"OPTIMIZATION OF RESOURCES IN THE PRODUCTION OF CHEESES OF THE SAN LUIS DAIRY INDUSTRY"

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Abstract. *The present investigation was carried out in the Dairy Industry San Luis and pursued as main objective, to optimize resources in the process of production of the fresh cheese line, through work organization tools and contrasting these, through a model of simulation. This was made possible through the application of methods engineering tools, time study. In addition, computer simulation tools such as FlexSim, in conjunction with its ExperFit and Experimenter tools; SPSS, MedTrab and Microsoft Excel, which facilitated the design and statistical and mathematical processing of information. FlexSim allowed to obtain in a simple and concrete way, data that the industry did not know and are of fundamental importance in the planning of its activities, such as: local and global production capacities, percentages of use of its resources, percentages of the incidence that they have stoppages in the object and means of work, among others. On the other hand, the culmination of this work demonstrated the feasibility of application of the simulation, in order to facilitate decision-making regarding the optimization of resources and their favorable impact on the current level of productivity.*

Keywords

FlexSim, Simulation, diagnosis.

1. Introduction

The Dairy Industry San Luis is a small industry located in the Pichincha Province, Cayambe Canton, where it has been producing for more than 40 years for the national market. In that then, it begins producing cheese for producers of biscuits in Cayambe and Tabacundo. Currently, it processes up to 4000 liters of milk daily and produces different types of cheeses such as: mozzarella, ripe, spun, fresh mainly. In recent times it has expanded its market to cities such as Quito, Guayaquil, Santo Domingo, Ibarra, and part of the Eastern region.

Since its inception the Dairy Industry San Luis produces in a traditional way, this form has served it for a long time. In recent years and due to the expansion of its market, it has been facing some problems that affect the good performance of production execution, as well as the fulfillment of customer orders. Among these problems, the following stand out.

- The key performance indicators of the production process are not controlled.
- From a sample of 99 orders, 59 of them are not delivered on time, which generates an inventory of approximately 30 cheeses per week that must be reprocessed.
- Estimated losses of time in the transport of raw material of 10% are detected, due to manual activities.

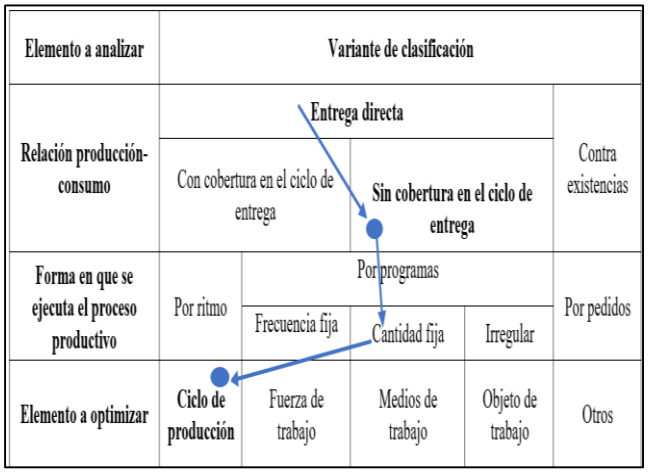
The aforementioned constitutes the problematic situation of the present investigation in the Dairy Industry San Luis, which is materialized in the lack of application of tools that allow to take correct decisions in the programming, execution and control of the productive process, which translates into a better use of existing resources; and, therefore, in improving the current level of productivity. The above is the scientific problem to solve with the present investigation.

2. Materials and Methods

Characterization and diagnosis of the production system

Characterization of the company

To carry out the general characterization of the industry, it was based on internal factors: mission, vision, raw material, organizational structure and range of products; and subsequently the external factors: main suppliers and customers, within the latter of which stands out the chain of supermarkets Santa María to which more than 70% of the total production is destined. According to the level of flexibility, the system was classified as a batch production with low nomenclature of products and medium production volumes. But also the system is classified as



Precision and enrichment of the problems that affect the productive system

Problems:

High levels of waste due to transportation between processes.

Unawareness of the work efficiency of the operators (productivity).

Lack of motivation and training for workers, that is, committing to the company.

Non-compliance in date and quantity of customer orders, affecting the image of the company.

Lack of standardization of the production process that leads to ignorance of all its associated indicators, such as standard times, production capacity, cycle times, production rate, among others.

