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SECRETARÍA DE EDUCACIÓN PÚBLICA

TECNOLÓGICO NACIONAL DE MÉXICO
INSTITUTO TECNOLÓGICO DE MILPA ALTA

TECNOLÓGICO NACIONAL DE MÉXICO

INSTITUTO TECNOLÓGICO DE MILPA ALTA

2nd INTERNATIONAL CONGRESS OF ENGINEERING

Ingeniería como motor de la innovación

Venue: Instituto Tecnológico de Milpa Alta

Date: 17th to 20th October, 2017

International Journal of Trend in Scientific Research and Development (IJTSRD)

www.ijtsrd.com **e-ISSN No: 2456-6470**

An International
Open Access Journal

Availalble on www.ijtsrd.com

Email us on editor.ijtsrd@gmail.com

e-ISSN 2456-6470

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TECNOLÓGICO NACIONAL DE MÉXICO
INSTITUTO TECNOLÓGICO DE MILPA ALTA

2nd International Congress of Engineering

" Engineering as an Engine of Innovation"

Event Date: 17th to 20th October, 2017

Congress Venue: Instituto Tecnológico de Milpa Alta

Objectives of the 2nd International Congress of Engineering:

- Disseminate theoretical and empirical research work on the frontier of knowledge related to engineering.
- Promote academic dialogue among students, researchers, speakers and institutions.

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Tecnológico Nacional de México, through the Instituto Tecnológico de Milpa Alta, presents its special edition: 2nd International Congress of Engineering, editorial effort with the International Journal of Trend in Scientific Research and Development (IJTSRD) from which it is detached this, the which presents the papers presented at the 2nd International Congress of Engineering, which had as its motto: Engineering as the engine of innovation and was held from October 17 to 20, 2017 at the facilities of the Instituto Tecnológico de Milpa Alta.

The objective of the 2nd International Congress of Engineering is to consolidate itself as a space for disseminating the academic and scientific work of our students and professors, as well as colleagues from other institutions.

At present it is necessary to reflect and share what happened in the field of research. The research in this edition is a guide to promote strategies in an environment of global competitiveness, in the different fields of research.

Hence the objective of presenting this special edition, which will deepen the scope of research within the country from different themes and various areas of analysis.

In general terms, the papers presented show the projects and results of theoretical and empirical research.

Before concluding with this message, I want to thank the organizing committee that greatly facilitated the successful development of this event. I would also like to express my deep appreciation to all the authors, speakers, workshops and assistants. Without its valuable presence could not have been carried out this 2nd International Congress of Engineering. Last but not least, I want to thank the International Journal of Trend in Scientific Research and Development (IJTSRD) who working on synergy could culminate in this extra special.

Fraternally

M.Sc. Domingo Noé Marrón Ramos
Director del Instituto Tecnológico de Milpa Alta

Inauguration of the Instituto Tecnológico of Milpa Alta

Conference Program

October, 17th 2017 **Dr. FRANCISCO JOSE GIL WHITE** **Tema: Los exámenes de personalidad en la selección de personal: ¿Nos están ayudando?** **Dra. MARÍA DEL CARMEN GONZÁLEZ** **Tema: Digital employer Branding**
October, 18th 2017 **Dr. JAVIER SUÁREZ ROCHA** **Tema: Un modelo de vinculación para una institución de educación superior: un estudio de caso.** **Dr. BENITO SÁNCHEZ LARA** **Tema: La consultoría de empresas y la intervención sistémica.**
October, 19th 2017 **Dra. GUOHUA SUN** **Tema: Física cuántica-- de las ficciones científicas a las tecnologías de la información** **MBA. PATRICIA I. VERDUZCO RAMÍREZ** **Tema: La comunicación como herramienta estratégica para el éxito personal y de la empresa**
October 20, 2017 **Dr. ATHANASIOS HRISTOULAS** **Tema: Seguridad en américa del norte** **Dr. GRIGORI SIDOROV** **Tema: Análisis automático de textos en redes sociales**

2nd International Congress of Engineering

" Engineering as an Engine of Innovation"

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October, 17th 2017

Speaker: María del Carmen Camacho González




Speaker: Francisco José Gil White


October, 18th 2017

Speaker: Javier Suárez Rocha

Speaker: Benito Sánchez Lara



October, 19th 2017

Speaker: GouHua Sun



October, 19th 2017

Speaker: Patricia I. Verduzco Ramírez




October, 20th 2017

Speaker: Athanasios Hristoulas

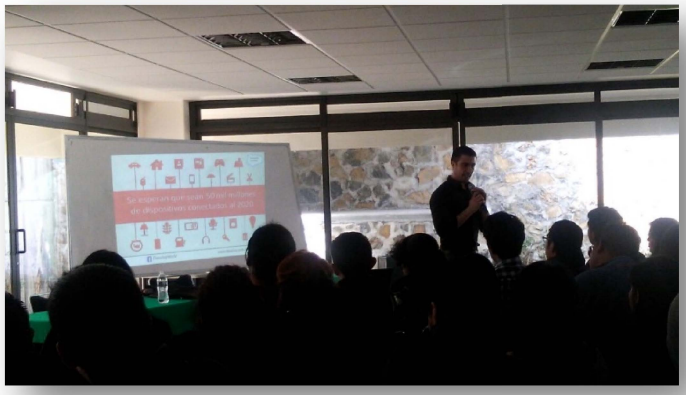



October, 20th 2017

Speaker: Grigori Sidorov

Special Conference

Speaker: Diego Rendón Peral




Competition of Robots Race

Workshop Program

PLANTA BAJA		
Tema: **Uso del microscopio e identificación de microorganismos** Tallerista: **M. C. Diego Emiliano Jiménez González** Laboratorio de Bioquímica	Tema: **Bioquímica Clínica** Tallerista: **M. C. Silvia Palacios Bahena** Laboratorio de Alimentos	Tema: **Reingeniería de procesos** Tallerista: **M. I. Marco Antonio Silva Nava** Aula: 104
PRIMER PISO		
Tema: **Reingeniería de procesos** Tallerista: **M. I. Marco Antonio Silva Nava** Aula: 104	Tema: **Práctica Fiscal 2017** Tallerista: **Lic. Jorge Eduardo Medina del Valle** Aula: 105	Tema: **Simulación de procesos básicos bajo el entorno del software especializado PROMODEL®** Tallerista: **Ing. Vianey Ríos Romero** Aula: 106
Tema: **Curso de Excel básico e intermedio** Tallerista: **Lic. Brenda Villamar García** Aula: A107	Tema: **Mantenimiento correctivo y preventivo de pc y laptop** Tallerista: **Ing. Josué Iván Jaimes Pérez** Aula: 108	Tema: **Java Básico** Tallerista: **Ing. Maximiliano Román Salgado** Aula: 109
SEGUNDO PISO		
Tema: **Marketing Digital** Tallerista: **Ing. Abisaí Morales Jiménez** Aula: 210	Tema: **Manejo de conflictos** Tallerista: **M. en E. Elizabeth Fernández Olvera** Aula: 211	Tema: **Ionic + firebase, aplicaciones hibridas** Tallerista: **Ing. Arístides Caballero Alfaro** Aula: 213
Tema: **SQL estándar básico** Tallerista: **Lic. Dalia Jocelyn Gómez Reyes** Aula: 214	Tema: **Programación WEB** Tallerista: **Ing. José Antonio Albarrán Galván** Aula: 215	Tema: **El proceso del éxito** Tallerista: **Jorge Venegas Labastida** Aula: 216

Workshop Photos

Organizing Committee

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Director del Tecnológico Nacional de México.

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Coordinador de cafetería y souvenir.

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Coordinador de gafetes y programa de actividades.

Joint Collaboration

The Technological Institute of Milpa Alta committed to the promotion and articulation of research, for the first time, worked in synergy with the International Journal of Trend in Scientific Research and Development (www.ijtsrd.com), the journal has its online registration of ISSN 2456- 6470

IJTSRD is an open peer-reviewed international exchange journal that provides a publication of research articles and aims to promote theory and practice along with the exchange of knowledge among researchers, developers, engineers, students and professionals.

Inaugurates the Instituto Tecnológico of Milpa Alta

Mexico, D.F., March 12, 2012, DGEST / DDC. President Felipe Calderón Hinojosa inaugurated the Technological Institute of Milpa Alta and delivered the 100-thousand University Scholarship, as well as the 500-thousand Scholarship.

Engineer Fernando Chapa Lara, Director of the Technological Institute of Milpa Alta, thanked President Felipe Calderón for his visit and the support of the federal government, before reporting that the enrollment for the school year to be 788 students in four professional careers, with an investment of 3.5 million pesos for laboratory equipment. He continued, *it is clear that investing in education is the key to the development of our country but also this is a way to prevent young Mexicans from becoming easy prey of crime and drug addiction.* Daniel Gutiérrez Aranda, a eight-semester student of Computational Systems, recalled that in July 2008, the opportunity for vocational training opened when the first generation of students was registered, and that now these new facilities encourage all students to make the most of their studies, and to graduate as competitive engineers. The president said that the new building of the Technological Institution was designed to provide specialized instruction in Biochemistry, Food Industries, Computer Systems and Business Management, as well as to meet the standards of high demand, and to contribute to the increasing productivity and competitiveness of the country. He described that the building, with a federal investment close to 80 million pesos, has 22 classrooms, four laboratories, two study halls and a library that would directly benefit 1,200 students

Subsequently, the Chief of the Executive reported that during his term, eleven technological institutes had been created in six delegations of the Federal District, benefiting more than six thousand students and easing the saturation problem of other public universities. At the national level, almost 1,000 high schools, 105 higher education institutions and 52 new campuses have been built in existing universities.

President Calderón affirmed that education is the most powerful tool to obtain a good job, to raise a family's income and to improve quality of life, all of which rebuilds the social fabric, and the Federal Government continues creating opportunities for more and more young Mexicans.

Finally, at the end of this inaugeration, the president delivered the 100 thousand University Scholarship, as well as the 500 thousand Scholarship to outstanding students.

Also present at the ceremony were the acting Secretary of Education, Dr. Rodolfo Tuirán Gutiérrez; the Director General of Higher Technological Education, Dr. Carlos Alfonso García Ibarra; the delegate of the Milpa Alta delegation, Lic. Francisco García Flores, Undersecretary of Higher Education Miguel Ángel Martínez Espinosa, among other personalities.

History of Technological Systems

The origin of the national system of technological institutes dates back to the end of the forties of the last century, 68 years ago. During this time, President Miguel Alemán Valdez was in office office. In 1948, the first two institutes were created: Durango and Chihuahua. This was the beginning of the development and expansion of the technological institutions of higher education not only in Mexico, but also in Latin America. Three years later, in view of the of the ruling class for the new wave of industrialization in the country, prominently in the northern border states, the Technological Institute of Saltillo, Coahuila, was founded in 1951, and in 1954 , another in Ciudad Madero, Tamaulipas. These four institutes were the fundamental pillar of the emerging excellence of technological education in the country. By that time, these four technological institutes had an enrollment of 1,785 students, of which the great majority, 688, were men, but with the important participation of 107 women.

Thus began the process of expansion of these institutions of higher education by the Mexican Republic. Veracruz was the next state that benefited from the construction of a technological educational center, by virtue of which in 1957, began to operate the Technological Institute of Orizaba.

At that time, the technological institutes depended on the National Polytechnic Institute (IPN), as stipulated in the Organic Law, but due to their growth there was a need to encourage their disincorporation from the General Directorate of Industrial Technological Education and Commercial, and their incorporation into the Secretariat of Public Education.

During the first 20 years, a vast network was formed in fourteen states of the Republic, made up of 17 technological institutes. This was the moment of true growth of these institutions of higher education, leading to double the number of institutions in the following. Between 1968 and 1978, 31 more were founded to add a total of 48 educational establishments in 28 entities of the country.

In 2005, the national education system was restructured by levels, which resulted in the integration of the Technological Institutes to the Subsecretariat of Higher Education (SES), transforming the General Directorate of Technological Institute (DGIT) into General Directorate of Higher Education Technological Development (DGEST). As a result of this restructuring, the higher level of the General Directorate of Science and Technology of the Sea and of the General Direction of Agricultural Technology Education were disincorporated and the newly created DGEST was incorporated.

The National System of Technological Institutes (SNIT) remained with this structure until July 23, 2014, and included 263 institutions, of which 132 were Federal Technological Institutes and 131 were Decentralized Technological Institutes that served a population of 521,105 undergraduate and graduate students in the national territory, the highest enrollment of any technological institution in the country. These figures also include the twelve institutes of Mexico City, and of course the Technological Institute of Milpa Alta, which has 1,219 students.

Computer Systems Engineering

Background

Engineering in Computer Systems is in high demand today. Programs dedicated to this career must be designed with the goal of staying aware of scientific advances and the demands of society in which professionals have to develop. For this reason, programs in this field are constantly updating.

