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APPLICATION OF ENGINEERING STUDIES OF METHODS IN THE PLANNING OF THE ADMINISTRATIVE AND OPERATIONAL MANAGEMENT OF THE PRODUCTION PLANT

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Abstract: This research deals with the application of the hypothesis test to the learning curves as production optimization techniques for the establishment of the uniform flow of the processes based on the production execution times in order to eliminate cost overruns and delays that affect the system; Through the use of methods engineering studies, it is sought to go beyond the mere calculation of the standard time to plan the administrative and operational management of the production plant, proposing for this purpose an applied engineering procedure to optimize the production problem of the manufacturing company of elements for the construction Multibloques S.A.S. The present study is carried out following a classic research methodology with a Mixed approach and the application of deductive, inductive and analytical-synthetic methods to establish relationships between the study variables, allowing the formulation of the optimization model that originates a set of solutions that show an approximation to the results of the approach developed. Currently the manufacturing sector adopts optimization techniques that are limited only to being in favor of reducing time and costs, so it is necessary through applied engineering work to obtain practical solutions that represent an agreement between the parties involved, this way With timely and reliable information, the company is able to implement management strategies and projects that provide continuous improvement.
Keywords: Learning Curves; Efficiency; productivity.

INTRODUCTION

Production is the obtaining of a good from tangible and intangible inputs, following a logical sequence of operations or activities that add value to the final product. As a result of the industrial revolution, business management requires that industrial processes be more specialized in order to have process technologies that increase productivity. However, the low growth of this is due to the economic deficiency of the companies, therefore, the new trends force to have better ways to use labor, physical and human capital existing in the company more efficiently, to thus raising productivity and adopting a determined and ambitious production plan. Which is achieved when the development and cognitive capacity of human capital is involved in the productive process, this way an approach to the discernment of how the functioning and nature of the rational human being operates is achieved. On the contrary, as Solow (1956) points out, productivity becomes "a measure of our ignorance" because efficiency gains are calculated residually, where the result is seen as a technological measure and as the portion of growth that cannot be attributed to factor accumulation.

The objective of this article is to apply the conceptualization of the hypothesis test to the learning curves that are used to plan the administrative and operational management of production plants, proposing for this purpose a procedure to optimize the production problem presented by of the company Multibloques S.A.S. which manufactures and markets elements for construction, these elements correspond to adobes for the erection of walls. The proposed procedure seeks to obtain a set of solutions that show an approximation to the results of the approach adopted for the case study presented.

Production is considered the heart of companies, so it is a daily task to determine through mathematical calculations the number of manufactured units and based on the resources used to establish productivity, since with the improvement of this parameter companies are more competitive in the market. (Heizer et al., 2007) point out that improving productivity means improving efficiency, given that only through an increase in productivity can the standard of living, salary remuneration, capital and management be improved, which is achieved, for example, reducing the inputs while keeping the outputs constant or vice versa. But this methodology has not been enough to involve the cognitive capacity of the operator in the process, for this reason a better way to solve these organizational problems is proposed, therefore, it is essential to make hypothesis testing and learning curves a technique for the optimization of productivity, considering the operator as the most valuable resource and fundamental axis of the organization (Cardona et al., 2019).

CONTENT

LEARNING CURVES

Throughout history, learning curves and their contribution to production have been studied. In this sense, Argote & Epple (1990) develop one of the most important statements about learning curves, pointing out that it varies from organization to organization. taking into account the factors of personnel, technology and productivity.

The publication made by Wright, (1936) is considered the first theory on the learning curve and it addresses the relationship between manufacturing time and their costs, arguing that "Given any process where there is repetition of operations, the average time will tend to decrease at the rate of doubling the number of repetitions". In accordance with this discovery, a mathematical model of linear decrease is established, where it is related that given the conditions of repetition of the tasks, the time required to complete it decreases at a constant speed. Implying a contribution to the efficiency of labor, the organization of work and the balance between labor and capital. Regardless of the productive environments in which the conceptualization is applied, the following mathematical expression is used to calculate the learning percentage.

$$\%\ of\ learning = 2^{\frac{Log\ t_i - Log t_f}{Q_i - Q_f}} \quad (1)$$

Where:

$$Log\ ti = Time\ spent\ in\ the\ initial\ unit$$
$$Log\ tf = Time\ spent\ in\ the\ final\ unit$$
$$Qi = initial\ amount$$
$$Qf = final\ amount$$

This way you have to

$$c = \frac{Log\ t_i - Log t_f}{Q_i - Q_f} \quad (2)$$

It corresponds to the slope as an exponent.

$$\%\ of\ learning = 2^c \quad (3)$$

With the learning curve it is possible to establish a relationship between the standard time per unit and the number of times the action is repeated or the number of units produced, the result of the above corresponds to the calculation in (Man Hours/Unit), (Cost / Unit), (Machine Hours / Unit) or failing that (Used Resources / Unit). Used for the manufacture of the denominator, that is, a manufacturing unit, batch or series.

