involvement from shop floor workers. This is because each operator will constantly maintain the machines, they use in the production process. TPM helps reduce failures, prevents accidents, minimizes environmental impact, optimizes overall equipment effectiveness, optimizes life cycle cost, and eliminates breakdowns.

Finally, downtime for maintenance is part of the production day or as an integral part of the production process. That is why it is important to implement maintenance as part of the production process to keep routine and unscheduled maintenance to a minimum.

3. Methods

The present study is a case study since it is based on only one specific topic in the baking industry.

Regarding the preparation of bread, it was observed that there is a large percentage of defective products, this is due to different factors, one of them is the order and cleanliness of the bread, another is that there was no inventory of raw materials, deliveries were not organized or how much should be produced for the next day, in addition to the failure of some machines at unexpected times.

Therefore, after identifying the main problems, it was decided to find the analysis of causes and the diagnosis of them by means of the elaboration of a problem tree.

According to the analysis of the problem tree in the diagnosis phase, we identified that the main causes are poor execution of processes, overproduction, and machine failure, in addition to a non-existent production and inventory plan. On the other hand, there are processes that are carried out consecutively where the necessary time and material resources have not been optimized.

Once the main causes and problems were identified, different solutions and tools could be analyzed to improve the indicators that have a significant impact on the process, where the application of the different tools is expected to reduce downtime, reduce defective products and the stops in the machines to have a better efficiency in the company. The variables that have been identified are reducing downtime, reducing machine failures, inventory of raw materials, a production plan and reduce costs.

For this reason, Figure 1 shows the model planted for the development of the implementation proposal.

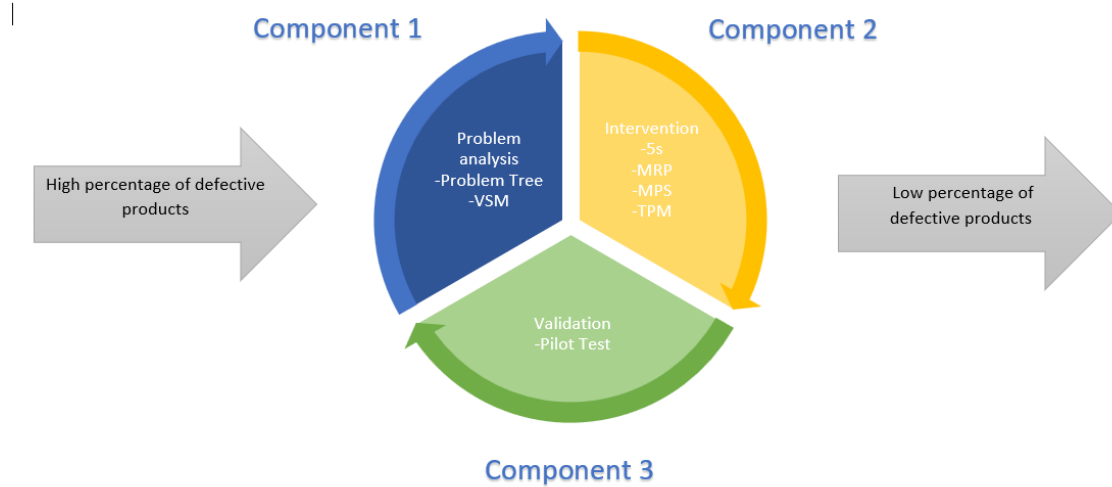


Figure 1. Proposed model

4. Data Collection

The data collection was obtained through various sources where it was possible to have a better complete vision of the company's problems, one of them was the interviews that were carried out with different company workers, in order to have information about the different activities that they perform and how they are performed, the Pareto diagram was also implemented to identify the most important problems and the problem tree to identify the causes. After collecting all the information

It was concluded that it is feasible to use the tools, such as 5S, MRP, MPS and TPM.

4.1. Implementation of 5'S

The 5s methodology is part of the Lean Manufacturing philosophy. This methodology has 5 steps whose purpose is to optimize the areas of the plants, turning them into more orderly and clean areas, obtaining better productivity and minimizing waste.