Professional Profile

An Engineer in Computer Systems is a professional capable of:

1. Analyze, develop and program mathematical, statistical and simulation models.
2. Recognize and be guided by social, professional and ethical aspects in their environment.
3. Lead and coordinate multi and interdisciplinary work teams.
4. Coordinate and carry out research that strengthens cultural, scientific and technological developments.
5. Apply new technologies to solve problems in their work environment.
6. Develop and manage information systems, computer networks and distributed applications.
7. Have a business vision, identify areas of opportunity to undertake this vision, and develop projects with new information and communication technologies.
8. Be able to select and manage the human and computer resources for different units of computation.
9. Be committed to sustainable development, respecting the social and cultural environment where organizations are developed.
10. Develop and administer applications and base softwares.
11. Develop Man-Machine interfaces.
12. Develop and integrate basic machine-machine architecture solutions.
13. Provide consulting to users of different levels in an organization.
14. To know and apply norms and standards to different technologies of information and communications.
15. Identify risks and apply security techniques throughout information and communication technologies.
16. Understand and apply the legacy of the use and exploitation of computer systems.

Engineering in Food Industries

Background

The course in Engineering in Food Industries, aims to have a high impact in the alimentary development setting and to define a policy relative to the use of natural resources taken from agricultural activity; additionally, it offers education and research policy that supports regional and national development. In this sense, it identifies the industrial transformation of raw materials and the commercialization of products with added value as areas of regional development.

Career Objective

To train professionals with solid scientific and technological bases, high social commitment, high ethical values, attitudes and aptitudes that allow them to become agents of change, able to integrate, develop and consolidate networks of value in the producting systems of their environment through the food industry.

Professional profile

1. Design, create, install, operate, maintain and run food industry companies within a framework of regional, national and international development.
2. Plan, evaluate and execute investment projects aimed at strengthening the development of the food sector.
3. Analyze, evaluate and design value networks in food production systems.
4. Analyze, evaluate and optimize industrial food production systems.
5. Develop, produce and market products with added value in the national and international market according to current regulations and satisfy the demands of food and nutrition.
6. Develop agricultural, livestock and poultry products with nutraceutical and functional characteristics.
7. Develop technology for the safety and preservation of food by physical, physicochemical, physiological and chemical methods.
8. Design systems for the packaging and packaging of fresh and processed products.
9. Research and develop technologies for the improvement of production and organization systems, while practicing technological appraisal.
10. Adopt, adapt, transfer and innovate technologies and the practice of technological development, for the transformation of food and sustainability of resources.
11. Promote the production of capital goods for the food industry.
12. Design and create networks of value for the integration of production systems with high intellectual capital, innovative and intelligent in the organization, holistic and resilient in the production systems that generate products and services of high added value.
13. Establish quality systems in processes and food products under international standards.
14. Perform inter and multidisciplinary work that allows the strengthening and integration of competition.
15. Designing food systems that improve minimum requirements of welfare: Health, nutrition, economy and organization.

Biochemical Engineering

Background

The program of Biochemical Engineering has existed for 36 years in Mexico and 20 years in technological institutes. During this period, the professional requirements have been formed, giving impetus to the development of the biochemical industry in other fields like health, food, environment and education sectors.

The professional field of Biochemical Engineers is relatively new and the speed with which it has developed is amazing. It is important to note that in so-called first world countries the emergence of biotechnological plants for the production of specific proteins and hormones that are difficult to obtain through other methods, and the transformation of microorganisms and larger species for environmental use, have existed approximately 30 years and their development only increases with every year.

Career Objective

To train Biochemical Engineering professionals who, with an ethical, critical, creative and enterprising sense, design, operate, control, simulate and optimize teams and processes that use natural resources and their derivatives, through sustainable development, in the production of goods and services that contribute to raising the standard of living in our society.

Professional Profile

The Biochemical Engineer is a professional that individually or in interdisciplinary and multidisciplinary groups is prepared to:

1. Design, select, adapt, operate, control, simulate, optimize and scale equipment and processes in which natural resources are used sustainably.
2. Provide technical advice to agencies and companies dedicated to the transformation and conservation of Natural Resources.
3. Identify, prevent, control and solve problems in the field of Biochemical Engineering.
4. Plan, organize and manage natural resource processing companies.
5. Apply, adapt and generate technologies for the sustainable use of Natural Resources.
6. Formulate and evaluate techniques, economically, socially and environmentally industrial projects.
7. Apply standards and programs for management and quality assurance.
8. Conduct research that contributes to the country's technological development and disseminate the generated results.
9. In addition, he/she must maintain an integral, critical, creative, enterprising attitude and continuously grow in his/her professional performance.

Business Management's Engineering

Career Objective

To form integrated professionals with a competent approach that contributes to the management of companies and process innovation; as well as the design, implementation and development of strategic business systems, optimizing resources in a global environment, with ethics and social responsibility.

Professional Profile

1. Design and innovate organizational structures, processes and products, with a competitive organization approach.
2. Manage integral systems of quality, exercise effective leadership and ethical commitment, while applying the basic tools of engineering.
3. Apply quantitative and qualitative methods throughout the analysis of data interpretation, process models and decision making.
4. Integrate and develop high-performance work teams for the continuous improvement and integral growth of organizations.
5. Manage the resources of the organization in order to provide quality goods and services.
6. Analyze and interpret financial information to determine areas of opportunity for improvement and investment to increase the profitability of a business.
7. Elaborate and implement business plans oriented towards sustainability and social responsibility in a competitive market.
8. Use new information and communication technologies in an organization to optimize processes, efficiently operate, control and make decisions.
9. Design and manage marketing strategies based on pertinent and truthful information of target markets.
10. Promote the development of human capital, for the most efficient and effective realization of the professional objectives within an ethical framework.

Philosophy of ITMA

Mission

Offer high quality technological education services, with national, relevant and equitable coverage, which contributes to the creation of a just and humane society.

Vision

To be one of the fundamental pillars of the sustained, sustainable and equitable development of the nation.

Values

- Commitment
- Creativity
- Perseverance
- Responsibility
- Quality
- Entrepreneurial spirit

Location of the ITMA

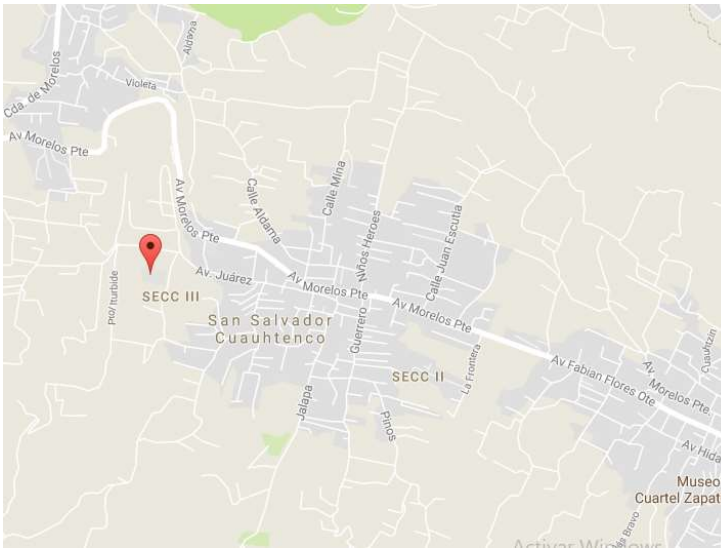
Independencia Sur No. 36,

Colonia San Salvador Cuauhtémoc,

Delegación Milpa Alta,

C.P. 12300.

Ciudad de México, México.



International Journal of Trend in Scientific Research and Development (IJTSRD)
2nd International Congress of Engineering
ISSN No: 2456 - 6470 | www.ijtsrd.com | Special Issue Publication

Improvement in the process of production planning applying the simplex method

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ABSTRACT

The manufacture of metal-mechanical parts is very important in the industrial field. Due to the increasing demand in the market, the company under study decided to develop the application of this method, to be able to know the production planning of its products. This study is limited to two products with the most demand currently: product A and product. A time study with a 95% confidence interval was also performed to determine the average processing time for each product, as well as the limits of each product. The result of the present investigation was to know the planning of the production of the two products with the most demand.

Keywords: *Simplex method, industrial company, improvement*

INTRODUCTION

The term Operations Research (IO) is first used in 1939 during World War II, specifically when the need arises to investigate the tactical and strategic operations of air defense, with the incorporation of a new radar, in opportunity of the German attacks on Britain. The accelerated advance of military technology has led British military executives and administrators to turn to scientists for support and guidance in planning their defense. The success of a small group of scientists who worked together with the military executive in charge of operations on the "line" led to a greater demand for their services and the extension of the use of the methodology to USA, Canada and France between others (Universidad de la República Oriental del Uruguay, 2016).

Alvarado (2009) points out that in the beginning the linear programming was known as Programming in a Linear Structure. According to Anderson Sweeney and Williams (2004), in 1948 Tjalling Koopmans told Dantzig that the name was too long and that it was convenient to change it, before which Dantzig agreed and the name was replaced by Linear Programming, which is even used nowadays. Taha (2004) in his book points out that a major element of operations research is mathematical modeling. Galicia (2013) notes that operations research is a branch of mathematics, focused on the study of mathematical models, statistics and algorithms, with the aim of helping the decision-making process. The first journal published in the operational field was Operational Research Quarterly, edited by the Operational Research Society in 1950. The following was Operatians Research, published in America by ORSA (Jimenez, 2009).

A definition of this concept is proposed by Durán (2006), this concept is the science of decision making. Similarly, Duran (2006) points out that in this discipline, professionals from the most diverse branches: engineers, mathematicians, computers, economists. All of them must learn a fundamental technique: mathematical modeling. Prawda (2000) points out that operations research is the application of the scientific method to decision-making problems

that provides methods that can represent and solve by mathematical models a real problem of a system, finding and controlling the relations between the components in order to evaluate the results associated with the stated objectives and to establish the necessary actions to modify the behavior patterns of said components. Izar (1996) defines operations research as a group of methods and techniques applicable to solving operating problems of systems.

Illés and Terlaky (2002) point out that mathematical optimization is one of the main branches of applied mathematics. Since its discovery in the mid-twentieth century, it is considered one of the most controversial fields of mathematical research. Marchena, Ornelas, and González (2007) point out that the purpose of linear programming is to optimize (minimize or maximize) a linear function of n variables subject to linear constraints of equality or inequality, called the objective function.

Awards

Jiménez (2009) points out that to know the main practical works in Operative Research can consult the Interfaces magazine published bimonthly INFORMS. Continuing with the ideas of Jiménez (2009), the awards given to important works of Operative Research, either for their applied interest or for the development of new theories, have been an important stimulus when planning and directing concrete lines of research. Some of these prizes have had an important historical and have been more fashionable in a few years than others. We can mention, among others, the following prizes:

- The Lanchester Prize, awarded annually by ORSA (now that it has been integrated into INFORMS, granted by this institute) for the best publication in Operations Research in English language. It is granted since 1954, and in 1994 it had a monetary endowment of $ 5000.
- Dantzig Award, awarded every three years by the Mathematical Programming Society and the Society for Industrial and Applied Mathematics for the best original contribution to the field of Mathematical Programming.
- Fulkerson Award, awarded every three years by the American Mathematical Society and the Mathematical Programming Society for the most brilliant research article in the field of Discrete Mathematics.
- Orchard-Hays Award, awarded every three years by the Mathematical Programming Society for excellence in Computational Mathematical Programming.

Simplex Method

Since George B. Dantzig developed the simplex method in 1947, linear programming has been widely used in military, industrial, governmental and urban planning, among others (Bazaraa and Javis, 1996).

The Simplex Method is a basic mathematical tool in decision making, but it requires understanding each of its steps and the constancy of practicing them. Minimizing costs or maximizing profits will depend on the needs of each company or subject, the paths to take them are infinite, but when it comes to more than two variables, the really optimum path is right at this moment in your hands (Valencia, 2015) . Morales (2012) points out that the operation of this method is as follows, we are looking for feasible solutions at the extreme points of the solution space until the objective function can not be further improved. The simplex method has been widely used for the unambiguous optimization of different analytical procedures; particularly in cases where there is an interdependence of the variables to be optimized. Compared to other optimization methods based on experimental designs or response surfaces, the simplex method generally allows the optimum to be reached in a simpler and faster way (Rodríguez, Díaz, Amanda, Ahumada and Guerrero, 2013).

Ariza (S / A) points out that the simplex method is a mathematical tool that solves planning and scheduling problems; that is, it solves the question about how much to produce according to the operational capacity and market studies. Also, this method uses the Linear Programming model, through the solution of a matrix, using the method of elimination of Gauss Jordan.

Instituto Internacional de Investigación de Tecnología Educativa S.C. (2009) points out that the standard or canonical form of the linear programming model is composed of an objective function and a set of constraints. In general, the standard form of the linear programming model can be expressed as:

$$Z_{Max} = C_1X_1 + C_2X_2 + ... + C_nX_n$$

Subject to:

$$a_{11}x_1 + a_{12}x_2 + ... + a_{1n}x_n \leq b_1$$
$$a_{21}x_1 + a_{22}x_2 + ... + a_{2n}x_n \leq b_2$$
$$.$$
$$.$$
$$.$$
$$a_{m1}x_1 + a_{m2}x_2 + ... + a_{mn}x_n \leq b_m$$
$$x, x_2 ... x_n \geq 0$$

And its matrix form is given by the expression:

$$Z_{Max} = CX$$

Subject to:

$$AX \leq B$$
$$X \geq 0$$

Where:

C = It is the matrix of costs or utilities, formed by the coefficients of the objective function.

