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Proposal for application of overall equipment effectiveness indicator in a hot sauce company

Propuesta de aplicación del indicador de eficiencia general de los equipos en una empresa de salsas picantes

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Abstract

The use of indicators within companies is highly relevant to help manage their processes. Particularly for equipment and machinery, the indicator of overall equipment efficiency (OEE) is commonly used with the objective of measuring equipment inefficiency and identify losses. This helps to foster an environment of continuous improvement that leads to increased productivity. During this investigation, an adapted methodology is used, which highlights the use of lean manufacturing techniques, from which our OEE metric is derived. The purpose is to know the efficiency of the equipment in order to take actions that help reduce the waste presented in a production line of a hot sauce company. This article will contribute to the promotion of the use of new tools that lead to continuous improvement, since our intention is to simplify the way the company visualizes its problems, which will lead to finding solutions in a faster and more objective way.

OEE, Productivity, Wastes

Resumen

El uso de indicadores dentro de las empresas tiene una gran relevancia para ayudar a gestionar los procesos; particularmente para los equipos se utiliza el indicador de eficiencia general de los equipos (OEE por sus siglas en inglés), el cual ayuda a medir la ineficiencia de los equipos y a identificar las pérdidas, fomentando un ambiente de mejora continua que lleve a incrementar la productividad. Durante esta investigación se utiliza una metodología adaptada de la cual resalta el uso de las técnicas de manufactura esbelta, de donde se deriva el OEE. El propósito es conocer la eficiencia actual de los equipos para posteriormente llegar a tomar acciones, las cuales ayuden a disminuir los desperdicios presentados en una línea de producción de una empresa de salsas picantes. Este articulo contribuirá a fomentar el uso de nuevas herramientas que lleven a las prácticas de mejora continua, lo que pretende es visualizar de manera más simple las problemáticas, lo que llevará a buscar soluciones de una manera más rápida y objetiva.

OEE, Productividad, Desperdicio

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1. Introduction

The globalisation of the world has brought with it an increase in competitiveness among companies, due to the ease of acquiring any product in different parts of the world.

This represents a risk for those companies that do not seek to innovate in their processes, falling behind and being overtaken by the competition. In addition, there are cases where the decrease in product quality is used as an attempt to reduce costs, which leads to other types of problems, leaving customers dissatisfied.

Therefore, quality is an important factor that should not be neglected, and another indicator of performance is productivity, with this we can know the capacity of a company to produce, but it can also be a little misleading because it could have a high productivity with low efficiency, which leads to increased product costs and sometimes these problems can become invisible if appropriate measures are not taken.

This shows that it is necessary that the procedures of a company are guided by some strategy or methodology, this is where lean manufacturing plays an important role, as these techniques generally seek to eliminate waste.

There are several types of waste, this opens the option to have a diversity of methodologies, which focus specifically on one of these types of waste. However, the implementation of any of them can be modified to solve different problems, or even reveal unexpected problems.

First of all, it is necessary to know the current state of a company, the indicators are in charge of showing this information, so that it is known if the objectives are being fulfilled or if they are being fulfilled in the right way, in order to later look for the most appropriate solution.

This research will be in charge of demonstrating that the current state has some problems that can be improved with the help of lean manufacturing techniques, specifically the development of the indicator of general efficiency of the equipment, so a modified methodology is developed to avoid waste during the production of hot sauce.

2. Theoretical framework

Food production requires standards and care in the production process that go beyond the common quality requirements. In Mexico, NOM-251-SSA1-2009: Hygiene practices for the processing of food, beverages or food supplements, is responsible for providing guidelines to achieve food safety in companies, covering the entire food chain (Arellano Narváez et al., 2020). Food safety has also been identified as a benefit of implementing ISO 22000, which provides the necessary requirements for an organisation to comply and deliver a completely safe and quality product. Another support system to ensure food quality is HACCP (Hazard analysis and critical control points), both of which provide competitive advantages to companies, leading them to expand their market and provide higher quality products with the main objective of protecting consumers (Gil et al., 2017).

Another way to achieve better quality and higher productivity is the lean manufacturing philosophy. It was born in Japan at Toyota Motor Company in the 1950s, when Eiji Toyoda and Taiichi Ohno developed their ideas to start the Toyota Production System; these ideas were born from a visit to Ford where they were able to observe their production process. Lean manufacturing techniques are based on eliminating waste in order to have better results in efficiency, so within this philosophy, waste is categorised into seven: overproduction, waiting times, transport, processes, inventories, movements and defective products (Taiichi, 1988).