Before using the 5 steps, an audit of the company is carried out, where it will be evaluated if the company has any knowledge of the methodology or if they have done something that contributes. Then, results will be produced through the evaluation and based on that, changes for improvement will be made.

We obtained the following results:

First S: 44% non-compliance, the second S: 36% compliance, the third S: 48%, the fourth S: 25%, fifth S: 23.33%.

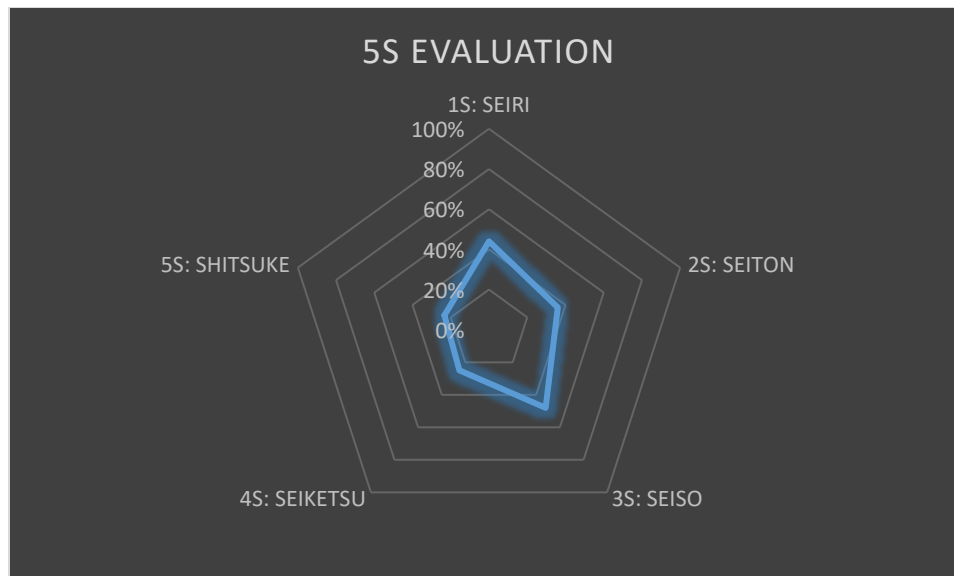


Figure 2. Assessment of the 5's

a. Seiri-Classification: The things that are really useful are separated from those that are not useful that are found in the different work areas that were mentioned above.

For the raw materials warehouse, any object that is not part of the category will be removed, for the work area, only the objects that are needed in this part of the process will be available, eliminating distracting elements, elements that are not part of the process; for the passageways, the objects that prevent transit through the station will be removed; on the other hand, in the machinery area, unnecessary objects found in it will be removed.

b. Seiton-Organization: After everything is in place, the tools, materials, machines that are used will be signaled and identified. In addition, the areas will be delimited with a floor marking. The yellow tape is for the passageways, the work areas, the areas occupied by the machines, the areas occupied by the opening and closing of the doors, the red color is for waste.

c. Seiso- Cleaning: The points where more dirt is generated were identified, a document was prepared with all that information.

A documented maintenance plan will be carried out, in which the areas to be cleaned with their elements, their frequency and the person responsible will be indicated. A work table with high edges will be implemented in order to reduce the amount of flour that falls to the ground, new colored cans will be added to throw the waste according to the classification

d. Seiketsu-Standardization: Staff will be trained on the 5s philosophy, a 5s applications manual will be produced, and a 5s panel will be added.

e. Shitsuke-Discipline: There will be monthly meetings to identify 5s improvement opportunities where everyone will participate including the manager and the operators.

4.2. TPM

To implement it, the number of operators and the number of machines used in the production process were identified. Subsequently, all the operators were trained on the characteristics of the machines and how to do proper maintenance after using these machines. In addition, a table was prepared with the responsibility of each operator's machine, this document will rotate from time to time. It is sought that the autonomous maintenance of each machine is part of the production process in order to reduce failures, reduce costs.