A = is the matrix of coefficients of the system formed by the constraints.

B = is the column matrix of independent terms of the constraint system.

X = is the column matrix of the variables X1, X2, X3, ..., Xn of the constraint system.

Romero, Muñoz, and Romero (2006) point out that Industrial Engineering as a discipline dedicated to the design, innovation, improvement, installation and administration of integrated systems of human resources, materials, equipment and technologies, organized for efficient and manufacturing and services. Acevedo and Linares (2012) point out that Industrial Engineering has been boosted since the industrial revolution, its importance grows by its efficient contribution to efficiency and business productivity that leads to new levels, the competitiveness of industrial sectors in the countries.

Guédez (2011) points out that linear programming (PL) is part of mathematical programming and is an optimization technique to deal with problems of allocation of scarce resources between competing activities, dealing exclusively with objective functions and linear constraints.

Schwarz (2014) points out that, within the professional career of industrial engineering, an area of research is the research of operations. The lines of investigation that emerge from there are:

- Optimization of operations and processes
- Route and transport scheduling
- Location of Facilities
- Process simulation
- Solutions with Artificial Intelligence techniques

Kowalski, Enríquez, Santelices, and Mercedes (2015) In engineering careers, and in the case of Industrial Engineering, algorithms occupy an important place, particularly in the discipline Operative Research.

Applications of the simplex method

This method or procedure has countless applications in linear programming, but also use in mathematics and geometry. Among the most common applications of the simplex method are (Martínez, 2012):

- It is a technique used to give numerical solutions to problems of linear programming.
- It is commonly applied to find an optimal solution to problems of maximization and minimization.
- It is useful for solving large and complex problems.
- Variables commonly used in linear programming have been developed from the simplex method.
- This method has been extremely useful for the development of software that facilitates the calculation process. An example of this is the WIN QSB®
- This model is used for the correct interpretation of decision models based on mathematical descriptions in order to help in decision making in situations of uncertainty.

Importance

Establishing a production schedule for a period of weeks or months turns out to be a difficult and important task in most production plants. The operations manager must consider many factors: labor, inventory and storage costs, space constraints, demand, etc. Generally, most plants produce more than one good, making the previous task even more complicated (Faulin, S / A). Corominas (2010) notes that operations management gives tools to solve the planning problem raised. In particular, aggregate planning is a typical case of the research area. Aggregate planning is an instrument to forecast, in the medium term, the activities of the area of operations. It is clear that the results of aggregate planning have a large impact on the planning and coordination of resources throughout the organization, there is a tendency to include in the aggregate planning decisions of other functional areas of the company, such as personnel, accounting and finance , procurement or marketing.

Geovanah (2017) points out that the simplex process is a powerful, sophisticated approach to innovation. It is suitable for projects and organizations of almost any scale. This process is an eight-stage cycle. At the end of the eight stages, you have to start again to find and solve another problem, thus helping to ensure continuous improvement.

Success stories

IOSA Operations Research S.A. (2016) in its page presents different achievements that the companies have had when implementing the simplex method. For example, the following examples stand out:

- CHILEXPRESS. Project: Models of optimization and simulation of Courier routes nationwide in Chile.
- Agricultural Society DROKASA S.A Project: Optimized planning of the asparagus harvest - master planning model for opening and closing fields.
- Minera Yanacocha S.A. Newmont Gold Company - Peruvian Branch. Project: Development of Mathematical Models Oriented to Long-Term Planning.
- Union of Peruvian Breweries Backus and Johnston S.A.A. Project: Development of Mathematical Models for the Planning of Supply of Malta to Plants (Decision Support System - SSD).

PHP SIMPLEX®

PHPSimplex® is an online tool for solving linear programming problems. Its use is free and free. To access it simply click on the icon on the left, or on "PHPSimplex" in the top menu (PHPSimplex, 2017). PHPSimplex® is able to solve problems using the Simplex method, the Two Phases method, and the Graphical method, and has no limitations on the number of decision variables or problem constraints (PHPSimplex, 2017).

Winqsb®

The initial version of the software Winqsb® called at that time QSB, was created in 1985 by Yin-Long Chang professor of the Georgia Institute of Technology (Henríquez and Hernández, 2010). Lugay (2014) points out that Winqsb® software, which is the intellectual property of Dr. Yih-Long Chang, consists of a series of individual modules or applications that help in the investigation of operations, work study, planning and control of the production, project evaluation, quality systems, simulation, statistics, etc., and there are a total of 19 modules, one for each type of problem.

General objective

Improve the production planning process by applying the simplex method.

Specific objectives

- Understand the contextualization of the topic.
- Know the existing models to evaluate the quality of an industrial process.
- Calculate the representative sample using 90% reliability and 10% error.
- Apply the simplex method for the planning of an industrial process.

- Analyze the results obtained from the analysis of the simplex method for the planning of an industrial process.
- Evaluate the results obtained from the analysis of the simplex method for the planning of an industrial process.

Justification

The understanding of the Simplex Method is important because it allows solving problems of linear programming, which is one of the most important techniques for formulating and solving various decision-oriented problems in the different areas of Engineering. Many companies are unaware that mathematical techniques exist that help to solve their own processes in a practical and easy way. The research is justified by the importance that the application will have in a production process, which will serve to have knowledge of its production planning.

Investigation methodology

The steps that were followed to develop the project are presented in figure 1.

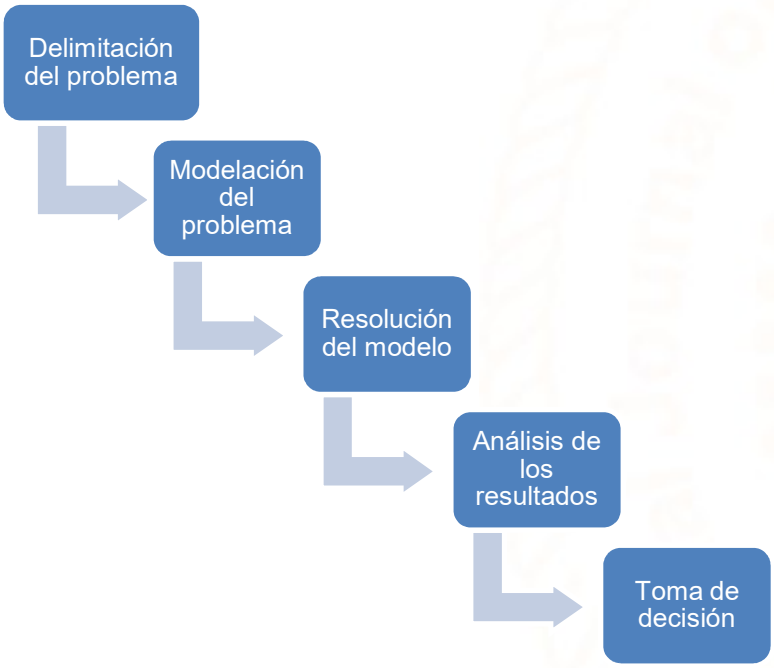

Figure 1. Example of project activities

For the Delimitation stage of the problem, a work sample was performed. The industrial process of two products was taken into account. The formula used was the one proposed by Dr. Bolaños (2012), which is used for finite or known populations. The formula is as follows:

$$n = \left[\frac{Z_{\alpha}^2 * p * q}{i^2} \right]$$

Where:

n: sample size
Z: value corresponding to the gauss distribution, for research Z = 90%, which is equivalent to 1,645.
p: expected prevalence of the parameter to be evaluated, if not known (p = 0.5), which makes the sample size larger.
q: 1 - p (if p = 70%, q = 30%)
i: error expected to be committed if it is 10%, i = 0.10
The development of the formula is as follows:

$$n = \left[\frac{(1.645)^2 * (0.5) * (0.5)}{(0.10)^2} \right] = \frac{67.65}{0.01} = 67.65 = 68$$

The study indicated that for the investigation of the production process, using 90% of reliability and 10% of allowed error, 68 observations or time takings will be needed for the investigation.

Once we know how many observations will be made, we took the time it takes each of the 3 processes with the 2 pieces (product A and product B) and these were the results obtained:

- Milling: part A takes 6.71 minutes and part B takes 8.71 minutes
- Production time is 480 minutes.
- Turning: part A takes 8.71 minutes and part B takes 10.71 minutes. Its production time is 480 minutes.
- Finishing finish: part A takes 11.71 minutes and part B takes 13.71 minutes.
- Its production time is 480 minutes.
- Part A is known to earn $ 100 and part B earns $ 125.

For the phase of modeling, and taking the variables that lead to the process, the mathematical model was then formulated. The mathematical model was as follows:

$$Max\ z: 100x_1 + 125x_2$$
$$6.71x_1 + 8.71x_2 \leq 480$$
$$8.71x_1 + 10.71x_2 \leq 480$$
$$11.71x_1 + 13.71x_2 \leq 480$$
$$x_1, x_2 \geq 0$$

Where part A will be the variable x1 and part B will be x2. The mathematical model remained with two variables and three restrictions, due to the processes by which the two products pass.

For the resolution phase of the model, the PHP SIMPLEX® tool was used, because it is a free and easy-to-use software for solving operations research problems. Figure 2 shows the main screen and the entry of the two variables and three restrictions.

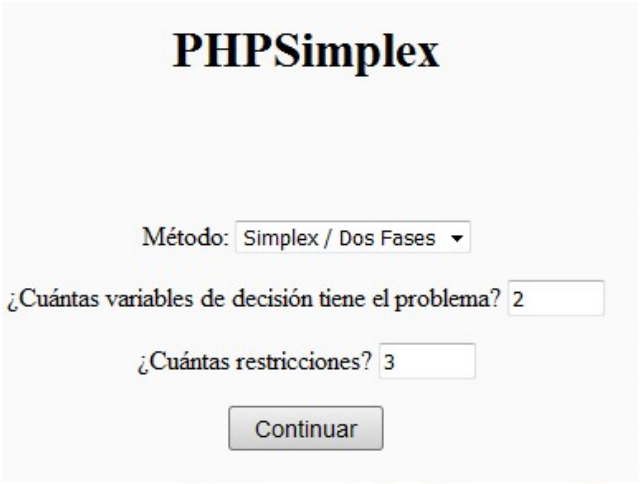

Figure 2. SIMPLEX® PHP main screen

Then Figure 3 shows the entry of the variables into the PHP SIMPLEX® program.

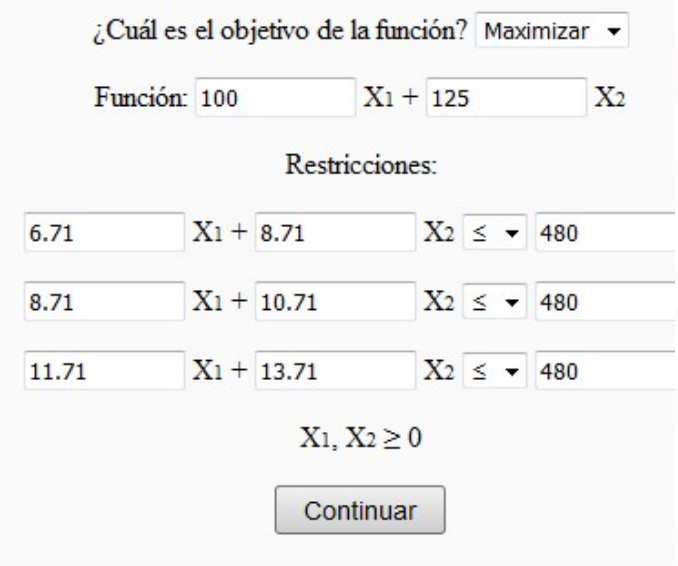

Figure 3. Example of input variables in PHP SIMPLEX®

The program helps to see how the problem is solved either directly or only the last result. For space saving, the last table of the final result is shown in figure 4.

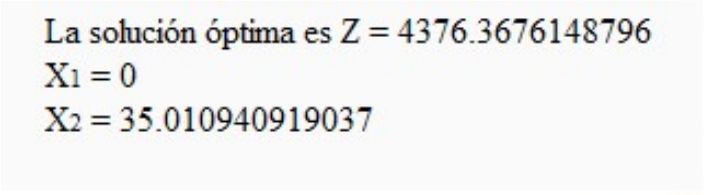

Figure 4. Final solution in PHP SIMPLEX®

The results of the problem are: Production of piece A equal to 0, production for piece B 35.01 products and maximum gain is $ 4376.36.

The results obtained by the PHP SIMPLEX® program, compared to the WIN QSB® software, is also a program that helps solving operations research problems. Figure 5 shows the entry of the variables into the WIN QSB® program.