Lean manufacturing helps to identify the activities that do not add value in a process and therefore helps to eliminate waste, leading to higher productivity, which makes companies more dynamic and involves them in a culture of continuous improvement. The staff plays an important role as they are the ones who must adopt these ideas in order to achieve the expected results (Palange & Dhatrak, 2021).

The purpose of lean manufacturing is to improve processes with the help of methods, techniques and practices available to companies. The aim is to solve recurring problems regardless of the company's activity, in order to achieve the goals set (Bouazza et al., 2021).

These techniques seek to identify and eliminate waste by improving the efficiency of operations at a high margin. These wastes are also known as mutes and according to the author Socconini (Socconini, 2019) the best translation of this word is "excess". To understand this, he explains that there are activities that generate value and for which the customer is willing to pay; waste then represents the opposite, as they are the efforts that are made that are non-essential and do not add value to production, leading to increased costs and decreasing the level of service.

The variety of techniques included in lean manufacturing are continuous improvement, 5S, anti-error devices also called poka yoke, rapid change and value stream mapping. Each used in different situations, but with the same purpose of helping to eliminate waste (Womack et al., 1992). Some of these techniques have a greater impact in certain types of industries; in the case of the food industry, the most frequently used are Poka Yoke, Kaizen, 5'S, Kanban and Total Productive Maintenance (Cuggia-Jiménez et al., 2020).

As part of the Total Productive Maintenance we find other tools such as the general efficiency indicator of the equipment, with which it is possible to know in a general way the efficiency of the process but also its quality and performance, this serves as support in the decision making process of corrective actions (Silveira & Andrade, 2019). Taking data to generate this indicator also provides information on downtime and maintenance activities which allows better planning of preventive maintenance as well as spare parts plans (Smirnov & Abdilova, 2021).

Although the techniques have their beginnings in the automotive industry, their success has created a trend and several industries such as metal, textile and aerospace implement these techniques (Durakovic et al., 2018). Particularly in the food industry these techniques are little used and there is little research in the area. However, the studies that have been practiced offer positive results such as increased productivity and efficiency, highlighting the importance of employee engagement in the organisation, as the success of the implementation of the techniques depends on them (Borges Lopes et al., 2015).

In addition, this technique brings benefits to human resources as it promotes the skills and abilities of employees during their development (Viteri Moya et al., 2016).

As mentioned, these techniques are beginning to gain strength in the food industry, a sector in which an extra benefit can be generated for the population, as waste is food that is not used, so reducing this waste increases the amount of food available without the need to increase production (Steur et al., 2016).

In Morocco, the food industry is one of the main sectors of the economy and has involved lean manufacturing in its processes. A research was developed that allowed observing its application in different companies of the food industry and they were able to observe its benefits in profitability, efficiency and effectiveness, however they mention that it is not fully implemented and this is because they need the support of managers to achieve it and that it is deployed in companies in a global way (Farissi et al., 2021).

Lean manufacturing techniques are frequently used in organisations, but it is necessary for each organisation to make adaptations and implement them according to their needs. As it is a long process, there must be enough knowledge to identify waste, so that it can finally generate an impact and benefit for organisations (Leksic et al., 2020). It is currently one of the techniques that helps to reduce waste, which allows companies to improve their strategies, ensuring their competitiveness by having better performance and more satisfied customers. As mentioned by Ibarra and Ballesteros (2017), its success will depend on correctly implementing this philosophy.

To achieve a correct implementation it is also necessary to provide a suitable environment, in which employees have the necessary tools to achieve a focused work generating solutions and process improvements, which must be measured. For this purpose Ramune (Čiarnienė & Vienažindienė, 2012) proposes that dimensions such as waste elimination, continuous improvement, continuous flow and pull systems, cross-functional teams and information systems should be used.

Accurate measurement is a very important part of knowing the processes, indicators have the function of evaluating and monitoring the processes, which allows them to be optimised, thus reducing losses (Diaz et al., 2020). To ensure the effectiveness of lean manufacturing, it is necessary that the correct selection of tools is made, that there is authenticity in the data, that the people involved participate with a positive mentality and that they accept the change in the work method and work culture (Kolla et al., 2019).

There are a number of application cases and the findings are similar, an example of which was conducted in a company involved in the production of carbonated soft drinks. It presented problems with packaging waste and after an analysis the factors causing the problem were identified, with which lean manufacturing techniques could be implemented, achieving a reduction of 81% of waste (López González, 2017).