Figure 1 shows that the three main problems that affect the performance of the organization are those that have to do with the measurement of performance indicators and their improvement that directly influences the optimization of resources.Diseño del modelo de simulación

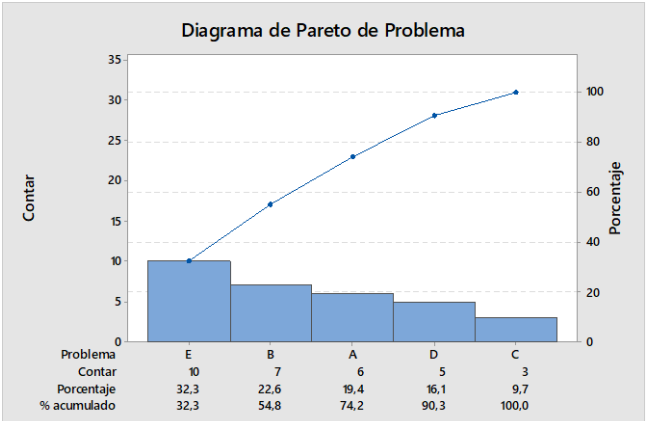


Figure 1. Pareto diagram major problems

For the development of the simulation model, FlexSim, version 7.7.4 and its Experfit and Experimenter packages were used for the statistical processing of data and for optimization, respectively. For other statistical analyzes the SPSS, version 22.0 was used and Excel was used to collect the numerical information

2.1 Collect and analyze system data

For the development of this step, the Experfit tool was used by taking real data and statistical analysis of them, in Table 1 the results and distributions to which they fit are shown.

Tabla 1. Análisis estadístico de datos

ANÁLISIS ESTADISTICO DE DATOS	
Recepción de leche llenado	loglogistic(477.417939, 10.863115, 4.575702)
Pasteurizado	beta(1863.129563, 2067.565922, 0.985688, 1.768948)
Enfriamiento	johnsonbounded(175.236408, 194.356079, -0.330726, 0.972127)
Coagulación	beta(1222.951931, 1331.673410, 1.182881, 0.837566)
Corte	weibull(0.000000, 309.619530, 34.483037)
Desuerado	beta(810.991815, 936.181800, 1.393121, 0.842459)
Transporte marmita - mesa	johnsonbounded(1486.852829, 1710.731355, -0.581163, 0.533364)
Moldeado	beta(12.454636, 17.908544, 7.969867, 8.860412)
Transporte mesa - prensa	weibull(0.000000, 739.336006, 26.370030)
Prensado	tiempo constante
Desmembramiento	johnsonbounded(60.933069, 66.197556, -0.184764, 0.400202)
Transporte prensa - salado	loglaplace(0.000000, 314.993651, 19.607089)
Salado	weibull(7213.069600, 1900.241490, 2.000000)
Retiro de salmuera	beta(104.940184, 117.146892, 5.720938, 1.875456)

2.2 Experimentation

To validate the model, it was necessary to conduct an experimental model, this was done with the Experimenter; one of the flexsim tools. In the model proceeded to design a single scenario taking as reference the number of workers currently working in the company, four workers who are considered as independent variables, based on that variable

were defined eight dependent variables, within which are established as the most important the following:

- Cycle time: duration of the process from the reception of the milk (filling) to the removal of brine, for a batch of 512 cheeses.
- Percentage of time spent on transport: times used to transport buckets of rennet from the kettles to the work tables, cheeses from the work table to the press and cheese drawers from the press to the brine vats. Said percentage was calculated by summing these times on the cycle time.
- Use of the Working Day: it is not taken into account for the validation of the model since in it there are not certain activities that are carried out in the real system.

Once the dependent and independent variables were defined, a pilot run of 50 replicas was carried out, without a warm-up period and running time of 32,400 seconds.

2.3 Validation

Once the reliable data were established with which we worked, we proceeded to perform the validation with the real system, for them we used the IBM SPSS Statistics program, version 22, in which a comparison analysis of means with a T test was performed. for a sample in each of the variables analyzed: cycle time and time spent in transport.

Estadísticas de muestra única

	N	Media	Desviación estándar	Media de error estándar
PORCENTAJE	26	9,7612	,41117	,08064

Prueba de muestra única

	Valor de prueba = 9.58					
					95% de intervalo de confianza de la diferencia	
	t	gl	Sig. (bilateral)	Diferencia de medias	Inferior	Superior
PORCENTAJE	2,247	25	,034	,18115	,0151	,3472

Figure 3. Test of atocking comparison T

H_0: μ=27737

H_1: μ≠27737

Estatical: Sigma

Critical Region: Sigma 0.021 < 0.05; H0 is accepted, the Cycle Time variable has equality of means with the behavior of the real system of the San Luis Dairy Industry.

Estadísticas de muestra única

	N	Media	Desviación estándar	Media de error estándar
SEGUNDOS	26	28169,77	894,404	175,407

Prueba de muestra única

	Valor de prueba = 27737					
					95% de intervalo de confianza de la diferencia	
	t	gl	Sig. (bilateral)	Diferencia de medias	Inferior	Superior
SEGUNDOS	2,467	25	,021	432,769	71,51	794,03

Figure 2. Test of atocking comparison T

H_0: μ=9,58

H_1: μ≠9,58

Estatical: Sigma

Critical Region: Sigma < 0.05; the H0 is accepted, the variable Time invested in Transportation has equality of means with the behavior of the real system of the San Luis Dairy Industry.

From the above analysis, it is concluded that the designed model has an operation similar to the real system since there is equality of means between them and they are in the same confidence interval.

