Distribution Process Model Based on Lean Manufacturing and BPM to Reduce Costs in SMEs in the Craft Brewing Sector

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Abstract

The purpose of this work is to provide information on cost improvements in SMEs in the brewing sector using lean manufacturing and BPM. A simulation model was created using Arena and Bizagi, where the model was made with the provision of a small brewing company, the indicators used to measure the effectiveness of the model are: distribution cost per bottle, percentage of use of containers, lead time and OTIF, these indicators seek to provide us with the necessary data to validate the process. This document shows us a more complete vision of the use of these tools and the result of their use. It will contribute to academic and professional work on lean manufacturing and BPM in small companies.

Keywords
Lean Manufacturing, BPM, data analysis, Brewery sector and SMEs.

1.Introducción
The beer sector is of great importance for the economy of a country, such is the case of Spain, where it contributes 1.3% of the GDP, generating a total of 3,600 million euros and more than 344,000 jobs (Álvarez, 2019), within this sector are craft beers that have also had a large increase in sales, as is the case in the US market, where craft brewers represent 24% of beer sales. On the contrary, the more industrial beers, with mass production and therefore more standardized, are losing ground (López, 2019). In Peru, the sector of craft beer production companies is constantly growing, managing to produce an estimated 2.5 million liters in 2021, exceeding the 2 million liters produced in 2019 (López, 2022). This is due to the great boom that the sector has had because it is expanding, in addition, the investment that it entails as machines and raw material for its production is not high compared to other products, factors that influence the decision for production.

According to the reviewed literature, the problem to be evaluated was identified as the high distribution costs in craft beer production companies. This occurs for reasons such as delivery delays, poor inventory management, low level of attention, among others. These can be found in other investigations such as the case of the company BODEMAX, from Ecuador, where it was established that the main limitation in the growth of the company was the management of its inventory of beer containers, keeping in useful stock only the 68% of the total stock (Aguilar et al., 2020). Similarly, inventory management is an issue that has little relevance and is not addressed within SMEs, generating a waste of resources and capital which is important for companies of this caliber (Ojeda, 2012). Likewise, in a study carried out in Ecuador, a survey was carried out among employees of a brewing company about whether there are delays in the time of attention to logistics deliveries, obtaining as a result that 74% of employees consider that there are, and 40% of the population considers that these incur in extra expenses. (Orange, 2016).

To solve the problems of the craft brewing sector, a case study was considered that shows the main problems of the sector in search of cost reduction. The main problems found are poor inventory management, low level of attention,

delivery delays and low response capacity to problems. That is why, in search of solving this problem, a distribution model will be developed, using the Kanban, BPM, Work Standardization and Process Standardization tools, following the Lean Manufacturing and BPM methodology. This research proposes a new distribution process model whose objective is to solve the problems of the craft beer sector, as well as problems related to logistics in general.

This scientific article is divided into seven parts which are Introduction, Literature Review, Methods, Data Collection, Results and Discussion, Conclusion and References.

1.1 Objectives
The main objective of the research is to reduce the distribution costs applied in SME companies in the craft brewing sector. Likewise, there are the following specific objectives:
- Improve the level of care by standardizing work and processes.
- Implement an inventory management system to increase productivity and reduce the time involved.

2. Literature Review
Lean manufacturing is a management methodology based on the philosophy of "everything can be improved"; seeking to identify and eliminate activities that do not add value; therefore, the optimization of resources is important to reduce the economic impact that may be generated (Condor, 2018). On the other hand, companies that apply Lean Manufacturing tools such as Kanban observe an increase in efficiency, reducing distribution expenses by 50%, which translates into a reduction in costs (Peralta, Torres, 2021). In addition, the application of this methodology implies standardization and documentation, which is proposed in our work, seeking to improve the quality of the products and services offered. The application of Lean manufacturing tools also contributes to reducing inventory adjustments, with improvements through value flow mapping and management indicators that measure its effectiveness and efficiency. (Molina, Mora, 2019).

