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Economic analysis of the pymes mexicans and the application of statistical models of optimisation for the increase of the productivity

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Abstract

In any economy, SMEs are a key point of industrial activities, agricultural and especially the service sector. Therefore, systems of continuous improvement and productive stability of these businesses is relevant, with this objective of study in this investigation, this investigation is formulated like a time model based on a theoretical course, to analyze and check its application in a real situation and get results in order to propose a model of time improved, with a statistical fundaments, math and quality fundaments. The changes made in the practice showed positive results compared with the old model, what is important to increase the life cycle, productivity, capacity and efficient use of SMEs in México.

Gross Domestic Product (GDP), Model times, Optimization, SMEs, Applied Statistics

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Introduction

Nowadays Small and Medium Enterprises (SMEs) in Mexico are the main pillar and the key link in the national economy, thanks to the impact in job creation (72% national level), and national production (52% GDP), so, in necessary the correct environment to SME's development, profitability and stability, with the aim of having a better forecast of life, helping to national products in the country and foreign markets. Once the time life comes to SMEs, they start to be worry about their survival in many cases they need financial support, but after that the same situation will come. One way to solve this case is the use of better production techniques or process optimization. In fact, it will be able to reduce costs and increase productivity and profits. This requires trained employers to implement those improvements, because is required basic knowledge of quality management and applied statistics to made a change in technical processes.

In this work these ideas will be taken with the objective to provide a tool for improvement and optimization of processes in SMEs focused on the productive sector and services, it will be done through the method of acceptance range which is used to measure the time of a process.

With experience and fieldwork we will get an improvement of the model which will give us a better representation of the results and a simple way of analysis, but this requires at least one trained employer to the interpretation and application of that method.

Finally this tool pretend to improve SME's processes and there is the possibility of growth in order to become a stable company and exceeds the lifetime statistics survival.

Research Problem

A significant percentage of Gross Domestic Product (GDP) of our country, is generated directly by the Small and Medium Enterprises, because of they generate 77% of employment and 73% of GDP.

However, even being a vital necessity for the country, are classified within the range of high risk and most of them do not survive more than 1 year, because of the economic situation, an inadequate financial support and a wrong management according to Condusef (2011), because of a bad work line, poor organizational structures and personnel with skills and abilities necessary to achieve continuous improvements in their production processes, generating the loss of money in production.

That's way is necessary adopt the use of new technology, practices in increase capital and strategies focus on increase productivity in order to obtain efficiency and reducing operating costs, avoiding excessive increase in prices or the need fire employers, that's way is important the application of this tool, having a control that improves safe production and improving performance and utility, reducing risks and losses, trying to eliminate the causes and situations failures in processes generate improving results and obtaining greater efficiency of resources.

Therefore, the correct implementation of functions in production through technological uses, trained employers or average application in these areas, leading to a better production in; cost reduction; increased productivity and an improvement in earnings, which is a fundamental part of the production processes, continuous improvement and survival of SMEs in Mexico.

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Objective

Analyze the use of optimization statistical functions in business environment, especially in SMEs, in order to conclude if it is necessary in the production step generating a quantitative improvement in productivity.

Hypothesis

Currently Mexican companies waste resources and time in production, which is derived from not having mathematical and statistical analyzes to see the break points where processes should be improved, therefore, through a correct approach of applied mathematics is possible to obtain continuous improvements in production processes.

Economic and production theories.

For purposes of this study three theories will be considered like a vital base for the analysis of optimization statistical functions:

1. To do a detailed analysis about the situation of SMEs in Mexico is necessary the use of information that explain us the economic, productive and resource aspects around these companies, for it we will call the microeconomics theory as *"These theory which pay attention in the study of the behavior of individual agents. The object of study is generally individuals, families and businesses. What is considered as the study of the allocation of scarce resources among alternative purposes "(Federico Anzil, 2006)...*

2. At the same time, in order to have a mathematical depth with a numerical and methodological rigor to give us with a data and numbers to manipulated and then apply a quantitative improve, for it, optimization theory it will be taken as *" the process of selecting from a base of possible alternatives, the best to get the objectives*

3. *"(Marta B. Ferrero and Omar JA Chiotti, 1999).*

4. In order to obtain a relationship between mathematicians and microeconomic aspects, where its main function is to find a maximization or minimization of production variable depending on the situation, Production Theorywill be used: *"The production theory is based on the assumption that the company wants to use the minimum resources to minimize total costs to obtain a given output. So, varying the production it is possible to build relationships cost-product "(Alfredo Valle Hernandez, 2004).*

SMEs and the GDP of Mexico.