Variable -->	X1	X2	Direction	R. H. S.
Maximize	100	125		
C1	6.71	8.71	<=	480
C2	8.71	10.71	<=	480
C3	11.71	13.71	<=	480
LowerBound	0	0		
UpperBound	M	M		
VariableType	Continuous	Continuous		

Figure 5. Example of problem entry in WIN QSB®

Once the data is entered, the problem solving step is taken, Figure 6 shows the results of the WIN QSB® program.

	19:33:31		Sunday	January	24	2016		
	Decision Variable	Solution Value	Unit Cost or Profit c[j]	Total Contribution	Reduced Cost	Basis Status	Allowable Min. c[j]	Allowable Max. c[j]
1	X1	0	100.0000	0	-6.7651	at bound	-M	106.7651
2	X2	35.0109	125.0000	4,376.3680	0	basic	117.0794	M
	Objective	Function	(Max.) =	4,376.3680				
	Constraint	Left Hand Side	Direction	Right Hand Side	Slack or Surplus	Shadow Price	Allowable Min. RHS	Allowable Max. RHS
1	C1	304.9453	<=	480.0000	175.0547	0	304.9453	M
2	C2	374.9672	<=	480.0000	105.0328	0	374.9672	M
3	C3	480.0000	<=	480.0000	0	9.1174	0	614.4538

Figure 6. Example of final resolution in WIN QSB®

The results of the problem are: Production of piece A equal to 0, production for piece B 35.01 products and maximum gain is $ 4376.36. As you can see the results do not vary, the two softwares are reliable for the use of operations research problems.

For the reality check stage, the results were compared with the original process and it was observed that there was no difference in the behavior of the variables. Finally, the mathematical model was implemented with the original process, and until now the process behaves as expected.

Analysis of results

The two programs used to solve the problem gave the following results.

- Production of part A equal to 0
- Production for part B 35.01 products
- Maximum profit is $ 4376.36.

The two results were similar, so you can be sure that the result is reliable and the two softwares are recommended for solving these types of problems.

Conclusión

In the field of Industrial Engineering, you have many tools to analyze and solve and evaluate a problem. The main purpose of an industrial engineer is to be able to apply the tools to understand his procedure, unfortunately many times, mathematics are taught with a theoretical approach, but the practical approach is neglected.

This project emerged from a classroom and was brought to reality in an industrial process. The simplex method tool was analyzed and applied using ICTs in specialized software, which aided the understanding and resolution of the research.

The applied Simplex method of pertinent form, allows to analyze, to solve and to evaluate a problem integrated by different variables. Improvement in the production planning process was achieved by applying the simplex method.

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International Journal of Trend in Scientific Research and Development (IJTSRD)
2nd International Congress of Engineering
ISSN No: 2456 - 6470 | www.ijtsrd.com | Special Issue Publication

Improvement of the production process through the application of the simulation technique

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ABSTRACT

The present research presents the results obtained from a practical study regarding the improvement of the production process through the application of the simulation technique. A 90% reliability and 10% error were used for the time-lapse study. For the analysis of the production process ProModel® specialized software was used in its test version. The results obtained in the research were that the simulation model behaves similar to the actual production process; Likewise, the productivity of the production process was 2.33%.

Keywords: *Production process, improvement, simulation.*

The macroeconomic environment facing firms is increasingly uncertain. At the same time, from the point of view of the company itself, it has to face greater competition, and relate to customers less and less captive with a high degree of information about the market. This results in an irreversible decline in results and an uncertainty that involves high levels of risk. Faced with this situation arises the need to manage new instruments to improve the strategic planning of companies (Fullana and Urquía, S / A). Labarca and Zulia (2007) argue that, at present, in the business sector there is a need to be more and more competitive, which forces organizations to analyze their processes to obtain a better quality that allows them to meet the needs and customer expectations. Business competitiveness, in the context of globalization, requires organizations to be sustainable in national and international markets to have a more efficient and effective administration of the productive processes of their financial, human and technological resources, among others. Gaither and Frazier (2000) point out that the leading organizations become more austere and more agile, and increasingly rely on their lean, reliable and efficient operation which should be managed in the best possible way if they are to make sound decisions about the activities of production systems.

The origins of the simulation lie in the theory of statistical sampling and analysis of complex probabilistic physical systems. The common aspect of both is the use of numbers and random samples to approximate solutions (Ferreiro, Azcárate and Mallor, 2011). Facultat d'Informàtica de Barcelona (S / A) argues that the origins of the simulation go back to World War II when mathematicians, J. V Neumann and S. Ulam, had the challenge of solving a complex problem related to behavior of the neutrons. Experiments based on trial and error were very expensive and the problem was too complicated to be addressed by analytical techniques. Mosterín (1987) argues that the use of a model allows us to elaborate a system theory, that is, to adequately describe the present functioning of the system, to explain what happened in the past and to predict what will happen in that system in the future, having present the limitations of the same with respect to the realized or represented with the model. The approach they chose is based on the use of random numbers and

probability distributions. The method developed was called Monte Carlo Method by the generation of random numbers and the game of roulette. D'Arthenay (2015) mentions that computer use in simulation began with the PACER program in 1966, and its increasing use in the simulation of industrial processes has been made possible by the development of numerical techniques and the use of new languages of simulation.

The process of experimenting with a model is called simulation. The process of designing the experiment plan to make the best decision is called optimization. If the experiment plan is carried out with the sole purpose of learning to drive the system, then it is called training or training (Tarifa, S / A). Harrington and Tumay (1999) point out that the simulation allows to experiment with a model of the system to better understand the processes, in order to improve the activity in the companies. Harrell and Tumay (1995) mention that simulation is a means of experimenting with a detailed model of a real system to determine how the system will respond to changes in its structure or environment. Arahal, Berenguel and Rodríguez (2006) argue that simulating consists of using a model to calculate and provide a certain output variable in order to produce similar evolutions with identical stimuli. Law and Kelton (2007) indicate that, in the general sense, the simulation deals with the study of dynamical systems in time. Kelton, Sadowski and Sturrock (2008) mention that computer simulation refers to methods for studying a wide variety of real-world systems models by numerical evaluation using software designed to mimic the operations or characteristics of the system, often in the course of time. Cabrera (2009) cites that the simulation is the discipline of the design and fictitious representation of real situations, by means of mathematical and technological elements in which it is experimented through a model that constitutes an abstraction of the reality; with the aim of understanding the behavior of the system and evaluating different types of strategies for its best operation. Soto (2010) points out that the simulation is the imitation of a dynamic system through a computational model. The experimentation on computational model, is sought to evaluate the operational characteristics of the system (or subsystem) that this being represented by the model. Experimentation on the model should help the understanding of the behavior of the system and in this way contribute to the decision making, which could lead to improve the performance of the system under study. Sánchez, Ceballos and Sánchez (2015) mention that the simulation of systems is an alternative to know in a correct way the critical points that can have the production processes of a company and with these model solutions that increase efficiency and reduce the times in the different activities carried out during the production of an article or the provision of a service. Olivas (S / A) mentions that process simulation is one of the greatest tools of industrial engineering, which is used to represent a process through another process that makes it much simpler and more understandable.

Álvarez and García (S / A) mention that simulation is becoming a necessary instrument in any area of work. Montoya (2007) argues that simulation as a support tool within the decision-making process can be used for the planning and improvement of different areas within the business scope of manufacturing and services, such as:

- Inventory system,
- Waiting line systems,
- Manufacturing system,
- Service industry,
- Transport and distribution systems

Prieto (2015) argues that the objectives for which the simulation is used:

- Analyze and study the impact on the overall performance of the system of small changes made to some of its components.
- Changes in the organization of a company.
- Suggest potential improvements in performance.
- Illustrate and facilitate the understanding of the results obtained through analytical techniques (can also be used with pedagogical vision).
- Experiment with operating conditions that could be dangerous or high in the real system.

Zapata and Lizardi (2013) point out that the use of simulation is an optimal and economic means to make changes in the actual processes in a maquiladora company. Therefore, it can be affirmed that the

simulation is fundamental for the construction of models used for the optimization of processes.

At the moment there are different programs that help the simulation of processes, among which are: QUEST, Flexsim, Arena, Witness, EM-Plant, Showflow, Enterprise Dynamics, Simul8, ProModel, E-Factory (Martínez, Bernabé, Hormaechea, Mínguez, and Ispizua, S / A). García, García, and Cárdenas (2006) argue that this commercial software is one of the most used in the market, which focuses on manufacturing processes of one or several products, transformation assembly lines, among others. Salazar (S / A) argues that ProModel is a magnificent and complete program of simulation of industrial processes, since it allows to simulate any logistic or manufacturing process, as well as strategic situations, and also to simulate the different processes of material handling. García, Eguia and Izaguirre (2015) mention that the choice of ProModel as a Simulation technology tool, has a great advantage because it is an interactive graphic software, which allows engineering students to adapt easily to their use and generation of practices.

The origins of ProModel go back in the year 1976. The plant was Ford Motor Company, which was developing a new car model. The challenge was to determine the right balance between machine capacities, buffering and allocation of resources to meet production levels defined for each production line. Of course, keeping the minimum cost of production. (Harrell, S / A) mentions that this was his first experience in computer simulation. At that time, simulation models were usually programmed by computer programmers in Fortran, a scientific programming language. However, there were mainly two drawbacks to this approach: (1) the simulation studies took too long (up to one or two years to program and revise completely, too late to deliver useful responses) and (2) programmers were not engineers and therefore, they normally had difficulty understanding the simulated process and knowing what solutions were feasible (Harrell, S / A).

ProModel® software customers include: Pfizer, Lockheed Martin, U.S. Army, TSA, Merck, West Point, General Dynamics, Medtronic, Baxter BioPharma, Driscoll's. Federal Express, Northrop Grumman, Boeing, MIT, U.S. Air Force, Nestlé Purina (Pinto, 2013). Trujillo, Vallejo and Becerra (2010) used the simulation to model a call center with ProModel®, which allows the identification of goodness of fit and homogeneity tests in order to formulate improvement proposals for system productivity. They raised the requirement for new staff and identified bottlenecks. Morales, Rojas, Hernández, Morales, Rodríguez and Pérez (2013) conducted a study with the supply chain model developed in ProModel® software, which achieves the representation of a supply chain according to the structure and behavior require for the experimentation of possible improvements with lean manufacturing. The parameters of the model subject to variation refer to reductions of waste in the process of the chain. Taddei, Rodríguez and Ruiz (2013) showed how the application of the simulation of systems allows to make more efficient the use of the resources, to reduce the waiting times and to give better attention, in this case to the aspirants to enter the Universidad of Sonora.

General objective

Improve the production process by applying the simulation technique

Specific objectives

- Understand the contextualization of the topic.
- Know the existing models to evaluate the quality of a production process.
- Calculate the representative sample using 90% reliability.
- Build the simulation model using specialized ProModel® software.
- Analyze the results obtained from the construction of the simulation.
- Evaluate the results obtained from the simulation analysis.

Justification

The project will be carried out in order to make known the benefit of using the simulation technique. Many companies are unaware of this type of technique, which helps not only understand a real model or system, but also, the simulation helps to make the best decision regarding the performance of a model or system.

The project will show a simulation of the production process, which will identify the areas of work and the

composition of the entire process. You have the information required to do the respective analysis of the manufacturing process as resources, elements, manufacturing times and the various activities.

Method Description

The study was carried out in 7 stages as shown in figure 1.