Business Process Management is a discipline and set of good practices, methodologies and technologies that allow proper management of business processes. The application of BPM manages to obtain an organization whose focus moves from a traditional hierarchical and functional structure to a more efficient, effective, articulated and committed one with the client (Santos López, Santos de la Cruz, 2013). In addition, the use of BPM in the distribution process seeks to systematize and simplify the processes, helping the company to be more efficient and capable of making changes according to the approach, being able to better adapt to market changes. Companies that apply BPM manage to reduce errors at the time of packaging, increasing their general effectiveness (Bustillos 2018), in many investigations, the implementation of BPM shows a great reduction in the times of carrying out tasks and even the decrease and nullification of human intervention (Odd and Bjørn-Morten, 2014)

Standardization is the way companies can reduce their costs (either financial or time). It is the way an organization aims to ensure a clear, visualized, and safe work environment. With a correct application of the standards, production defects are prevented, and, at the same time, procedures are established to avoid the occurrence of other errors that could have an impact on production. Therefore, it is desirable to standardize all the processes that are carried out in the manufacturing sector. (Mĺkva et al. 2016). In turn, the implementation of this tool, depending on the degree of its development, could bring other benefits such as: improving space management, promoting a strong work ethic and strengthening the commitment of the operators (Agrahari et al. 2015). Because efficiency is sought in the company through the elimination of unproductive and inefficient activities, it is necessary to study the processes and their standardization (Torres, 2021).

3.Methods
Currently, with the rapid growth of SMEs dedicated to the manufacture and distribution of craft beers in the sector, it has been necessary to streamline and modernize processes. For this reason, considering the review of the literature, in consideration of the problems found in the company, it has allowed us to identify the use of Lean Manufacturing tools, through Kanban for the control of activities and the standardization of processes, in addition to the application of BPM (Business Process Management), which will allow us to control the processes, seeking to improve the efficiency of the company. The following table is presented with the comparative matrix in which the items and components considered most important are identified.

3.1. Proposed Model

The proposed model is based on the use of BPM, standardized work, and Kanban. We seek to manage the processes, in addition to modeling and managing them through BPM. On the other hand, the standardization of the processes and work will improve the efficiency and productivity throughout the business. Finally, with the usage of lean manufacturing, specifically the Kanban methodology, we will be able to visualize the workflows and have mapped the tasks and activities to be carried out in the amount and time necessary for these processes to be carried out (Figure 1 and Figure 2).
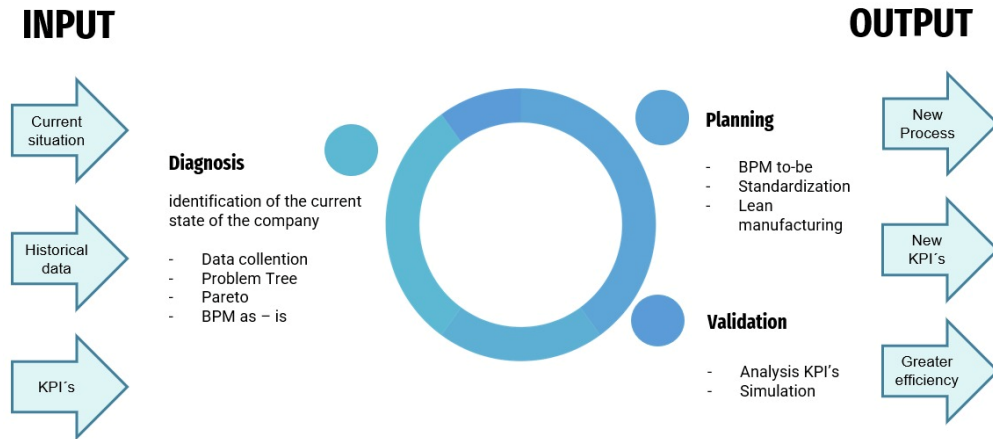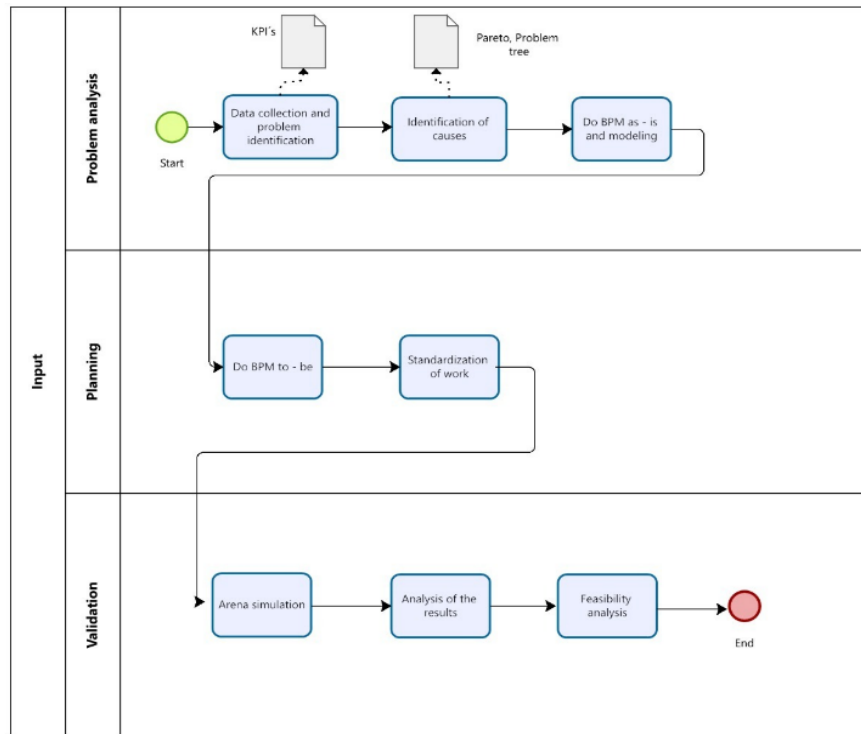