According to the Bank of Mexico, the economic growth of the nation can be measured directly by relating the value of gross domestic product (GDP) of a period, concerning previous periods. With respect to GDP is an indicator that includes the monetary value about final goods and services are sold in the country in a given period. GDP is usually regarded as the most representative for measuring a country's growth indicator because of reflects the production capacity that has the economy and the competitiveness of enterprises.

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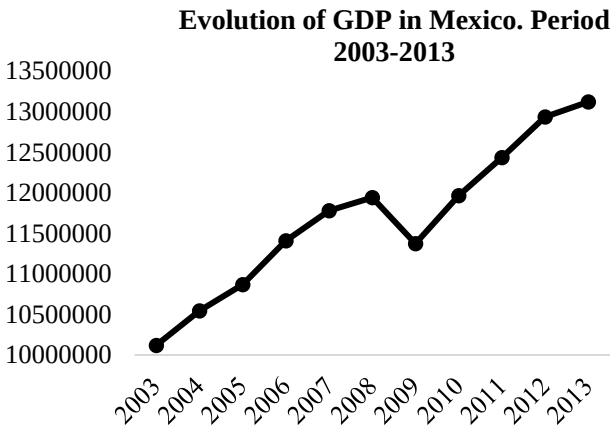


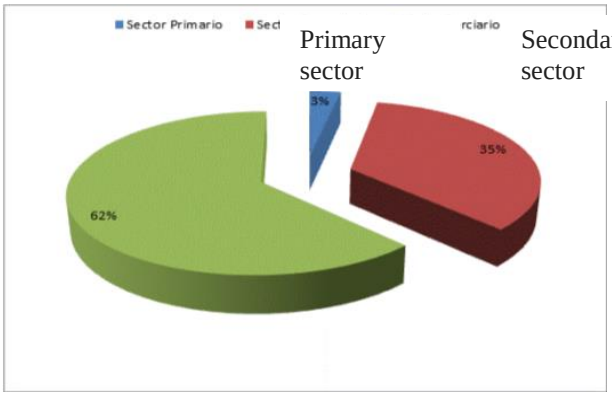
Source: Bank economic information (BIE), INEGI.

Graph 1 Evolution of GDP in Mexico. Period 2003-2013

The economic activity that reflects the GDP by activity, consists of three sectors that are segmented according to the type of activity:

1. The first sector is about agriculture activities, livestock and fisheries,
2. The second sector, pay attention in manufacturing and construction activities.
3. The third sector related to service activities and trade.

In order to analyze the economic growth by sector in Mexico (2013), we did a comparison among the three sectors to see the percentage of contribution of each sector to total GDP in the economy and know the importance everyone.



Graph 2 Percentage Share of total GDP of the Mexican economy by Economic Sector. Year 2013.

Source: Made by myself. Obtained Information by Bank Information Economic (BIE), INEGI.

The graph 3 shows that the tertiary sector is the one that has a higher percentage of participation in the country's economic growth contributing 62.3% of GDP meanwhile the secondary sector contributes 34.5% and the end is the primary sector with 3.10%.

With regard to Small and Medium Enterprises in Mexico are those having 1 to a maximum of 250 employees for its operation, Its main objective is regional development, improving the economy and creating jobs, bringing development and social cohesion, have an important role for the contribution made to the economy by generating jobs, income and supply of those niche markets not covered by the largest company in addition to boosting the productive activity of local economies.

According to the INEGI (2014) these businesses represent 99.8% of all economic units in the country representing about 77% of GDP and help to generate more than 73% of jobs in Mexico. In addition, smaller companies are preponderant in the states with the greatest lag in terms of income and have a high share of informal employment.

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Because of this, it`s essential to strengthen these businesses as part of the strategy to increase levels of productivity in the country, generate stable jobs, facilitate the transition to formality and reduce regional gaps. (National Development Financing Program 2008-2012).