Finally we can identify that the design productivity of the simulation model is::

$$Productivity = \frac{512 \text{ cheeses}}{462{,}28 \text{ minutes}} = 1.11\ ch/m$$

3. Results

After realizing the simulation of the real system it is evident that there are significant times invested in transport in relation to the cycle time without being necessary in the production of fresh cheese, having the possibility of minimizing said times since the Dairy Industry San Luis has machinery capable of performing these activities, optimizing these transportation times. By virtue of looking for an optimization method, the Reyes Cheese Factory has been taken as reference, which is dedicated to the production of cheeses, it has a system of transportation of rennet by means of hoses and a pump.

The San Luis Dairy industry has equipment such as: transport hoses and an emulsion pump, used in the process of draining, which can facilitate the transport of the rennet, optimizing the percentage of time used for it.

3.1 Simulation of the aptimization proposal

S On the basis of the model designed and described in the previous chapter, the proposed improvement alternative was implemented, which consists in eliminating the transport of the rennet in buckets from the pots to the work tables by the operators and implementing a transportation system with hoses. and a bomb. In view of the fact that it is a discrete model, conveyors (conveyor belts) have been used, instead of pipes that are usually used in fluid models. In addition, for the experimentation process, a new dependent variable was created referring to the time of transport of rennet from the pots to the work tables. The proposed model system is shown in Figure 4.

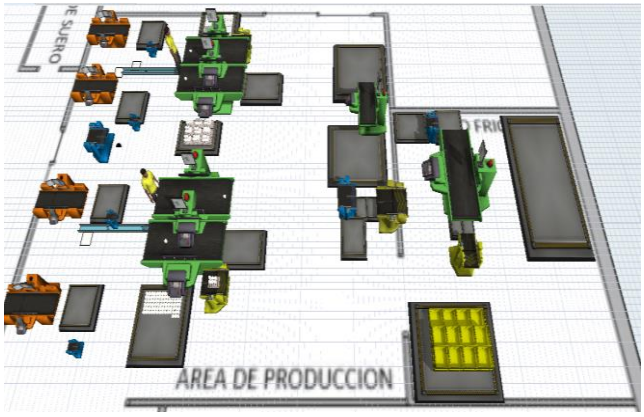


Figure 4. Proposed model

The validation of the proposed model was made taking as analysis variables the "transport time of rennet", for it the IBM SPSS Statistics program, version 22 was used again and a comparison analysis of means of a T test for a sample was carried out. , where the T test was obtained from the research carried out in other companies that already use this transportation system, taking as reference 1500 liters of rennet and the sample was obtained from a run of 50 replicas of the proposed model

Once the improvement proposal has been validated and having demonstrated the reliability of the data obtained; Table 2 shows a comparison of the results of the dependent variables between the current system and the proposed system, these results have been obtained for a run of 50 replicas, with a confidence interval of 95% and for a production batch of 512 cheeses (1500 liters of rennet).

Table 2. Comparison table of reslts.

	CURRENT MODEL SYSTEM	PROPOSED MODEL SYSTEM
CYCLE TIME	27737 seconds	26324 seconds
EMPLOYMENT OF THE LABOR DAY	46,05%	50,05%
PERCENTAGES OF TRANSPORTATION	9,58 %	8,97 %
PRODUCTIVITY (cheeses per minute)	1,11	1,17

From the comparison made between the current system and the proposed system it can be seen that the percentage of time in transport decreases considerably, since it represented 9.58% of the total time and with the proposed system these times represent 8.97% of total time, thus minimizing the total cycle time in 1413 seconds, with reduced time causes productivity to increase by 0.06 cheeses per minute; that is to say, using the time of the current system, the quantity of the production lot can be increased from 512 to 540 cheeses.

In addition, it can be evidenced that there are improvements regarding the waste of rennet, since with the implementation of the proposed system and without the direct manipulation of the workers the amount of rennet left from the pots is the same that arrives at the work table for molding, a situation that previously did not exist

4. Conclusions

The compilation of the theoretical bases around the technical-professional problem raised allowed to confirm the broad conceptual base about each of the issues addressed, in view of achieving the optimal use of available resources and a better performance of the main performance metrics of this process.

In the diagnosis it was evidenced that one of the main problems are the transports that are carried out of a procedure through small batches of production; There is a time of transport of rennet from the pots to the tables of 1657 seconds that represent 60% of the total of transport and at the same time they represent 10% of the total time of the production process, besides it was evidenced that there are no indicators that reflect the current productivity in the company.

A simulation model was designed through the Flexsim tool, which showed a behavior equal to the real system, with a cycle time of 27737 seconds, an advantage of the working day of 46.05%, transports of 9.58% , and a productivity of 1.11 cheeses per minute.

It was proposed the implementation of a system of transportation of rennet through hoses and a pump, thus reducing rennet transport time from the pots to the work tables by 0.61% or 1237 seconds, which increases the productivity by 5.4%.

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