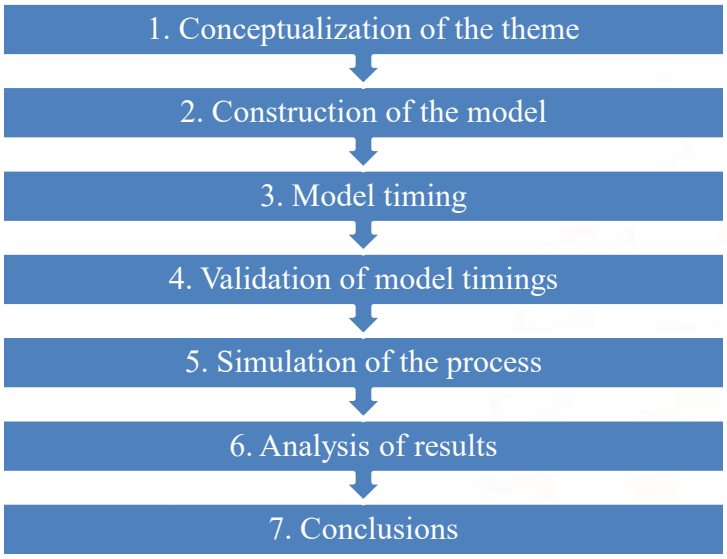
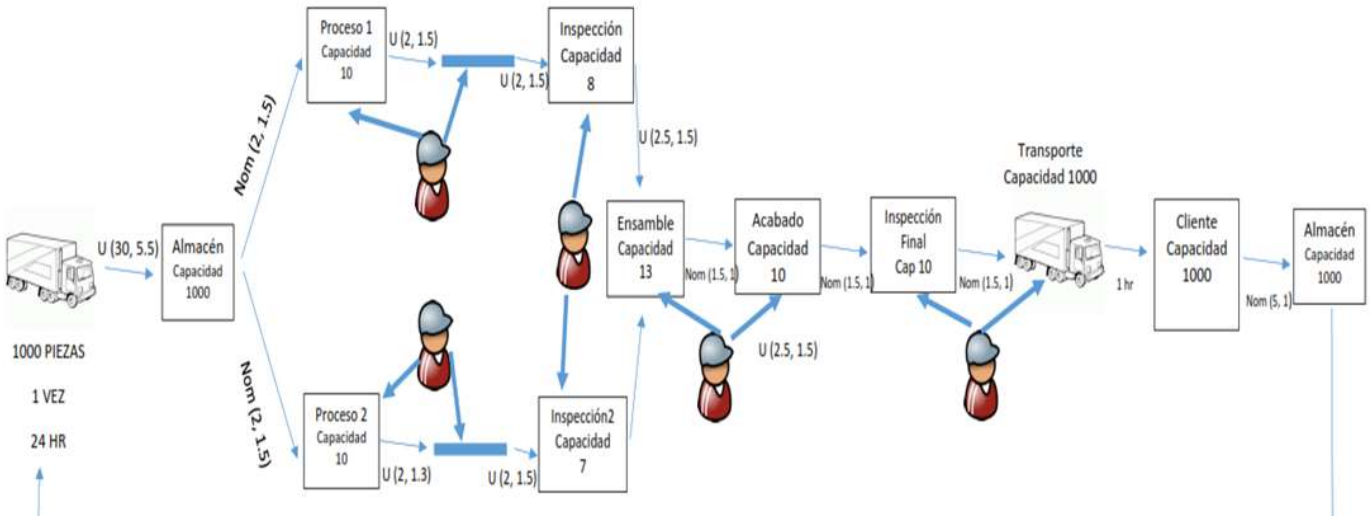


Figure 1. Example of methodological steps.

- **Conceptualization of the theme.** At this stage a bibliographic search of the subject was made, in order to better understand the theme.
- **Construction of the model.** In this phase the process to be analyzed was observed. In order to better understand how the production process is formed, random visits were made in order to better understand the study.



Example of the production process

- **Model timing.** Once the production process was studied, samples of each activity were made. We used the formula of Dr. Bolaños (2012), who proposes the following formula for an infinite sample:

$$n = \frac{Z_{\alpha}^{2} * p * q}{i^{2}}$$

Where:

n: sample size.
z: value corresponding to gauss distribution, 90% (1,645) was used for the study.
p: expected prevalence of the parameter to be evaluated, if not known (p = 0.5), which increases the sample size
q: 1 - p (if p = 70%, q = 30%)
i: error expected to be committed if it is 10%, i = 0.

The formula developed is as follows:

$$n = \frac{(1.645)^{2} * 0.5 * 0.5}{(0.10)^{2}} = 67.65 \diagup 0.01 = 67.65 \approx 68$$

The study indicated that for the investigation of the production process, using 90% of reliability and 10% of allowed error, 68 observations or time takings will be needed for the investigation.

Also, once it is known how many time takers should be made for the investigation, it was carried out. Figure 3 represents an example of the timing of each activity.

1 ***

C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22
almacen	proceso1	proceso2	inspeccion1	inspeccion2	ensamble	acabado	inspeccion final	transporte	cliente	almacen de cliente	BANDA 1	BANDA 2
12.15	5.69	7.10	5.25	6.20	4.25	4.25	5.36	15.25	20.25	13.15	5.36	7.25
10.58	7.36	7.25	5.21	6.21	4.10	5.01	4.25	14.36	18.25	12.58	6.32	7.10
10.69	5.36	8.36	5.20	6.01	5.10	4.55	5.36	15.55	17.69	10.69	5.20	7.20
11.55	6.25	9.25	5.36	6.20	4.25	5.10	4.58	15.36	18.69	12.55	5.10	6.25
10.69	7.36	7.10	6.20	5.20	5.01	4.36	5.36	14.58	18.69	11.69	5.20	6.33
12.58	6.32	7.25	6.01	5.20	5.10	5.36	4.69	15.69	17.69	12.58	6.01	6.68
10.36	5.28	8.36	6.10	6.20	4.26	5.10	5.36	15.58	18.36	13.36	6.20	7.25
10.25	7.36	8.25	6.20	7.10	5.01	4.36	5.41	14.36	18.88	10.25	5.15	6.25
11.25	5.36	9.25	6.36	6.25	5.10	4.58	4.69	15.69	19.36	13.25	5.25	6.58
12.69	6.36	7.55	6.25	5.25	4.25	5.36	5.69	14.69	18.69	11.69	6.20	6.55
10.36	6.36	8.25	6.10	5.20	4.26	4.25	5.21	15.15	19.69	10.36	6.33	6.24

Figure 3. Example of model timings

- **Validation of model timings.** At this stage it was validated whether sixty-eight preliminary samples were more than sufficient for the study. All samples of each activity of the production process were validated, the formula used was as follows:

$$n = \left[\frac{Z * \sigma}{e^{2}} \right]^{2}$$

Where:

n: number of samples needed for the study.
Z: value corresponding to the gauss distribution, for the investigation Z = 95%, which is equal to 1.96.
σ: standard deviation of the preliminary sample.
i: error expected to be committed in the study. The error is set to integer.

It is worth mentioning that, if the result of the formula is smaller than the size of the preliminary sample, the study is considered good or sufficient. Otherwise, if the number of the formula is greater than the size of the preliminary sample, the study is not suffering, which means that samples are missing to perform for the study to be complete.

The development of the formula for the warehouse activity is as follows:

$$n = \left[\frac{1.96 * 0.915}{5}\right]^2 = \left[\frac{1.7934}{5}\right]^2 == (0.3586)^2 = 0.1286 \approx 1$$

The study indicated that using 95% reliability, a 5 of allowed error and a standard deviation of 0.915 for the activity of the warehouse, will be needed 0.1286 samples, if rounding this number to the greater integer, would be a sample of time. Which means that with a time-out is more than enough, the preliminary study was carried out sixty-eight times, which means that those sixty-eight times are enough.

- **Simulation of the process.** In this phase the model was built with time in ProModel® specialized software in its student version. Figure 4 shows an example of the model constructed with specialized software.

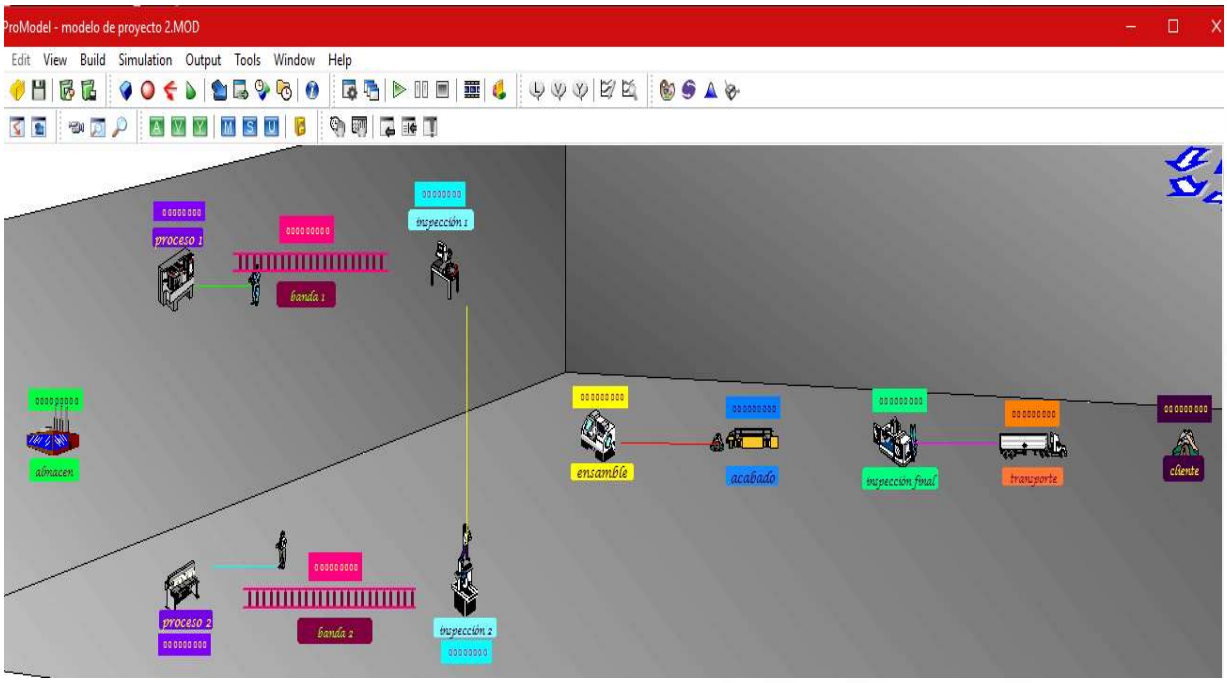
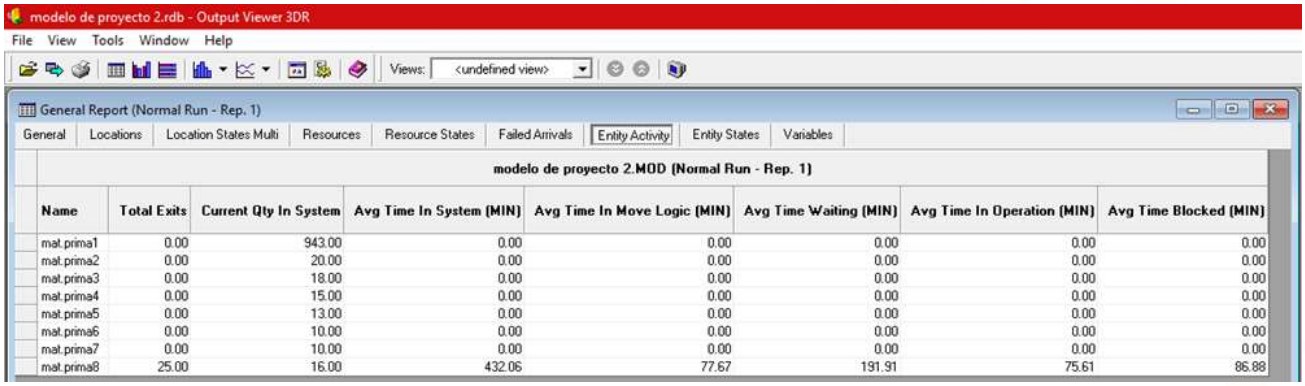


Figure 4. Example of model built in ProModel® software.

- **Analysis of results.** Once the model was made in ProModel® software, the results of the production process were examined. Figure 5 represents an example of the results of specialized software.



Name	Total Exits	Current Qty In System	Avg Time In System (MIN)	Avg Time In Move Logic (MIN)	Avg Time Waiting (MIN)	Avg Time In Operation (MIN)	Avg Time Blocked (MIN)
mat.prima1	0.00	943.00	0.00	0.00	0.00	0.00	0.00
mat.prima2	0.00	20.00	0.00	0.00	0.00	0.00	0.00
mat.prima3	0.00	18.00	0.00	0.00	0.00	0.00	0.00
mat.prima4	0.00	15.00	0.00	0.00	0.00	0.00	0.00
mat.prima5	0.00	13.00	0.00	0.00	0.00	0.00	0.00
mat.prima6	0.00	10.00	0.00	0.00	0.00	0.00	0.00
mat.prima7	0.00	10.00	0.00	0.00	0.00	0.00	0.00
mat.prima8	25.00	16.00	432.06	77.67	191.91	75.61	86.88

Figure 5. Example of the results of the production process

Continuing with the analysis of the results, Table 1 represents the indicators of the production process.

Table 1. Example of the results of the production process.

Failed Parts	0
Parts in the system	1045
Successful parts	25
Total of parts	1070

Continuing with the analysis of the production process, the productivity of the system is calculated:

$$Productivity: \frac{Successful\ parts}{\text{Total of parts}} : \frac{25}{1070} x100\% = 2.33\%$$

The above formula shows that the productivity of the analyzed process is 2.33%, which represents a pauper result. The present investigation allows to observe that the use of the simulation helps to know the operation of a process.

Conclusions

It was possible to improve the production process by applying the simulation technique, which shows that the general objective was achieved.

Also, it was possible to understand the contextualization of the subject and the importance of the technique of simulation applied in the processes. In addition, it was possible to identify the main components and activities of the production process, which went from general to specific.

There are different programs specialized in simulation, all softwares are good provided you have the knowledge and skills to manipulate them. In this research, ProModel® software significantly helped the understanding and analysis of the production process to be studied.

A more comprehensive study is recommended by increasing the minimum confidence interval to 95% confidence, with this the maximum allowed error will be reduced and even more accurate data will be obtained.