According to Sullivan et al. (2004), "learning curves as a mathematical model explain the phenomenon of increased efficiency of a worker and the improvement of the performance of an organization from the repeated production of a product or service". The learning curve is a method of great importance for the analysis of productivity improvement in organizations. To establish itself as a competitive advantage, workers must be considered as the organization's most valuable resource and invest in their knowledge; Since it is vitally relevant to productivity, innovation, and performance, it actually performs more effectively. Olea, et al (2011).

HYPOTHESIS TESTING

A hypothesis is a premise, which may or may not be true, but can be temporarily accepted, until proven otherwise, if the hypothesis has any inconsistency or failure, it must be rejected, since the end of hypothesis testing is to assess the level of that inconsistency or failure. (Dagnino, 2014).

To accept or reject a statement regarding a population, the hypothesis test is used, this depends on the evidence presented by the data sample. This hypothesis test examines two hypotheses in a context in which both assertions cannot coexist. These are the null hypothesis and the alternative hypothesis, the null hypothesis being the statement that is tried to be tested, almost always referring to the fact that "there is no effect" or that there is "no difference". For its part, the alternative hypothesis corresponds to the statement that it is desired to be able to show or conclude that it is true according to the information extracted from the sample. The test determines whether it is possible to reject the null hypothesis. If a p-value is used to make a decision, but if the p-value is less than the significance value denoted by alpha (α), then the null hypothesis can be rejected.

A hypothesis test is the process of making an observation, establishing a question based on the information obtained to continue with the application of the scientific method to try to solve the problem posed in the question. The beauty of the scientific method is that it is gradual and deliberate and each phase is recorded and the hypothesis is continually modified until a strong and solid conclusion is reached.

RESEARCH METHODOLOGY

This investigation is subscribed to the analysis and interpretation of the results obtained from the information collected through the open interviews carried out during the first phase of the investigation, since the objective is to gather information and data on the defined topic to generate a broad vision. of the same. Additionally, use is made of the deductive method to draw conclusions from a series of principles and the inductive method to reach a general proposal based on the analysis of the case study; the Analytical-Synthetic method is also put into practice to identify the elements of the problem and establish the interrelationships of the variables, allowing the formulation of new schemes in the problem. A classic type of research is carried out with a mixed approach that seeks to study a contemporary problem within a real context within companies in the real sector of the economy.

INFORMATION COLLECTION

Quantitative techniques such as experimental studies are used for the anticipated elaboration of hypotheses.

Retrospective survey with open answers and an analytical approach applied in a face-to-face meeting carried out during the first phase of the investigation in order to explain and describe the company's problems.

Experimental design to test the hypothesis in order to establish a cause-effect relationship on the studied model.

The qualitative research techniques that were implemented were ethnographic studies to get to know in depth the behavior of the members of the company; observation and grounded theory as a complementary technique for developing theory from the data obtained.

Analysis of data

With the data collected, it is possible to calculate the process times, both normal time and standard time, aimed at calculating operational efficiency. The normalization point of the learning curve is calculated, that is, the number of units necessary to manufacture so that the process times remain the same and with this the employer participates in tenders and negotiations, taking into account the application of the value curve in the extension of production.

PROBLEM STATEMENT

Most of the micro or medium-sized companies do not prevail over time due to ignorance of productive variables such as cost/Unit, costs and marketing of raw materials, profits and market use. Which brings with it the need to have new work and administration methods and procedures that provide the company with a better administrative and operating system that provides high profits, in order to optimize production and dignify the work of the operator, since a An efficient company will be one that, in the use of its resources, guarantees a better standard of living by providing better income and expanding market horizons for the generation of sources of work and the strengthening of its social function.

The system variables that are modeled are:

Product costs: Raw materials, labor, cost of machinery and projection of profits.

Indicator Product Costs/Unit

The research question is summarized as: To what level does the lack of knowledge of the manufacturing costs of a product influence the administrative and operational systems of a microenterprise? For this we have the following approach.

Batch production is 16,000 units in batches of 2,000 units. The process time in Man-Minutes required for the manufacturing of the units is 105 minutes. The first batch was made in 40 minutes and the second was planned to be made in 38 minutes.

With the previous data, the aim is to obtain the percentage of the learning curve calculated for the manufacture of the first two batches, the time used for the manufacture of the 8 batches, the % of the learning curve, the equation of the curve and the R value.

RESULTS AND DISCUSSION

To calculate the learning rate, you have to:

$$\%\ of\ learning = \frac{Second\ unit\ time}{First\ unit\ time}(100)$$

Replacing values

$$\%\ of\ learning = \frac{38\ Minutes - Man}{40 Minutes - Man}(100)\ = 95\%$$

It is stipulated that with the learning rate of 95% the first batch is done in 40 minutes, therefore, the second batch is done in:

$$(40\ Minutes/Section\ )\ (0{,}95)\ = 38\ Minutes$$

The results obtained for the double of the 8 manufacturing batches are presented below.

Section	Time in Minutes-Man
1	40
2	38
4	36,1
8	34,295
TOTAL	148,395

Table 1. Time in man-minutes with the 95% learning rate for the double of the 8 manufacturing batches.