Size	Sector	Range of number of employees	Range of annual sales number (MxN million)
Micro	All	Until 10	Until 4
Little	Commerce	11 to 30	4.01 to 100
	Industry and services	11 to 50	4.01 to 100
Median	Commerce	31 to 100	100.01 to 250
	Service	51 to 100	100.01 to 205
	Industry	51 to 250	

Source: www.compite.org.mx/DOFNuevaEstratificacionDeLasPyMEs.htm

Table 1 Classification of companies in Mexico, according COMPITE.

Even being a fundamental part of the economy in Mexico, SMEs tend to fail and not having a lapse of more than one year life, this is due to the economic situation insufficient funding and poor management, this factor accounts for 43 % of businesses that fail as only 2 of 10 entrepreneurs have training in administrative plus new entrepreneurs tend to centralize power.

One of the factors that must be taken into account is the problem solving and planning of production processes lack of which limits the growth of the company taking unilateral decisions without being prepared for crisis situations. In this context, 65 of 100 companies of this type that are created in a year, disappear within 2 years of life mainly due to lack of knowledge in administration and finance.

However, SMEs have positive aspects, such as: represents a large sector economic units about what refers to the total number of companies in the country, its strength in entrepreneurship and self-employment and contribution to employment, also the birth rate of these companies is high reflecting substantial growth of the number of units and thus an increase in the production of goods and services giving as resulting in increased productivity above the average established for the size of the microenterprises.

It is of utmost importance to create the administrative, scientific and technological mechanisms in order to reach the evolution and improvement of SMEs, this through using financial resources and investment in new assets, finance working, hire new staff, prospecting new markets and improvements in production, all of the above, in order to avoid premature death.

Given these challenges the following key aspects are defined:

- Increase productivity and profitability in micro and reduce the size and scope of the informal economy.
- Rebalancing the economy of SMEs to larger scales of size and facilitate the evolution of smaller to medium-sized companies.
- Improve the innovative performance of SMEs.
- Prevent further perpetuating regional economic imbalances by increasing business births and the number of existing and performance in productivity, profitability and production. OCDE (2013).

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Field study: Empresa Comercializadora de Abarrotes Metropolitana, S. A.

This is a distributor and grocery marketing Company established in 1984 in the city of Irapuato, Guanajuato, Mexico. Currently the company has a structure of more than 800 employees and presence in 85% of the Mexican Republic by establishing 6 wineries porterage, same that are spread strategically across the country, 7 distribution centers (DCs) and 14 counters.

Mission: To market consumer products of the highest quality, satisfying each of our consumers through personalized service, supplying on time and orders, always competitive prices. Also into our company, maintain a profitable operation that meets and respects the country's laws and allows the personal and professional growth of our employees and families through honest and dedicated work.

Vision: To be the leader in providing consumer products nationwide company, meeting the needs of our customers through professional management, with products and quality services, providing opportunities for development, respect and trust to our customers, employees and suppliers under a labor climate of openness and constant renewal.

Values:

- Personal: We are people who give ourselves daily activities we play, we love and respect our work because each of us is an essential link in the chain of process which we are proud.
- Productivity: As the main task of all our employees and reflected in the same way towards our customers and suppliers.
- Respect: An individuality and dignity of every employee and the ideas that drive our operation and daily activities.
- Quality: Not only in the products we sell but in all our operations and processes.
- Growth: To reach more consumers every day and never stop us in our constant struggle for development.
- Responsibility: Always bearing in mind the consequences of our actions, serving as an evaluation factor when making decisions.
- Confidence: Providing security, honesty and transparency in all our actions.
- Technology: To make increasingly dynamic, fast and reliable day our internal operation and distribution.
- Innovation: To provide new processes and benefits that meet the needs of our customers.

Mathematical model

As already noted, for purposes of testing the hypothesis statistical optimization models in order to achieve maximum benefits was taken, through decision making based on a mathematical criterion by business executives in choosing the amount of labor, capital and raw materials.

Methodology

Once assembled the elements of research: problem, objective and hypotheses; an outline of scientific research was articulated, for this purpose, a documentary search to provide information about the Gross Domestic Product (GDP) and the percentage of participation of SMEs was conducted, on the other hand the literature that refer to the models reviewed mathematics and its application in business operations, thus a theoretical framework underlying the study was formed. Research is defined as a descriptive - correlational, since looking through statistical analysis to find a correlation between the variables involved in an operating process.