4.3. MPS

We decided to implement a master production plan because it was possible to observe in the bakery that there was a low control of how much product should be produced and when it should be produced.

The first thing that must be done is the demand forecast, with this we must consider the customer's request, in this case the month of October was taken to carry out the pilot test and the forecast units were 33,500 in the four weeks of October.

The second thing that must be known is the availability of materials, which is known from the MRP, because thanks to this, there is knowledge of the available capacity of the different materials that are needed to make ciabatta bread.

- Initial inventory: the bakery sector does not have an initial inventory.
- Lot size: units that are produced for each period. In this case there are 756 units of loaves.
- Demand forecast for September: 30,500 units of ciabatta bread.
- Demand forecast for October: 33,500 units of ciabatta bread.

*Forecasted demand is evenly distributed between the 4 weeks of September and October.

The MPS is found through the value of the forecast units and customer orders, since, if the value of customer orders is higher, that value must be considered because that is what we are going to sell and cannot be produced less than that, instead if the greatest value is the predicted units, we choose that.

5. Results and Discussion

The application of the improvement to reduce defective products in the production of bread in a bakery was carried out for a month, during this time the necessary information and work techniques for each activity were provided to the different employees of the company, through different training.

5.1 Numerical Results

The results of the pilot test are shown in the following table, where each indicator reduced its percentage.

Table 1. The results of the pilot test

Indicator	Unit	As-Is	Improvement
Downtime rate	percentage	35.26%	10%
Stock break	percentage	25%	19%
Machine failure	percentage	48%	15%
Defective products rate	percentage	10%	5%

As can be seen in the table, the results were positive, since all the percentages decreased significantly, and in the case of the defective product index, it was possible to reach the standard of 5%.

5.2 Graphical Results

It is important to mention that we used MRP because we identified zero inventory control, so missing materials such as yeast or sugar were obtained and had to be purchased at that very moment, which caused a loss of time and resources.

To apply this tool, it is necessary to have some data recorded in the Excel tables, such as the master program of the different articles, where the quantity to be manufactured for each week is detailed, then in Excel the record of the Inventory. Following this, it is also important to identify the gross needs of the company, this is the number of materials that are available to be manufactured. Then the scheduled receptions are identified and the amount of order that will arrive and the week in which this order will arrive is placed. The available inventory must also be detailed to carry out the MRP, this is the material that we have in each period, and to find this, the final inventory of the previous period must be added and added with the scheduled receptions and subtracted with gross requirements for that period. The net needs must also be detailed, these are obtained when the available inventory is not enough and therefore an order must be generated. The penultimate thing that must be recorded are the receipts of production orders, which is the amount of raw material that is received in a period due to the launch of an order, and in this case the bakery that we are analyzing handles the batch-to-batch system, which means that the order is equal to the quantity required. Finally, it is important to register the release of an order, since it is necessary to have the supplies available at the desired time, for this reason it is important to have issued a purchase order periods before.

In the following figure we will see the results of the MRP.