Applying logarithm to the data in Table 1, a graph of linear decrease with straight line equation is obtained: *Y* = -0,074 *X* + 1,602 where log *Y* = *Y* y *LOG K* = 1,6021, therefore, $K = 10^{1{,}6021}$=40,00 y *N* = -0,074.

Given the above, the equation of the learning curve is

With this equation we find the times for the double of the 8 batches, as shown.

Section	Y=KX-0.074
1	40
2	38,0000153
4	36,1000291
8	34,2950415
Total	148,3950859

Table 2. Times calculated for the double of the 8 batches from the learning curve equation.

To calculate the percentage of learning by means of a direct formula, that is, without interpolation, we have.

$$n = \frac{\Delta y}{\Delta x} = \frac{Log\ 105 - Log\ 40}{Log\ 1 - Log\ 8} = \frac{0{,}419129307}{-0{,}903089987} = -0.464105$$

With this value of n, the value of % learning b is calculated, as follows:

$$b = 2^{-0{,}464105806} = 0{,}724920249$$

Process times can now be calculated to meet the required time of 105 minutes.

Section	Time with C=72.49%	Accumulated time
1	40	40
2	28,99680996	68,99680996
4	21,0203747	90,01718466
8	15,23809526	105,2552799
total cumulative time	105 Minutos 15,316794 Seg	

Table 3. Accumulated time in Man-Minutes that are required to meet the 105-minute standard

The logarithmic method allows calculating labor for any unit and the time required for any value of N, as follows.

$$T_N = T_1 N^{\frac{Log\ b}{Log\ 2}}$$

$$T_N = T_1 N^{\frac{Log\ 0{,}95}{Log\ 2}} = T_1 N^{-0{,}074000581 \simeq -0{,}074}$$

Therefore, for the batch, the process time is calculated as follows:

$$T_N = T_1 N^{\frac{Log\ b}{Log\ 2}} = (40)1^{-0{,}074} = 40\ Minutes$$

Section	Units	Total cumulative units	Processing time
1	2000	2000	40
2	2000	4000	38,00001531
4	2000	8000	36,87678222
8	2000	16000	36,1000291

Table 4. Times in man-minutes for the initial values, obtained by means of the logarithmic method.

From experience manufacturing similar prototypes in the past, it is known that the manufacturing time must be in a population mean. μ=0,50 hundredths of a minute.

- $\underline{X} = 41{,}8178638 \simeq 41{,}818$
- $\mu = 0{,}50\ hundredths\ of\ a\ minute$
- $n = 64\ samples$
- $S = 14{,}481\ sample\ standard\ deviation$

The null hypothesis and its alternative hypothesis are stated (Time given in 1/100 of minutes)

- $H_0: \mu = 0{,}50\ minutes/unit$
- $H_1: \mu \neq 0{,}50\ minutes/unit$

For the population-appropriate test statistic, given that X has an unknown distribution and $X_1, X_2, \ldots, X_N$ is a random sample X wit $n > 30$ hand it is unknown σ but it is possible to estimate it with S.

$$Z_{test} = \frac{\underline{X} - \mu}{\frac{S}{\sqrt{n}}}$$

You want to work with a level of significance ($\alpha = 0{,}05$) therefore, the $Z_{Critical}$=0,50-0,05=0,45 Now since we are using a table of area under the total curve equal to 1, then to this value we add 0.5 and this is the value that we place in the table to establish the $Z_{Critical}$ therefore:

Value to locate in the table 0.45+0.50=0.95. The coordinates of this value in the table are.

For the value in the table of 0.9505 the value Z=1.65

For the value in the table of 0.9495 the value Z=1.64

Then the Z value to be taken as

$Z_{Critical} = (1,64 + 1,65)\ /2 = 1,645$

Now, calculate the observed value of the test statistic

$$Z_{test} = \frac{\underline{X} - \mu}{\frac{S}{\sqrt{n}}} = \frac{41,818 - 50}{\frac{14,481}{\sqrt{64}}}$$

$$= \frac{-8,182}{1,810125} = -4,520129825 \cong -4,520$$

In summary, given the confidence intervals calculated and the theory related above, the null hypothesis H0 is rejected. Therefore, it is established that the average manufacturing time in the adobe prototype process is 50 hundredths of minutes.

CONCLUSIONS

The procedure described in this article offers the possibility of using a method for calculating the percentage of the yield curve that guarantees obtaining the 8 batches in 105 minutes. The manufacturing process can be standardized keeping in mind the establishment of a stable behavior and the standardization of the work method for the subsequent calculations of standard time and labor efficiency, which is achieved in part by the repetition of the task, obtaining with it a better knowledge of the productive work. The application of the yield curve gradually provides greater efficiency in the use of machinery and labor. In the case study it was not possible to calculate the standard time due to the instability of the processes and failures in the logistics of the company, however it was possible to conclude with criteria which is the optimal production batch of each product reference, of procedure when trying to minimize these errors.

Once this investigation is completed, it is necessary to confirm that all micro or medium-sized companies must maintain an efficient Balance Scord Card at their service that allows the management of the company through the proposed indicators.

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