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International Journal of Trend in Scientific Research and Development (IJTSRD)
2nd International Congress of Engineering
ISSN No: 2456 - 6470 | www.ijtsrd.com | Special Issue Publication

Evaluation of the quality of a prognosis for an industrial product using the regression analysis

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ABSTRACT

The present research presents the results obtained from a practical study with respect to the evaluation of the quality of a forecast for an industrial product using the regression analysis. A 95% reliability and a 5 error were used for the validation of the partial samples of the conductivity and density of the product. For the regression analysis the specialized software Minitab® was used in its test version. The results obtained in the research were that the regression model and the parameters of the model are significant, reason why, the regression analysis is significant.

Keywords: *Regression analysis, model, parameters.*

INTRODUCTION

Human beings have always sought to anticipate any eventuality with the aim of minimizing risks in any of their recreational activities as well as those of an economic nature (Anonymous, S/A).

In companies, the behavior is the same, many of them try to prevent the future, in order to meet the demand for their products. Keener cited by Gómez (S / A) points out that linear regression is used in business to predict events, manage product quality and analyze a variety of data types for decision making. Hanke and Reitsch (1996) argue that all organizations operate in an atmosphere of uncertainty and despite this fact, decisions must be made that affect the future of the organization. For organizational managers, academic conjectures are more valuable than non-academic ones. Thus, decision makers will do better if, from an understanding of forecasting techniques, they use them properly, instead of being forced to plan the future without the benefit of this valuable supplementary information.

On the other hand, Estepa, Gea, Cañadas and Contreras (2012) mention that among the basic statistical notions whose teaching must be optimized are those of correlation and regression. From prehistory to the present day, discernment about the possible relationship that may exist between two events has been an important aspect of human knowledge. The formation of the notions of correlation and regression comes, to a large extent, from studies in Biology, Biometry and Eugenics. The first author interested in the subject was LambertAdolphe-Jacques Quetelet (1796-1874), known as Adolphe Quetelet, born in Ghent, Belgium. He obtained his doctorate in Mathematics with a thesis on conic sections, becoming director of the astronomical observatory of Brussels. He was a man of great energy, enthusiasm and organizational talent that he used to create several international institutions (Estepa, Gea, Cañadas and Contreras, 2012).

Within companies, they seek to have their all their processes under control, the essential characteristics of a process are: variability: never two results are exactly the same and repeatability: the more repetitions the more experience (García, 2016). In the modern business world Pelayo (S / A) says that the concept of management has been installed, although this term may be broad or unclear we will refer to management as defined by ISO 9000-2000 in point 3.2 .6 where management is defined as "Coordinated Activities to direct and control an organization". This concept of management is also the one that uses the National Quality Award (1999) in its bases.

Companies today use regression analysis to forecast future data, but many of them are SMEs unaware that there are mathematical models that help predict this data. Varela and Reyes (2009) point out that the purpose of forecasts is to predict the future development of different projects, to assist in decision making on projection measures such as the level of investment, production, and other measures that influence, lesser degree, on the tendency of the object raised, in our case the measures and actions that could be taken is in the level of preferences of the population with respect to the sector of white line.

Quality today is fundamental for the assurance of conforming products, with statistical control of quality being fundamental (Díaz, Bautista and Ortiz, 2013). For this reason, it is established the need to engage simple linear regression analysis in the forecast of a production process, in order to know if the company knows well the subject of forecast and, in turn, to know if it uses well the techniques of linear regression. It has been detected that the employees of the company under study make their forecasts in an archaic way and are unaware of the aforementioned issues.

REGRESSION ANALYSIS

The oldest discipline seems to have made a special pact, to contribute (almost all), each from its point of view, to the "gestation, birth and upbringing" of units, which later would be associated to constitute that conceptual body called Statistics and Soto, 1988).

Seal (1967) points out that Augusto Bravais contributed to the development of this theory from another field: astronomy, when studying the errors in the measurements of the coordinates of space bodies. It was he who first used the term correlation in a study presented in 1846 at the Academy of Sciences in France. However, Pearson (1965) will indicate that Bravais, when studying the theory of errors, did not consider correlated random variables, but considered errors independent of each other; therefore, did not arrive at a true idea of the correlation, as we know it today. Devore, (2005) notes that the term regression was first used as a statistical concept in 1877 by Sir Francis Galton, who conducted a study that showed that the height of children born to high parents tended to regress or "regress "Towards the average height of the population. He designated the word regression as the name of the general process of predicting a variable (the height of the children) from another (the stature of the father or the mother). Later, statisticians coined the term multiple regression to describe the process by which several variables are used to predict another.

Morales and Parra (2016) point out that, in an environment of uncertainty, where decision making is increasingly complex, the preparation of forecasts is a very useful tool for managers, since they are necessary to establish the general course of the organization both over a long period through long-term forecasts and in a short period designing immediate strategies to meet future needs through short-term forecasts.

Reyes (2009) mentions that prior to the 1950s the efforts developed at the time were limited to analysts, despite handling some theories of linear regression and decomposition of time series, lack of appropriate data and tedious calculations required to obtain a forecast.

A forecast is information with a certain degree of probability of what might happen. The probability of success is a direct function of the preparation of the forecasts. In other words, the result of the planning and operation of the company is directly linked to the certainty of the forecasts (Grijalva, 2009). Everett and Ronald (1991) mention that a forecast is a process of estimating a future event, projecting data from the past into the future. Past data is systematically combined by default to estimate the future. Zurita (2010) argues that forecasts support decision-making in different areas of business management: sales forecasting will help design the production plan, forecast commodity price developments, supplies, etc. Zeissig (2010) argues that forecasts can be estimated

by two criteria: the quantitative and the qualitative. The former analyzes historical data using mathematical models and statistics, and the second using knowledge of the current market situation and its environment. The best production forecast will be the one with the best information mix of both criteria. Chapman (2006) defines the formulation of forecasts of the technique to use past experiences in order to predict expectations of the future.

Montgomery, D., Peck, E. and Vining (2006) mention that linear regression models are widely used in engineering since they serve to analyze the behavior of input (or regressor) and output (or response) variables predictions and estimates. On the other hand, Badii, Guillen, Cerna, Valenzuela and Landeros (2012) indicate that regression and correlation are two closely related techniques and comprise a form of estimation. More specifically, correlation and regression analysis include the study of sampling data to know what two or more variables are related to one another in a population. Correlation analysis produces a number that summarizes the degree of correlation between two variables; and regression analysis gives rise to a mathematical equation that explains and predicts this relationship.

Lopez and Romero (2014) mention that the simple or bivariate RL models are used as models of prediction or prognosis. The most typical case is when the predictor, regressor or independent variable X is a controlled variable (non-random), while the response variable or dependent variable Y is a random variable that has an approximately normal distribution for each x value of X, but with constant variance σ^2. Escalante (2013) mentions that regression analysis is a technique used to relate, through a model, one or more independent variables to a dependent variable (response).

Orellana (2008) mentions that the simplest function for the relationship between two variables is the linear function:

$$Y = a + b\,X$$

Cardona, González, Rivera and Cárdenas (2013) mention that the general equation describing the relationship between the two variables is:

$$y = \alpha + \beta x + \epsilon$$

Following the ideas of the same authors, they mention that in this model, y is a linear function of x (the part $\alpha + \beta x$) plus ε (Greek letter epsilon) representing the error y is a random variable. Anderson, Sweeney and Williams (2001) point out that the error term explains the variability in y that cannot be explained by the linear relationship.

The method of least squares has a long history that goes back to the beginning of the nineteenth century. In June 1801, Zach, an astronomer Gauss had known two years earlier, published the orbital positions of the celestial body Ceres, a new "small planet" discovered by the Italian astronomer G. Piazzi in the same year. Unfortunately, Piazzi had only been able to observe 9 degrees of its orbit before this body disappeared after the sun. Zach published several predictions of his position including one of Gauss that differed remarkably from the others. When Ceres was rediscovered by Zach in December 1801 it was almost exactly where Gauss had predicted (Cruces, S / A). The method of ordinary least squares consists of obtaining a hyperplane so that the sum of the squares of the distances between each of the observations of the variable and said hyperplane (residues) (Chirivella, S/A).

GENERAL OBJECTIVE

Assess the quality of a prognosis for an industrial product using the regression analysis.

Specific objectives

- Understand the contextualization of the topic.
- Know the existing models to evaluate the quality of an industrial process.
- Calculate the representative sample using 95% confidence.
- Apply the regression analysis on the representative samples.
- Analyze the results obtained from the regression analysis on the representative samples.
- Evaluate the results obtained from the regression analysis on the representative samples.

METHODOLOGY

The study had seven stages, Figure 1 shows an example of the phases.

Figure 1. Example of methodological steps

1. Conceptualization of the theme. At this stage a bibliographic review of the topic was carried out.
2. Preliminary sampling. In this phase the problem proposed by Dr. Grunenfelder (2017) was taken into account, where 6 important samples of the process were taken in the identification of a suitable substitute for biodegradable materials in the fast food packaging industry. Six samples of the conductivity and 6 samples of the density were taken.

Table 1. Example of the samples taken for the preliminary study.

Conductivity	Density
0.048	0.175
0.0525	0.22
0.054	0.225
0.0535	0.226
0.057	0.25
0.061	0.2765

3. **Validation of preliminary samples.** At this stage it was validated if six preliminary samples were more than sufficient for the study. Both the conductivity and density samples were validated, the formula used was as follows:

$$n = \left[\frac{Z * \sigma}{e^2}\right]^2$$

Where:

n: number of samples needed for the study.
Z: value corresponding to the gauss distribution, for the investigation Z = 95%, which is equal to 1.96.
σ : standard deviation of the preliminary sample.
i: error expected to be committed in the study. The error is set to integer.

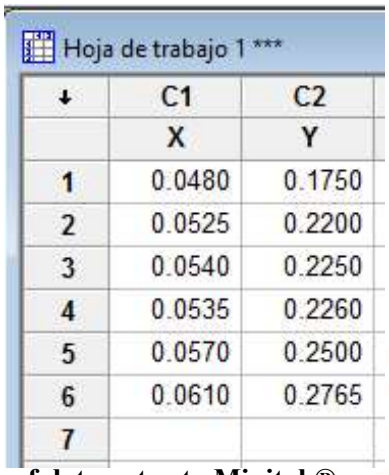
Very important, if the result of the formula is smaller than the size of the preliminary sample, the study is considered good or sufficient. Otherwise, if the number of the formula is greater than the size of the preliminary sample, the study is not suffering, which means that samples are missing to perform for the study to be complete.

The development of the formula for conductivity is as follows:

$$n = \left[\frac{1.96 * 0.0043}{5}\right]^2 = \left[\frac{0.0084}{5}\right]^2 == (0.0016)^2 = 0.000002 \approx 1$$

The study noted that using 95% reliability, a permissible error 5 and a standard deviation of 0.0043, will require 0.000002 samples, if this number is rounded to the largest integer, it would be a sample. Which means that with a preliminary sample is more than enough, the preliminary study was performed six samples, which means that these six preliminary samples are sufficient. For the case of density, the result of the formula was 0.00017. In the same way, it is rounded to the largest integer, giving a result of 1 sample. Preliminary study was performed six samples, which means that those with the six samples is sufficient for the study.

4. **Calculation of regression analysis.** In this phase the specialized software Minitab® was used in its test version. Data were entered: conductivity (predictor variable) and density (response variable). Figure 2 shows an example of the above.



	C1	C2
	X	Y
1	0.0480	0.1750
2	0.0525	0.2200
3	0.0540	0.2250
4	0.0535	0.2260
5	0.0570	0.2500
6	0.0610	0.2765
7		

Figure 2. Example of data entry to Minitab® specialized software.

As can be seen, the previous figure shows how the data of both the conductivity variable and the density variable were entered. Figure 3 shows an example of how the Minitab® specialized software in its test version, the predictor variable (x) and the response variable (y) are chosen.

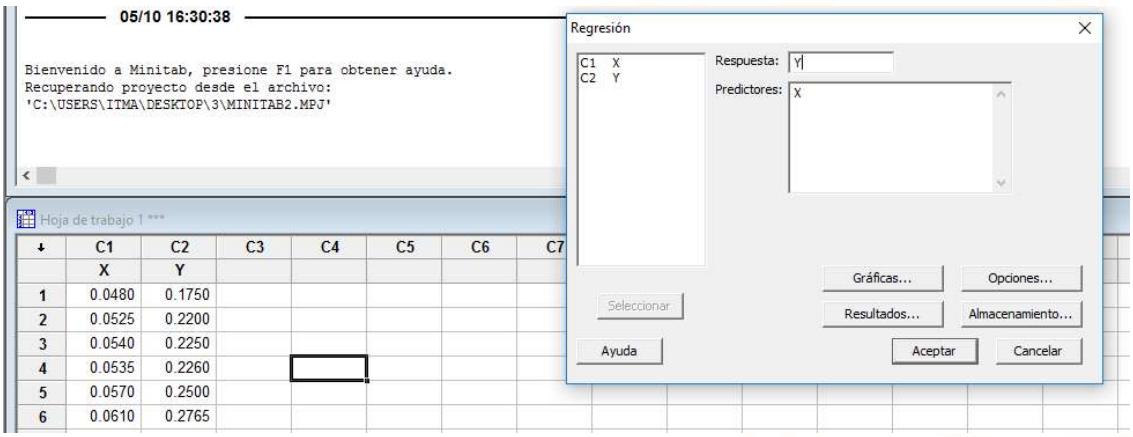


Figure 3. Example of choosing variables in Minitab® specialized software.