Materials planning									
Article	Amount to make parent element	Lead time	Available inventory	Security stock	Concepts	Time frame			
						1	2	3	4
Ciabatta bread	0	1	0	0	Gross needs	756	756	756	756
					Scheduled receptions	0	0	0	0
					Available	0	0	0	0
					Net needs	756	756	756	756
					Order receipt				
					Release order	756	756	756	756
Flour	22.5	1	4500	20	Gross needs	17010	17010	17010	0
					Scheduled receptions	100	120	100	120
					Available	20	20	20	140
					Net needs	12430	16890	16910	0
					Order receipt	12430	16890	16910	0
					Release order	16890	16910		
Water	14	1	100000	0	Gross needs	10584	10584	10584	0
					Scheduled receptions	0	0	0	0
					Available	89416	78832	68248	68248
					Net needs	0	0	0	0
					Order receipt	0	0	0	0
					Release order	0			
Yeast	0.3	2	40	0	Gross needs	226.8	226.8	226.8	0
					Scheduled receptions	100	100	100	100
					Available	0	0	0	100
					Net needs	86.8	126.8	126.8	0
					Order receipt	86.8	126.8	126.8	0
					Release order	126.8	126.8		
Salt	0.45	1	50	0	Gross needs	340.2	340.2	340.2	0
					Scheduled receptions	0	0	0	0
					Available	0	0	0	0
					Net needs	290.2	340.2	340.2	0
					Order receipt	290.2	340.2	340.2	0
					Release order	340.2	340.2		
Butter	0.4	2	50	10	Gross needs	302.4	302.4	302.4	0
					Scheduled receptions	100	100	100	100
					Available	10	10	10	110
					Net needs	162.4	202.4	202.4	0
					Order receipt	162.4	202.4	202.4	0
					Release order	202.4	202.4		
Suggar	0.5	1	50	0	Gross needs	378	378	378	0
					Scheduled receptions	250	250	250	250
					Available	0	0	0	250
					Net needs	78	128	128	0
					Order receipt	78	128	128	0
					Release order	128	128		
Enhancer	0.17	2	25	0	Gross needs	128.52	128.52	128.52	0
					Scheduled receptions	100	100	100	100
					Available	0	0	0	100
					Net needs	3.52	28.52	28.52	0
					Order receipt	3.52	28.52	28.52	0
					Release order	28.52	28.52		
Oil	1.5	1	24	0	Gross needs	1134	1134	1134	0
					Scheduled receptions	0	0	0	0
					Available	0	0	0	0
					Net needs	1110	1134	1134	0
					Order receipt	1110	1134	1134	0
					Release order	1134	1134		

Figure 3. MRP

5.3 Proposed Improvements

In the following table we can see the MPS already implemented

Table 2. MPS

Weeks	October				November			
	1	2	3	4	5	6	7	8
Initial inventory	-	-	-	-	-	-	-	-
Forecast units	30500	30500	30500	30500	33500	33500	33500	33500
Customer orders	31277	30029	31658	30311	32949	31892	32849	33041
Final inventory	-	-	-	-	-	-	-	-
MPS	756	756	756	756	756	756	756	756

5.4 Validation

The model that was proposed was validated through the implementation of a pilot test, with a duration of 1 month, implementing the tools, such as the 5S, where the order and cleanliness of the plant is improved, then the MRP, the MPS and the preventive maintenance of the machines, all this was done in the months of October and November 2022. Then with the data that was obtained after the implementation of the tools, we were able to calculate the proposed indicators, resulting in the following percentages:

The downtime rate: This decreased from 35.26% to 10%, using the 5S methodology, this was reduced thanks to the implementation of cleanliness and order in the plant, with this indicator we are getting closer to our goal and a large amount of downtime has turned into production time.

Out of stock: This decreased thanks to the implementation of the MRP, down from 25% to 19%, with this indicator it was possible to know how much raw material is needed to be able to produce the final product.

Machine failure: This indicator decreased from 48% to 15%, thanks to the implementation of the TPM, thanks to this the company was able to have better productivity.

Defective product index: This indicator managed to drop from 10% to 5%, with this the company achieved better profitability and had fewer economic losses.

6. Conclusion

It can be concluded that the application of Lean (5S) tools can improve the order and cleanliness of the plant. This is extremely important because it can improve production, reduce waste, avoid accidents, have all the tools and machines more organized, have documents that help feedback on the 5s philosophy. Finally, this influences the reduction of defective products and losses.

In addition, it is important that the operators have knowledge of the machines that they use in order that they can do maintenance after using them to avoid finding continuous failures.

Likewise, it can be concluded that the application of the MRP helped significantly to be able to plan the materials, and how many of them were needed and in this way not run out of stock, since this delayed the preparation of ciabatta bread by not having the necessary materials to make it.

On the other hand, it was possible to conclude that the implementation of the MPS helped significantly to reduce losses and waste, because it was planned how many loaves should be manufactured and at what time, and in this way an overproduction was not produced.

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