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Then an optimization model under the range method of acceptance with original variables shown:

Operation	M	LM	Lm	A	Rank	M	Tc,M-1	IM	I	X

A=0.5*[|X-LM|+|X-Lm|]
Acceptance Rengo [X + A, X -A]
Where:

- M: Number of observations in the sample
- LM: higher reading
- Lm: less reading
- A: Variation
- IM: sample interval
- I: predefined interval
- X= sample mean
- Tc, M-1= Confidence level 90%

In order to adjust the model to the reality of Mexican SMEs for the category of warehousing and distribution, a change was made to the method of acceptance range, in this case, confidence coefficient 95%. This, in order to create a range of values derived from the statistical sample, possibly including the value of the unknown population mean. In this modification working with small sample sizes, a situation that allows us to apply probability T-Student.

The modification to change the order of variables for better analysis, including better statistical use It should be noted that the already modified search range that 95% of the situations occurring in production processes fall into the proposed range and therefore the decision is made more accurately.

Operation	n	$\bar{x}$	S	LCS	LC	LCI	IC 95%	I

Where:

- n= sample size
- $\bar{x}$= average sample
- S = Sample standard deviation
- LCS = Upper control limit
- LC = Central limit
- LCI = Lower Control Limit
- IC 95%= Confidence interval 95%
- I = Interval

By making these changes is necessary to use elementary statistics that allow us to develop a reliable model, the first step to carry out, is to perform two sampling:

1. the first will be preliminary (n') and provides the first approach to obtain the actual sample size we require, and
2. the second we provide the true sample size (n), which should (It is suggested that the observations are random for proper operation) used for future observations:

$$n = \left(\frac{40\sqrt{n'\sum x^2 - (\sum x)^2}}{\sum x}\right)^2$$

- n = Sample size we want to calculate (number of observations)
- n' = Number of observations of the preliminary study
- Σ = Sum of the values
- x = Value of observations.
- 40 = Constant for a confidence level of 94, 45%

Already established the number of observations and after making these samples the next step is to get the average of the sample which is obtained from the following formula:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

Where:

- $\bar{x}$ =It is the average of the sample
- x_i= Value of observations.
- n = sample size

Then it proceeds to obtain the sample standard deviation (s), which is the standard deviation is the square root of the variance.

That is, the square root of the mean square deviation scores. It is a statistical formula helps us to calculate reliability and provides samples.

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

Where:

- x_i=value of observations
- n = sample size
- $\bar{x}$ =It is the average of the sample
- s = sample standard deviation

Then it proceeds to calculate the specification limits, if these already exist or whether they are established in a manual they must be respected, if otherwise the following formula for obtaining them will be used, knowing that we will get the 99.38% of the data, allowing for only 0.62% error or anomalies.

- Limit oversight$\bar{x} + 2s$
- Central limit $\bar{x}$
- Limit oversight$\bar{x} - 2s$

For obtaining confidence intervals of 95%, the following formula is with n-1 degrees of freedom will apply as we are building on the Student's t distribution (tables are appended to the end of the document):

$$\bar{x} \pm t_{\frac{\alpha}{2}} \frac{s}{\sqrt{n}} = \bar{x} \pm t_{.025} \frac{s}{\sqrt{n}}$$

Where:

- n = sample size
- $\bar{x}$ = It is the average of the sample
- s = sample standard deviation
- $t_{\frac{\alpha}{2}}$=Confidence level (in this case 95%)

If we want a change in the confidence interval must change the value of $t_{\frac{\alpha}{2}}$ that for values of 90%, 85%.