Another application case that helps to demonstrate the benefits of lean manufacturing techniques is one developed in India, in which a questionnaire is carried out to several manufacturing companies that applied the techniques in question and were finally able to demonstrate significant changes in production. In this case they highlight the use of lean manufacturing techniques and mark it as a vital factor for improvement, in particular, they highlight just-in-time as a very useful technique that helps to increase productivity. It requires teamwork and good coordination among those involved to make it work, so the researchers conclude that it is necessary to review those obstacles that prevent the application of lean manufacturing techniques (Singh et al., 2018).

The methodology on which this article is based seeks to eliminate a specific type of waste, which is inventories, however it can be adapted to deal with other waste as it includes in its phases a proposal of lean manufacturing tools which can be modified, as will be done in this case (Chávez & Romero, 2017). This methodology was compared against DMAIC which is one of the most used methodologies with lean manufacturing because for many companies this is a more known option and that facilitates the extraction of information with a very marked structure, in addition another of its advantages is that it can be worked with other strategies (Rifqi et al., 2021).

3. Argumentation of the solution

This research is carried out in a hot sauce company in the city of Hermosillo, where there has been a chronic problem of loss of raw material. This occurs to a different extent with each product, some of the most affected are hot sauce, chamoy and red and green habanero sauces. Being a company with international trade with the possibility of expanding in the market, it seeks to implement new tools that help them stand out from the competition, which is why they investigated methodologies that include lean manufacturing in order to integrate it into the company's activities.

In order to choose the tool, we looked for methodologies that integrated lean manufacturing in their practices, because it is known that the main purpose of this philosophy is to reduce waste.

The DMAIC methodology was reviewed as it is one of the most implemented and also one of the best known, it has a structure that tends to be more familiar to some, however it is not always necessary to implement lean manufacturing and other tools could be used.

For this reason, the methodology of ortega del castillo (2019) was also reviewed, which is a modification of the proposal of Chávez and Romero (2017) and will be modified again for this occasion. Unlike DMAIC, this new methodology establishes lean manufacturing as its central solution proposal and although its origin is focused on inventory waste, it can be easily modified, it is only necessary to modify the proposed tools to adapt it to other situations, making it a better option for the problem addressed.

The selected methodology helps not only to solve the problem but also to find the weak points in the company that lead to a lack of control in the processes. The only problem with this methodology is that it does not include a control phase, and the current conditions of the company with the lack of controls has led to the problem.

Therefore, not including this phase in the methodology would leave the project very vulnerable to new problems, which justifies the addition of the sixth phase to strengthen the methodology.

This last phase will allow monitoring the changes made and will alert in case of new changes that may create deviations in the process.

In addition, with this last phase it is expected to generate a cycle, as it will be possible to have a direct follow-up of the company's results and it will be easier to detect future problems, thus avoiding chronic problems. This methodology will lead to the implementation of the lean manufacturing philosophy in the company, which will generate changes in the working methods of the personnel that will help the company as a whole.

4. Methodology

In order to implement the lean manufacturing techniques that are appropriate for the particular situation of this company, we propose to use a modified methodology of Ortega del Castillo, shown in figure 1.

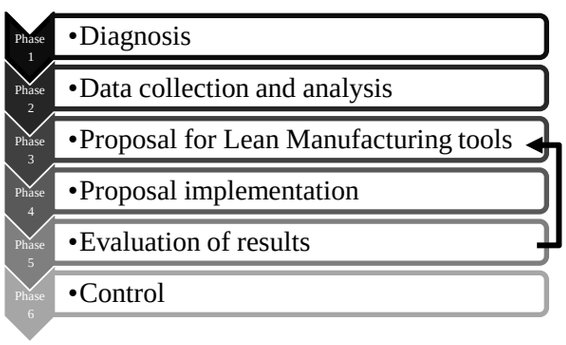

Figure 1 Diagram of proposed methodology
Own Elaboration

The methodology is composed of six main phases, which will be described below.

A. Phase 1. Diagnosis

During this phase, the company's environment, its areas of opportunity, processes and flow of operations are known. In this way, it is easy to understand the problem and to find the cause.

B. Phase 2. Analysis and data collection

In this phase data will be collected that will help to understand numerically what are the effects of the problem and also with these measurements it will be possible to know which area generates the most waste, this will be very important to determine the lean manufacturing tools to be used.

C. Phase 3. Proposal of lean manufacturing techniques

In this phase the possible causes and the areas that are affected by the problem will be known. Therefore, a proposal will be made with the appropriate techniques for each area, hoping that each one will be applied by the whole team in a general way.