5. Analysis of results. At this stage we proceeded to examine the results obtained from specialized Minitab® software. Table 2 shows an example of the results obtained from Minitab® software.

Table 2. Sample result of the model

Model
Y = -0.188 + 7.67 x

The above table indicates the linear regression model that will have the study process. With this equation it will be possible to predict future data of the density of the product.

An analysis that must be performed within the regression analysis is the meaning test, which determines in a statistical way if the regression model is worth obtaining (Escalante, 2013). For this and following the ideas of the same author, the hypotheses that are raised are the following:

- Ho: B1 = 0 (There is no linear relationship between x, y). Regression does not make sense.
- Ha: B1 ≠ 0 (x is valuable to explain the variation of y).

For this, the analysis of variance was used. In the same way, the specialized software Minitab® was used in its test version, Table 3 shows an example of the obtained results.

Table 3. Example of variance analysis result.

Análisis de Varianza	GL	SC	MC	F	P
Fuente	1	0.0056371	0.0056371	275.84	0.000
Regresión	4	0.0000817	0.0000817		
Error residual	5	0.0057189			
Total					

The above table shows the results obtained in the analysis of variance using Minitab® software. The important thing and following the ideas of Escalante (2013), is to put much emphasis in the column of F. If the F calculated in table 3 is greater to the F obtained from the book, it is said that Ho is rejected. According to Escalante's book (2013) and using a $F_{0.05,1,4} = 7.71$, comparing this result with that of the F of Table 3 that was 275.84, we conclude that Ho is rejected, which means that regression makes sense.

Continuing with the analysis to be performed within the regression, the significance test for the model parameters was applied. For the parameter Y and x, the following hypothesis was used:

- Ho: $B1 = 0$
- Ha: $B1 \neq 0$

For this, the analysis of variance was used using the specialized software Minitab® in its test version, Table 4 shows an example of the obtained results.

Table 4. Example of result of analysis of variance for model parameters.

Análisis de Varianza				
Predictor	Coef.	Coef. De EE	T	P
Constante	-0.18796	0.02516	-7.47	0.002
x	7.6696	0.4618	16.61	0.000

The above table shows the results obtained in the analysis of variance for the model parameters using Minitab® software. The important thing and following the ideas of Escalante (2013), is to put much emphasis in the column of the P, that is equivalent to the P value. If the value $p < \alpha$, Ho will be rejected. The P value of the parameters Y and x are as follows: Y is 0.002 and x is 0.000. Comparing the two results of the P values it is observed that the two are less than the value of α which is 0.05, therefore, in both parameters Ho is rejected, which means that the regression model is significant.

6. Conclusions After analyzing the data obtained from the partial samples, both general and specific conclusions were taken, in the conclusions section the above mentioned is explained.

7. Design of proposals for action. From the analysis of the results and conclusions obtained, lines of action are proposed to improve the quality of the process.

CONCLUSIONS

The simple linear regression forecast is an optimal model for trend patterns (increasing or decreasing), that is, patterns that have a linear relationship between demand and time. (Salazar, 2016).

The present research reached the general objective set. It was possible to evaluate the quality of the process of an industrial product using the regression analysis. It is inferred using 95% reliability and 5 errors in the research, that the regression model and its parameters make sense, in other words, they are reliable.

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International Journal of Trend in Scientific Research and Development (IJTSRD)
2nd International Congress of Engineering
ISSN No: 2456 - 6470 | www.ijtsrd.com | Special Issue Publication

The use of information technologies and communication create an educational change

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ABSTRACT

In this theoretical-conceptual research, it is given to know an overview of the need for the teaching update in the field of Information and Communication Technologies ICT, this in response to the need to comply with the requirements of the current life where technology is present in all daily activities and the school is no exception, it must adapt teaching-learning models that go in line with the current environment.

Keywords: *Information and Communication Technology (ICT), learning, education, knowledge*

INTRODUCTION

The 21th century represents a radical change in the way of transmitting knowledge and learning to learn in the classroom, changes have been made in different areas of life: social, academic, personal, work, etc., and in all of them makes present a common factor that are Information and Communication Technology (ICT), which have come to put in a latent way the initiative that teachers have to be provided with the knowledge and skills necessary to face the changes that occur globally around learning communities supported by ICTs. However, we must be aware that this is a process, because these technological changes have been vertiginous and the teachers who are currently in front of a group are mostly those that have to be updated and thus be part of the world of technology.

The constructivist theory is retaken, because it is seen learning as an active process in the construction of meanings in it and this is how it is denoted the need to update the teacher.

Educational institutions and the use of ICT

With all the current advances in science and technology, which play a transcendental role in the dynamics of societies and are present in the productive system, it is indispensable to bring students as much as possible to knowledge in these areas, educational institutions have the challenge to prepare them to develop adequately to the needs in the workplace, academic, personal, social, etc.

The academic education starts from the teacher-student relationship with which the pedagogical process begins, this one has several nuances, that is to say that it is not given in a single way, since it can be classroom, in class, and in another site or distance; but without a doubt the role of the teacher is basic, since in this relationship is where the individuality of the student is respected, but is guided to bring it to the reflection.

There are several theories which approach the topic of learning, but the one that is taken up is that of constructivism where Piaget, Vigotsky, Ausubel and Bruner; make contributions that are based on

analyzing the factors that join in it and determine that these can be internal, previous experiences and environmental; the school conceives it as a space where there is equality and everyone can achieve success, the student is the one who builds the knowledge

Based on the above, the classroom has to be a space where the student understands reality and learns to live in it, the teacher not only guides him to assimilate knowledge, but also learns, both are an active part, the teacher creates meaningful contents for the student to assimilate easily.

To understand what we are saying is necessary that the actual society retakes the use of ICT, because they represent a fundamental tool in the academic environment , not wanting to see it this way would be deceiving, since they have now become part of the culture for the youth. Then his foray into school has been inevitable; therefore, they are present in a significant way in the teaching-learning process.

Garcia (2007) argues that from the beginning of the nineties until the current (2015) the web has been developing in such a way that today is spoken of new generations, known as web 1.0, web 2.0 and web 3.0, the latter allows end users (we teachers and students) to experience greater interactivity, not only between users, but also with the educational content, which some call the semantic web, allowing the paradigm of the teaching-learning process to change vertiginously, allowing the collaborative work in network. For its part, the Editorial Board of the Interuniversity Journal of Teacher Training (2007) mentions that ICT is a powerful instrument at the service of teaching, whose presence can be seen in numerous formulas and pedagogical tools, both with regard to equipment and media. Cano (2012) points out in his research that the use of Information and Communication Technologies (ICT) has a significant impact on the modernization of the education system and shortens the learning gap in the knowledge society. Its evolution is fast and this is perceived throughout Latin America, the Caribbean, North America and Europe. Cabero (2006) points out that information and communication technologies have become a fundamental part of our daily life and more in the educational context where everything revolves around new advances, new policies and educational reforms.

With the beginning of this millennium, attention is directed toward the role played by ICT in society. There is no clear and precise definition of the concept of ... ICT, so it is often referred to in order to explain how technologies are linked to communications and information through computer media. That is, the ICT label has been used as a tailor's box referred to any device or application that serves to transmit information or establish communication, either line - such as a CD-ROM - or on-line, through of the internet (Cataldi y Cabero, 2007).

Hawkridge (1985) defines ICT as the technologies applied to the creation, storage, selection, transformation and distribution of information. FUNDESCO (1986) defines them as the set of technologies that allow the acquisition, production, storage, processing, communication, recording and presentation of information in the form of voice, images and data contained in acoustic, optical or electromagnetic signals. Adell (1997) defines them as the set of processes and products derived from new tools (hardware and software), information carriers and communication channels related to the storage, processing and digital transmission of information. UNESCO (2002) defines them as the set of scientific disciplines, engineering and management techniques used in the handling and processing of information: their applications; computers and their interaction with men and machines; and associated content of a social, economic and cultural nature. The OECD (2002) defines them as the devices that capture, transmit and deploy electronic data and information and that support the growth and economic development of the industry manufacturing and services sectors. Roblizo and Cozar (2015) define them as the revolutionary, shocking and changing phenomenon, which encompasses both the technical and the social, and which permeates all human, labor, training, academic, leisure and consumption activities.

The information and communication technology and knowledge

The attractiveness and pedagogical possibilities attributed to ICT have been enough arguments to open the doors of schools to supports and devices that used to belong exclusively to the business world. Thus, more and more common international organizations that endorse the introduction of ICT in the teaching process (Braña, 2008).

The European Union from the year 2000 emphasizes the need for ICT to adapt to the education and training systems demanded in the knowledge economy, in order to achieve a decisive role and thus students not only develop knowledge if not also indispensable personal and professional skills.

The use of ICT in academically is a current need, are a tool that helps to improve the contents of a subject, help the teacher to be a guide in the acquisition of knowledge, which is given in an interactive, Intelligent classrooms mark a transcendental change in interpersonal relationships, because it gives a more collaborative environment where academic contents allow a communication based on novel and dynamic aspects. In them is formed a whole set of ICT (computer, video-projector, smart board and camera).

The information and communication technology, is part of an academic transformation for the teacher.

Academic institutions are the generators of knowledge, teachers work with him and the guided students have the laborious task of learning to learn, providing a service such as education, one must be prepared to comply with it 100%, of according to the needs of students, seeking above all to get involved, interact and motivate.

The new generations have a great advantage, since they were born immersed in all these technological changes and their perspective is totally different from those who acceded to them as a way of being updated; such is the case of many of the teachers who have in their classrooms pupils that their life is technology from the use of cell phones, computers, tablets, etc. For this reason, the design and practice of teaching have to do with facing the challenges of education by boosting quality in it.

The teaching-learning process has to promote the incorporation of ICTs, as well as the development of contents that must be meaningful and pertinent, with this is the transformation of education, where the scenario teachers-students-content agree changing the traditional evaluation system and promoting innovation based on the needed skills.

"The shift from teacher-centered learning to student-centered learning can create a more interactive and motivating learning environment for both students and teachers themselves. This new scope also implies a change in the roles of students and teachers ... the role of the teacher will stop being only the one of transmitter of knowledge to become a facilitator and guiding of the knowledge and in a participant of the process of learning along with the student. This new role does not diminish the importance of the teacher, but requires new knowledge and skills. Students will be more responsible for their own learning as they seek, find, synthesize, and share their knowledge with other peers. ICTs are a powerful tool to support this change and to facilitate the emergence of new roles for teachers and students (Braña, Real y Rial, 2008).

However, the conception of the learning process has been transformed, it is now known that not all people assimilate knowledge in the same way because they have different learning styles, and is in this situation where the teacher faces a great challenge: an appropriate environment that is interesting and stimulates all students.

In the same way learning has to be seen as a collaborative process with peers, parents, teachers, etc., where everyone in one form or another participate to provide the student with quality in their work, in addition to ICT it is possible to interact with any person of any part of the world, without having the limitations of distance, schedules, etc., which makes it even more interesting because in the classroom itself can be connected to the network and share experiences; giving rise to producing and reproducing knowledge, because there is a proactive interaction in which it shares, discusses, resolves and learns about diversity of subjects, thus the student becomes significantly involved in the challenge of creating knowledge.

Therefore, the task faced by the institutions is to train the teaching staff so that they incorporate in their classes strategies that are based on the use of all those tools that originate effective learning environments.

Teaching skills a challenge

Sanchez and Talavera (2008) recognize that competencies can be defined according to different guidelines or procedures and offer a definition of competence for curricular planning purposes, such as good performance in diverse and authentic contexts based on the integration and activation of knowledge,

techniques, procedures, skills and abilities, attitudes and values. Castañeda, Acosta and Morea (2013) argue that technological competences are part of the set of personality traits, attitudes, knowledge and skills that make possible the professional performance in the teaching area; they are a conglomeration of associated elements such as knowledge (KNOW), attitudes (TO BE), and skills (DO).

As a teacher you have to be aware that you work with a diversity of students, you cannot treat everyone equally, which makes the work more complex, but also more enriching.

The teaching competences to be developed are:

1. "Plan the teaching-learning process
2. Select and submit disciplinary content
3. Offering understandable information and explanations
4. Didactically manage the NNTT
5. Manage methodologies of didactic work and learning tasks
6. Connect constructively with students
7. Advise students and, where appropriate, colleagues
8. Evaluate the learning (and the processes to acquire them)
9. Reflect and investigate teaching
10. To contribute in institutional matters (Fernández, 2012)

However, the implementation of ICT in educational practices facilitates the dynamics in the processes to reach the aforementioned competences, because it is possible to use tools such as online learning communities, which are a space where activities are shared, knowledge, proposals for solving problems, etc., that is, represent a viable alternative of learning and collaborative work.