Figure 1. Proposed Model

Figure 2. Proposed Method

4. Data Collection

To collect the data to work on the model, we used physical reports within the brewery company, to achieve the expected results. Accordingly, we have obtained the following indicators (Table 1- Table 3).

Average attention time: Time in minutes that it takes to attend an order from its generation to its delivery. It must be considered that the company uses two attention times, one for orders within Oxapampa, and the second for orders to Lima.

$$Average\ attention\ time = \frac{Total\ time\ of\ attention\ in\ orders}{Total\ number\ of\ orders}$$

Objective: Reduce the average service time by 25%.

Table 1. Indicator traffic light Average Service Time

🟥	Less than 5%
🟨	Between 5% and 15%
🟩	Greater than 15%

Labor efficiency: Percentage of useful hours in the labor shift.

$$Labor\ efficiency = \frac{Man\ hours\ used}{Total\ working\ hours}\ x\ 100\%$$

Objective: Increase the efficiency of the workforce by 20%.

Table 2. Indicator traffic light Efficiency of labor

|	
🟥	Less than 10%
🟨	Between 10% and 20%
🟩	Greater than 20%

Average preparation time: Time in minutes that it takes to prepare an order. Consider that there are two preparation times, one for Lima and one for Oxapampa.

$$Average\ preparation\ time = \frac{Total\ order\ preparation\ time}{Total\ number\ of\ orders}$$

Objective: Reduce the average order preparation time by 40%.

Table 3. Indicator semaphore Average preparation time

🟥	Less than 20%
🟨	Between 20% and 40%

	Greater than 40%
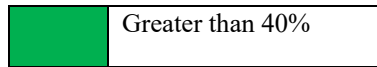
5. Results and Discussion

Simulation: To validate and verify the improvements, the Arena simulation software will be used. This software will allow the creation of the current model in search of results in the current conditions, and then propose an improved model that allows assessing whether the changes made provide an improvement to the proposed model. Likewise, in the software it will be necessary to represent the scope of the simulation, the entities, variables, and attributes that will lead to the results.

Scope: The scope of the system covers from the arrival of the orders to the worker in charge, until the corresponding deliveries are made to the clients. Likewise, it has the travel processes, being divided into two. On the one hand, there is the trip that takes place from Oxapampa within the same city, and on the other hand, there is the trip that takes place towards the city of Lima, with variations in the modeling.

Simulation process:
Definition of variables: within the developed system, various random variables were identified, which allowed the simulation to be carried out and the results to be adjusted to a realistic scenario. As specified in the following Table 4.