With this information you can observe the operation of the model for this study was conducted in a consumer products company and the following results were obtained:

Sampling:

In order to gather enough data for the application of mathematical model designed a sampling that covered the period from 04.07.2016 to 18.04.2016 was made, which covered a total of 93 items, which they are shown in the following table:

Process: Loading and unloading of trucks; holiday 07/04 / 2016- 18/04/2016

Date	Time/hrs	Date	Time/hrs	Date	Time/hrs	Date	Time/hrs	Date	Time/hrs
07-April	5	08-April	7	12-April	4	14-April	5	18-April	6
07-April	4	08-April	4	12-April	4	14-April	9	18-April	7
07-April	6	08-April	7	12-April	8	14-April	4	18-April	5
07-April	7	08-April	7	12-April	5	14-April	5	18-April	7
07-April	6	08-April	4	12-April	4	14-April	8	18-April	4
07-April	4	08-April	4	12-April	7	14-April	5	18-April	4
07-April	6	08-April	4	12-April	8	14-April	4	18-April	5
07-April	6	08-April	5	12-April	8	14-April	6	18-April	5
07-April	4	08-April	5	12-April	6	14-April	4	18-April	6
07-April	4	08-April	7	12-April	9	14-April	5	18-April	7
07-April	6	08-April	6	12-April	7	14-April	8	18-April	8
07-April	6	08-April	5	12-April	4	14-April	4	18-April	6
07-April	6	08-April	6	12-April	6	14-April	10	18-April	7
07-April	5	08-April	5	12-April	8	14-April	7		
07-April	3	08-April	5	12-April	6	14-April	5		
07-April	7	08-April	4	12-April	7	14-April	8		
07-April	2	08-April	7	12-April	8	14-April	5		
07-April	5	08-April	4	12-April	6	14-April	7		
07-April	8	08-April	8	12-April	6	14-April	4		
07-April	8	08-April	8	12-April	8	14-April	5		

Source: Empresa Comercializadora de Abarrotes Metropolitana, S. A.

Table 2 Data Collection Company

With the data of Table 2, the following data attached to the original method acceptance range were obtained.

M	LM	Lm	A	Range	M	Tc. M-1	IM	I	X
93	10	2	4	8	93	1.66	[2-10]	[1.8494-9.8494]	5.84946237

X-LM	4.150537634		A	4
X-lm	3.849462366		LI	1.849462366
			LS	9.849462366

Interpretation of results found:

- This model does not explain what size should be the size of research sample to be no variation, on the other hand, in order that there is no discrepancy in the results, the same formula for obtaining sample size used, although it should be clear that this should only be applied in the model range method modified acceptance.

- The upper and lower limits in this case are considered as anomalies in the sample observation these are presented only once, thereby it tends to be broad range.

- Obtaining the variation found in the total of the items taken in terms of time, it is from the mean and the limits in absolute value, this being a simple operation with little ability to represent it.

- One of the deficiencies found in this model is that from varying intervals acceptance are created, which at submit a wide range contemplates the lower limit as an acceptable abnormality and if the upper limit acceptance only It presents a minimum distance. This situation directly affects the acceptance limits in the reality of the companies, since the more data are concentrated around the mean, therefore, anomalies represent a risk for the model to be accepted as normal data.

- If it is assumed that the Student t is necessary to create confidence intervals, we found that although the model includes it does not provide clear information on its application in the same, the above based on the intervals they are provided by the difference between upper limit and lower limit.

- The way that data is fit is not optimal for analysis or understanding, this assertion is founded on the data of the sample mean (X) to be the first representative data of the observations, it is placed at the end of the table and not with the upper and lower limits, where is the value and significance of this measure of central tendency.

Range method of modified acceptance

N	x average	s	LCI	LCS	LC	IC 95%	I
93	5.84946237	1.58763042	2.67420152	9.02472321	5.84946237	[5.5224-6.1764]	[2.(

Student 95% confidence, 92 g.l	IC(-)	IC(+)
t=1.9861	5.522491506	6.17643323

Interpretation of the results found with range method of modified acceptance:

- This method allows us to apply the formula of sample size, get the information attached to the fact that the sample size should be, which will be subject to the proposed study.

- The sample standard deviation obtained with the method modified acceptance, behaves within normal standards, it means, the information are grouped around the average, which indicates that it is representative (see scatter plot).

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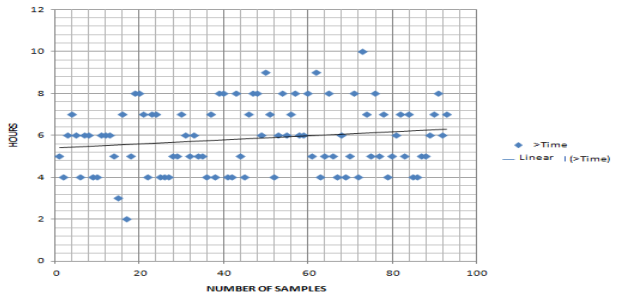

Source: Done with data from Empresa Comercializadora de Abarrotes Metropolitana, S. A.