D. Phase 4. Implementation of the proposal

The implementation of the proposal is the central part of the methodology, where changes will be seen and possible conflict situations will be presented. In this phase, new data derived from the changes will be obtained and will serve as support for the next phase.

E. Phase 5. Evaluation of results

In this phase a comparison will be made between the data obtained at the beginning and the data obtained during the implementation. This will allow an evaluation to be made and determine if the correct activities were carried out or if it is necessary to make changes in the developed proposal.

F. Phase 6. Control

Finally, in the control phase, tools will be implemented to help maintain the changes and to be able to measure the indicators, so that it will be easier to detect if a new problem arises.

The development of this methodology aims to answer the following research questions:

1. What is the current production process like and what are the potential causes of sauce wastage?
2. In which part of the production process of the final product does the most sauce waste occur?
3. Which equipment has the most efficiency problems?
4. What control methods will be used to prevent future wastage and ensure continuous improvement?

5. Results

During phases 1 and 2 we got to know the company and its ways of working, we observed for some months the operation and the problems that arise. The phase presented some difficulties, firstly there were problems in the collection of data as they are collected manually and sometimes the staff did not have adequate control, this was one of the first obstacles, after this some of the working practices that the company has did not help to have reliable data in the flow meters, leading to have inaccurate data.

In addition, there are no control methods that help to know if the data obtained are accurate, and some discrepancies are observed where the waste obtained with the meters is zero, but during the observation of the process it is known that this result is not possible. Even though the numbers were not entirely clear, it was possible to determine that most of the waste occurs in the filling area, which is largely related to equipment stoppages or maintenance problems. Table 1. Waste shows that the highest percentages of waste are found in the stage from the filler to the bottles.

Waste				
Month	Tank-Filler		Filler - Bottles	
	Liters	%	Liters	%
May	46,976.49	4%	39,987.83	6%
June	73,194.16	6%	52,494.54	5%
July	53,317.22	5%	64,928.37	6%
August	27,173.86	2%	53,058.97	4%

Table 1 Waste in litres per month
Own Elaboration

With these results, we proceeded to phase 3 of the proposal, in which we had two options: to apply a total productive maintenance programme (TPM) or to apply an OEE indicator to the process that would allow us to identify the deficiencies in the equipment and which were the most problematic.

It was decided to implement the OEE as the other option required a greater investment of time and resources, and some of the activities that the company already performs work as a basis for the implementation of the OEE.

In order to implement the indicator as an initial step, it was necessary to inform the company's participants about the subject, its purpose and the benefits it would bring to the process.

Subsequently, a format was structured to record the line stoppages, which are classified by equipment, which will make it possible to know which one generates the most problems. The company already had a record of stoppage times, but the data was not processed or used, so the OEE will help this activity to be useful and beneficial for the company. With this record it was possible to observe the efficiency of the equipment, but it was also observed that there is equipment that does not have the same production capacity, so the imbalance of the line generates stoppages that are not related to maintenance.

Another observation is that the problem with measurements and control is present in different parts of the process, for the OEE it is necessary to measure the quality and so far only a record of the waste of bottles, labels, caps and boxes is kept, giving as a result the final waste for each run. The problem is that these inputs can present administrative errors due to inventory issues, leading to the indicator not showing the true results.

Finally, it is expected that the activities that will help generate the OEE will help to control the activities, so that actions can be taken that will lead to a more efficient line with less waste, which in turn will lead to improvements in production costs. Once the changes are made it will be necessary to take new data to evaluate whether the actions taken were effective and helped to reduce waste, but also to evaluate the efficiency of the equipment by comparing the OEE obtained.

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7. Conclusions

The purpose of this project is to generate an impact on waste reduction, the implementation of this methodology will help the company to generate a change in their activities that will lead them to know more about the status of their process, it is common to know in a general way the situations that occur and when they become frequent occurs the so-called workshop blindness, so maintaining an indicator is important to maintain the continuous improvement of processes.

It is hoped that this is only the beginning of lean manufacturing applications within the company and that more indicators will be established in the process to help control more activities. It was observed that waste is present during several production processes and with this new way of working it is hoped that more similar projects can be developed to further reduce production costs.

It is important to be able to see the activities in greater detail in order to generate changes and it is also necessary to have a high level of commitment from those in charge so that the activities proposed are carried out and, above all, analysed. The realisation of this project will allow a higher production capacity by having equipment working efficiently, thus increasing sales as well as reducing current production costs.

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