Table 4. Random variables of the system

Nº	Random Variable	Units	Variable Type
1	Time between arrival of orders	minutes	Continuous
2	Number of dozens per order	dozens	Discreet
3	Order destination probability		Discreet
4	Order reception time and stock verification	minutes	Continuous
5	Validation time	minutes	Continuous
6	Probability of accepting new quantity		Discreet
7	Time to confirm stock	minutes	Continuous
8	Time to generate order and invoice	minutes	Continuous
9	Time to prepare order	minutes	Continuous
10	Time for stowage	minutes	Continuous
11	Time for travel to delivery point destination Lima	minutes	Continuous
12	Travel time to different delivery points in Oxapampa	minutes	Continuous
13	Time for unloading at Oxapampa delivery points	minutes	Continuous

Calculation of system replications: With the intention of being able to have the data in the best possible way, 3 runs were made to be able to adjust the most relevant indicators. Within this process, the "half width" data was considered specifically for the average service time of Oxapampa. The "half width" is a statistic that helps to determine the statistical reliability that are obtained from the results and the different replications. In this case, having a half width of maximum 8.589 will help us assure that the simulation and the results are reliable.

- First run

    With the first run we obtained a half width with a value of 10.89, higher than the desired value of 8.589. This was done using the following formula:

$$N = No \ x \ \frac{ho^2}{h^2}$$

    Where:
    - N: Optimal number of replicas
    - No: Initial number of replicas or sample

- Ho: Half width obtained for initial replicas
- H: Half width desired

$$N = 30 \; x \; \frac{28.63^2}{8.589^2} = 333$$

- Second run

  Since the value is greater than the one sought, a second run was carried out where a half width with a value of 8.82 was obtained and the value found in the previous formula was replaced. This was done using the following equation:

$$N = 333 \; x \; \frac{10.89^2}{8.589^2} = 535$$

- Third run

  Finally, with the third run, a half width of 8.5 was obtained, being the necessary to carry out the simulation.

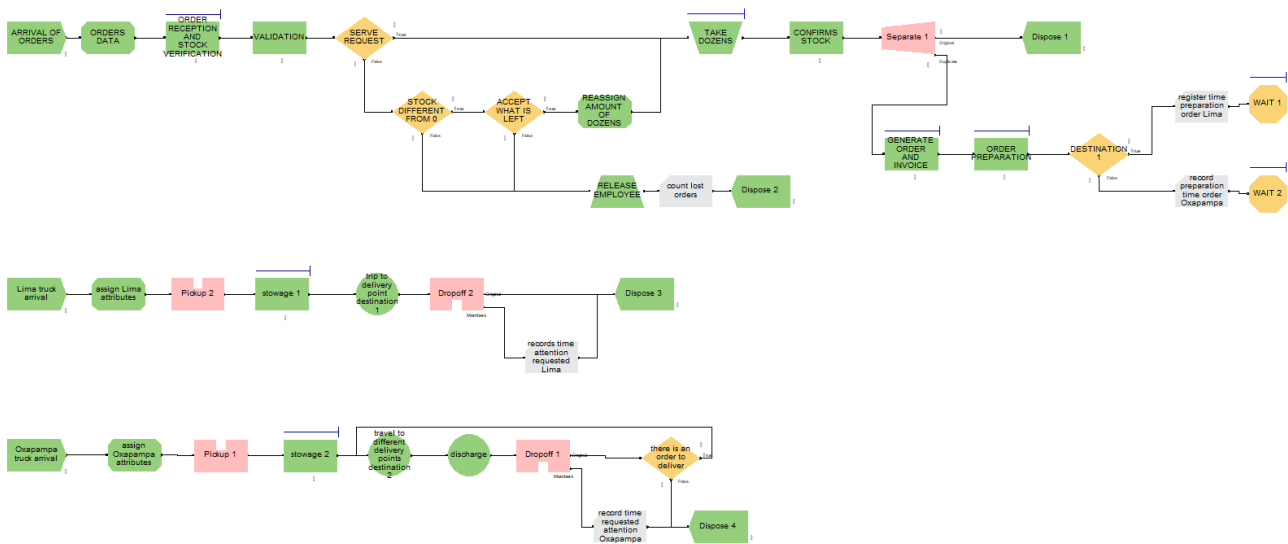Simulation model (Figure 3 and Figure 4):