Graphic 3 Scatter plot

- Control limits are derived from statistical formulas, to this, the sample mean ($\bar{x} \pm 2s$) and standard deviation are used, this situation encompasses most of the data considered in the sample, besides not be affected by anomalies, as included in the calculation done. Then is get the acceptance range (9.0247 2.6742) with a confidence margin of 99.2% where anomalies are excluded.

- Explains the use of the function T of Student, to obtain the confidence interval, which shows us that the average of the sample (5.84946237) is within the limits [5.5224-6.1764], this data indicate that the 95% confidence that the items are within established limits.

Comparative analysis

Upon completion of the two calculations under different methods, we proceed to a comparative analysis in order to observe their main advantages and disadvantages of each. Then the comparative is as follows:

Range method of original acceptance	Range method of modified acceptance	Observations
M= 93	N=93	The same sample size is taken to av discrepancies.
X=5.84946237	X=5.84946237	The average is the same value, sinc obtained under the same formula.
A=4	S=1.58763042	Obtaining the standard deviation is since the former is the result of a m ranking and the second by a statisti formula. It is important to note that on the range method are very dispe which reduces reliability.
Range=8	Range=null	It is considered an obsolete data, w given that the formula for the stanc deviation which is not required.
Tc. M-1= 1.66	IC 95%=[5.5224-6.1764]	The value of T Student differs becau method of range only provide it wit it a utility. Moreover, in the range n method it tells us that the confiden is 95% and that the average falls wi confidence interval, thus, is represe
IM=[2-10]	IM=null	The range is not representative for interval.
LM=10	LCS=9.02472321	The superior limit is reduced under modified method, besides indicatin item that comes out of this, is outsi operational efficiency.
Lm=2	LCI=2.67420152	The lower limit increases under the modified method, besides indicatin item that does not reach to this, is operational efficiency.
X=5.84946237	LC=5.84946237	The central limit is represented in b models as the average of the sampl
I=[1.8494-9.8494]	I=[2.6742-9.0247]	The operating range obtained unde modified method range, has more a data that allow us to deduce the eff and optimization of time, in additio excluding anomalies. With the meth original range by accepting anomali is wider, which leads companies to efficiency and profit.

Conclusions

After completing the math and literature review, the most important findings of the research are:

The hypothesis about the waste of resources in Mexican companies derived from the lack of mathematical and statistical analyzes to make decisions attached to reality checks. On this basis, the calculation of the mathematical indicator I (interval process) is that by initiating the investigation have I = [1.8494-9.8494]; with modifications based on the observations and measurement time a new interval is obtained: I = [2.6742-9.0247], which tells us precisely the range in which 99.38% of the operations of loading and unloading they must be done.

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Analyzing Table 2: "Process: Loading and unloading of trucks; period 07/04 / 2016-18/04/2016 "shows that the company Empresa Comercializadora de Abarrotes Metropolitana, S. A. makes this process a waste of time in the process studied, this is mainly because the operations are performed without any chronometer and left open how long it should take every operation, it is important to note that this is translated into economic losses to pay more time than required to achieve their goals in the process previously mentioned.

One important thing was found in the investigation is the value of the T of Students: 95% CI = [5.5224-6.1764], from which it follows that it has a confidence interval and use 95%, is say that for purposes of making other sampling have as constant value T of Students. On the other hand, it points the interval in which the average must fall to be meaningful, otherwise the average is not representative and the analysis is worthless.

According to the research, the position of Mexican Pymes should make use of statistical methods of optimization, in order to streamline their processes and reduce operating times, costs and use of equipment, also generating an increase in profits. Applying a greater number of the aforementioned methods, guarantees to companies not to resort to bank loans with high interest rates that reduces their profit margin and cuts a high percentage of the life cycle of the company.

It is important to designate that the proposed model can be applied to different areas of the company, in order to improve each company processes, this in order to solidify the position, increase its profit margin (EBITDA), it reduces the operation time and busy team, with all these benefits you have the possibility that Mexican companies cover a greater market share, generate more jobs and pay better wages.

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