Figure 3. Actual simulation
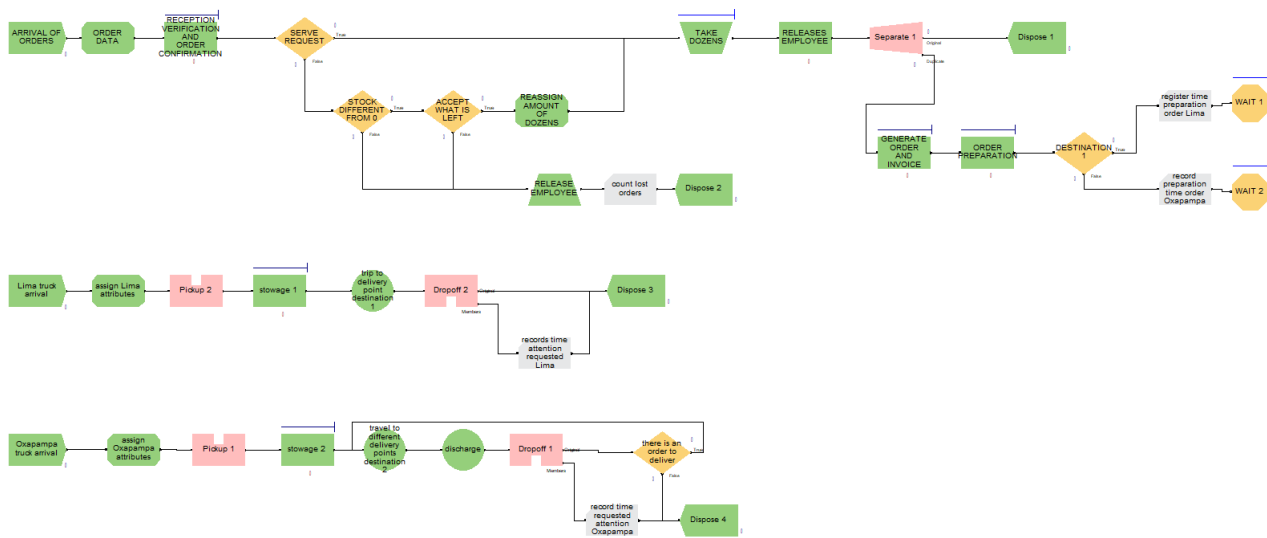
First change

Second change

Figure 4. Improved simulation model

To realize the second system, the best modifications were made, mainly at the first part of the simulation (Table 5):

Table 5. Proposed Variable

Nº	Random Variable - Proposed	Units	Variable Type
14	Time of receipt of order, verification, and validation of order	minutes	Continuous

A unification of processes was proposed to reduce the times used in the processes, seeking to improve the level of attention and time indicators.

From the simulation, the following results were obtained (Table 6):

Table 6. Results of indicators in the simulation

Indicator	As Is	To Be	Improvement
Average attention time Oxapampa	447.2	352.97	27%
Average attention time Lima	953.09	965.64	-1%
Labor efficiency	0.1665	0.3312	99%
Average preparation time Lima	287.26	111.7	157%
Average preparation time Oxapampa	289.7	113.07	156%

6. Conclusions

Through the implementation of Lean Manufacturing tools, the average service time in Oxapampa was reduced, with an improvement of 27%, streamlining the process. In addition, the standardization of the work used helped us reduce service times, greatly reducing errors that could affect the quality of our products and services.

The application of lean manufacturing increased the efficiency of the workforce by 99%, which translates into a better use of time by our staff. We can conclude that the use of Lean manufacturing tools reduced the average order preparation time in both Lima and Oxapampa by 157% and 156%, respectively.

The use of lean manufacturing, process standardization and BPM help companies in the brewing sector improve average service time, increase workforce efficiency, and reduce order preparation time for shipping customers. translating into a reduction in the variable costs of distribution, having as distribution cost per case of beer $2.56, being $1.28 fixed and $1.28 variable, after the application of these methodologies, the variable costs were reduced by 50-57% having as mean decrease in $0.64. Achieving that the final distribution cost is not $2.56 but $1.79 - $1.92, reducing the final distribution cost by 30-25%.

7. Acknowledgements
To our families, for the unconditional support provided over the years, for educating us with the values to be good people in society.

To the University of Lima and its professors for their commitment to train great professionals, committed to the development of a just, equitable and supportive society, which also seeks to improve the quality of life of the people who comprise it, supporting the construction of a better country

To our thesis advisor, Ing. Martin Collao-Díaz, who with his knowledge and commitment led us to the development of this research work. And to all the people who in one way or another supported us in the realization of this project.

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