It is also possible that it can be given, it may also be the case that for some teachers to face continuous changes as a result of interaction with ICT can affect their professional competence, understood as: the comprehensive set of skills that people put into play in real work situations to solve the problems they pose, according to the level of professionalism and social responsibility characteristic of the different professional areas (UNESCO, 2004).

One of the first authors to approach the concept of digital literacy was Gilster (1997). Bawden (2008) presents a series of skills and attitudes that comprise it. Covello (2010) identifies as part of this digital literacy, from the definition and identification of the need for information, to the management and interpretation, evaluation, creation or communication of information and knowledge through ICT tools . Hobbs (1996) defines it as the access process, critical analysis and creation of messages through multimedia tools, and whose objective is to promote autonomy through the development of analysis, reasoning and communication. Lankshear and Knobel (2005) define digital competence as a set of specific competencies or skills that name truthcentric. Gutierrez (2011) points out that digital competences are the set of values, beliefs, knowledge, abilities and attitudes to use properly the technologies, including the computers as well as the different programs and Internet, that allow and enable the search, access, organization and use of information in order to build knowledge. OECD (2003) argues that digital competencies are understood as a sophisticated repertoire of competencies that permeate workplace, community and social life, including skills needed to manage information and the ability to assess relevance and the reliability of what you are looking for on the Internet. The European Parliament (2006) notes that in particular on digital competition it claims that it refers to a safe and critical use of technologies and the mastery of information and communication technologies.

It is from the above that then they would have to develop:

1. Instrumental and technical competences: these are the result of daily practice in the use of ICT, which allows familiarity with them and therefore do not have to represent any problem.

2. Didactic competences: Communication, participation and interaction are promoted based on the evaluation of teaching-learning processes with ICT.

3. Communication skills: Communication from ICT can be given in different ways, since the codes and channels to be used can be audiovisual, multimedia, etc. will depend on the ingenuity and creativity of each teacher.

The above presents a challenge for teachers who have to integrate into the world of ICT, but it is not impossible to achieve, if you start by being an active participant in which gradually have access to ICT and pose practices that contribute to the knowledge they have but now implementing novel scenarios.

In its action plan, UNESCO (1998) points out that in order to modernize higher education in all its aspects: content, methodology, management and administration, the rational use of ICT as an object of study, research and development is required. According to the OECD's first PISA assessment of digital skills, schools have not yet tapped the potential of technology in the classroom to address the digital divide, and prepare all students with the skills they need in the connected world of today (OECD, 2015). Santiago, Caballero, Gomez and Dominguez (2013) argue that information and communication technologies (ICTs) have a growing role in Mexico and in the rest of the world, in order to orient education in any of its levels. The ICT Development Index (IDI) measures the performance of countries in ICT infrastructure, use and skills. The measurement scale has a theoretical range of zero to ten. The IDI of the LA countries is 2.77 to 6.95, reflecting the different conditions in which technology lies in these nations, even with similar income levels. Internet access in schools in the Dominican Republic, for example, was only 5% in 2012, in contrast to 100% of several Caribbean islands. In Argentina, Brazil, Costa Rica and Mexico less than 50% of schools are connected to the Internet, while Chile has 78% and Uruguay 96% (International Telecommunication Union, 2014).

Based on the National Survey on the Availability and Use of Information Technologies in Households (ENDUTIH), which was first raised in 2015 to give continuity to the previous module, 62.4 million people, six years of age or more in the country, users of the services offered by the Internet, which represents 57.4 percent of this population (INEGI, 2016). Islas (2016) argues that in the recent edition of the report The Global Information Technology Report 2016. Innovating in a digital economy, which responds to the need to assess the technological competitiveness of countries, Mexico was ranked at position 76 and the assigned assessment it was 4.0.

Villasana (2014) points out that in Mexico the reform promoted by former President Ernesto Zedillo (1994-2000) was more prominent for the decentralization of education than for its achievements in having expanded educational coverage. Technology in Mexican education was practically non-existent. The world was just beginning to discover its benefits, power and scope in the field. In the same way, and following the ideas of the same author, Vicente Fox's 2000-2006 term was characterized only in the attempt of his program "educational revolution", although it must be recognized at least he sought to incorporate technology as a tool to enrich the teaching process. This was called the Enciclomedia program. And with the term of Felipe Calderón (2006-2012) his legacy focuses on the pact he made with the former magisterial leader Elba Esther Gordillo to win the presidency. The technology, whether it was teaching in basic education or its application, practically happened at night and put the last nail to the coffin of Enciclomedia.

Conclusion

People born around the new millennium have access to information in a disproportionate way and with this they have handled the technology from a very early stage of their life, reason why they are immersed in a dynamic in which their world is based on the ICT.

The information they have access influences in a transcendental way in the life of the young people, reason why the educational institutions must be in the vanguard and for that reason the academic practices have to be based in the current lifestyle, economic and technological context from of expanding the teaching role in the transformation of the teaching-learning processes.

It is time to be an active part to achieve a more open and flexible learning centered on technological innovation, academic training is without a doubt the way forward.

Acknowledgment

- González Torres Arturo for his advice on the project.

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International Journal of Trend in Scientific Research and Development (IJTSRD)
2nd International Congress of Engineering
ISSN No: 2456 - 6470 | www.ijtsrd.com | Special Issue Publication

Customer service quality assessment within the industrial corporation applying the servqual tool

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ABSTRACT

In the present investigation we show the results obtained from a study carried out in an industrial corporation located in Mexico City with respect to quality in the service. A 95% reliability and 5% error were used in the study. The SERVQUAL tool was used for the analysis. The results obtained in the research were that the reliability dimension had 85%, the response capacity obtained 85%, the security achieved 82.5%, the empathy achieved 80% and the tangible elements reached 80%. The overall average quality of service was 82.50%.

Keywords: *Quality of service, Servqual, reliability.*

INTRODUCTION

All kinds of companies have increased their interest in improving customer loyalty. The results of several field studies show that customers loyal to a particular brand or company are much more profitable to the company than to create other customers (Schneider, 1998). A good service will always seek to listen to the customer to be able to keep them and that they keep buying in the company, in other words, to make them loyal to the company. Also, a good service, has as quality its quality of it. Quality of service is defined as the perception of the customer about the service received (Zeithaml and Bitner, 2000).

Lancaster (1995) argues that the subject of evaluation begins to be addressed in the 1960s and begins with studies related to the evaluation of collections, a field widely discussed since. Quintanilla (2002) argues that from this perspective, the quality of service and the satisfaction of users is one of the main areas of study of the behavior of consumers and users, since the performance of service organizations is valued by the own people who buy and / or use these consumer goods and / or services, therefore studies of the quality of service and consumer and user satisfaction, have in common the importance of the point of view of customers when valuing the product and the service provided by the organization itself, to perform an adequate quality management is necessary to know what people are looking for in their consumption activities. Moliner, Carrasco, Martínez-Tur and Marzo (2004) point out that several studies show that the perception of a low quality service by the customer is one of the main reasons for the change to another company of the competition. Begazo (2006) mentions that achieving full customer satisfaction is one of the most important objectives of any company. Continuing with the ideas of the same author, the benefits of achieving are as follows:

- A satisfied customer re-purchases.
- A satisfied customer communicates all of their positive experiences with a product or service.
- A satisfied customer leaves out the competition.
- A fully satisfied tourist is willing to return and, above all, to pay more.

For all of the above, Orgambídez and Almeida (2015) point out that the study of the factors related to the quality of service has acquired special importance as a key competitiveness element, especially the role played by the contact employee. Gadotti and Franca (2008) argue that quality assessment has always been more complex for services than for products because they are inherently heterogeneous, inseparable between production and consumption, intangibility and perishability.

Gabriel (2003) points out that one of the most important works about the quality of services is the "Service Profit Chain" (SPC) model, made by the authors Heskett, Sasser and Schlesinger based on the analysis of successful service companies. This model combines strategies for the creation of value of the service through the satisfaction and loyalty of the clients and the satisfaction and productivity of the employees.

Another model that has taken a lot of importance in measuring the quality of services is the SERVQUAL model, which is an instrument widely accepted by the international scientific community that measures the quality of service and summarizes the models mentioned above. This scale was designed by researchers Parasuraman, Zeithaml and Berry in 1985 (Moreno and Coromoto, 2006), and has undergone some changes and improvements, as well as been revised and validated in Latin America by Michelsen Consoulting, supported by the Latin American Institute of Quality in Services in 1992 (Morales, 2005).

Researchers have determined that when one compares the general expectation of the user (also called client, patient, beneficiary, etc.) with the perception of the service received from an organization, it is a measure of quality in the service, and The gap between the two indicates the areas of opportunity for improvement (Morales, 2005).

Importance of measuring the quality of services

A service is defined as a type of economic good, it constitutes what it calls the tertiary sector, everyone who works and does not produce goods is supposed to produce services (Fisher and Navarro, 1994). Bon (2008) argues that it is a means to deliver value to customers, facilitating the results that customers want to achieve without assuming specific costs or risks. Kotler (1997) points out that a service is any activity or benefit that one party offers to another; are essentially intangible and do not give rise to ownership of anything. Its production may or may not be linked to a physical product. Lehtinen and Lehtinen (1982) argue that service quality occurs in the interaction between a customer and the elements of the organization providing the service.

Müller (2001) mentions that a company is in balance and is of high quality when it exceeds expectations of customers, staff and shareholders. Requena and Serrano (2007) point out that a high or low definition of quality of service depends on how consumers perceive the total service, in the context of their expectations. Pizzo (2013) mentions that it is the habit developed and practiced by an organization to interpret the needs and expectations of its clients and consequently offer them an accessible, adequate, agile, flexible, appreciable, useful, timely, safe and reliable service, even under unforeseen situations or errors, in such a way that the client feels understood, attended and served personally, with dedication and efficiency, and surprised with greater value than expected, thus providing higher income and lower costs for the organization. The fundamental characteristics of services are: intangibility, non-differentiation between production and delivery, and inseparability of production and consumption (Parasuraman, Zeithaml and Berry, 1985). Cronin and Taylor (1994) mention that the ServQual and Servperf scales are tools designed to measure the quality of service.

Customer satisfaction is one of the fundamental results of providing a proper customer service. The importance of measuring the quality of service in a company is very important today because in this study you will be able to observe the perception that the customer has towards the products and / or services that the organizations offer. Likewise, companies that are looking for ISO 9000 certification should emphasize the importance of measuring their customers, because the same standard marks that this should be done. Quality and Management (2011) defines customer satisfaction as the result of the comparison that inevitably takes place between the customer's previous expectations placed on the products and / or services and on the processes and image of the company, with respect to the perceived

value at the end of the business relationship. Aguilar and Jáuregui (2004) argue that it costs four or five times more to get a new customer than to keep one that already has. But it is more spent on attracting more customers than on maintaining what they already have. Satisfied customers are loyal customers. A customer's loyalty is worth at least 10 times the price of a purchase.

Servqual Model

Morales (2003) argues that the SERVQUAL model has been applied to several areas since its inception. The SERVQUAL model uses a scale ranging from 1 to 7 of semantic differential (Osgood, Suci and Tannenbaum, 1957). Pineda, Estrada, and Parra (2011) point out that the expectations and perceptions were assessed by the level of importance that the respondents give each of the 22 items. As for perceptions, 1 indicates that one is totally dissatisfied and 7 totally satisfied; and in expectations, 1 indicates totally insignificant and 7 totally important.

Universidad TecVirtual del Sistema Tecnológico de Monterrey (2012) points out that the Servqual instrument serves to measure customer expectations of a service organization, the perceptions that the same customers have of that service organization and the hierarchy that customers make of the service dimensions relevant to the organization (typically tangible aspects of reliability, assurance, response speed and empathy). Among the applications of the Servqual model, Dal Corso, Vianello, De Carlo and Robusto (2001) evaluated the quality of school services with a sample of 640 parents, teachers, and auxiliary staff in Padua. In addition, Lowndes and Dawes (2001) examine in their study whether the dimensions of service quality that emerge from the factorial analysis in a company's purchasing data based on the SERVQUAL instrument are the same as those found in the literature.

Dimensions of SERVQUAL

This instrument has been applied in organizations, both public and private and in several entities, which has allowed validating and revising the tool as an instrument for measuring quality in the service (Morales, 2005).

AITECO consultants (2016) points out that the dimensions of this model are as follows:

- Reliability: Ability to perform the service carefully and reliably.
- Responsiveness: Willingness and willingness to help users and provide fast service.
- Safety: Knowledge and attention shown by employees and their ability to build trust and confidence.
- Empathy: Personalized attention that the organization dispenses to its clients.
- Tangible Elements: Appearance of physical facilities, equipment, personnel and communication materials.

General objective

Evaluate the quality of customer service within the Industrial Corporate by applying the SERVQUAL tool.

Specific objectives

- Understand the contextualization of service quality.
- Know the existing models to evaluate the quality of the service.
- Calculate the representative sample using 95% confidence.
- Apply the Servqual questionnaire in the representative sample.
- Analyze the results obtained from the questionnaire applied to the representative sample.
- Evaluate the results obtained from the analysis of the questionnaires

Justification

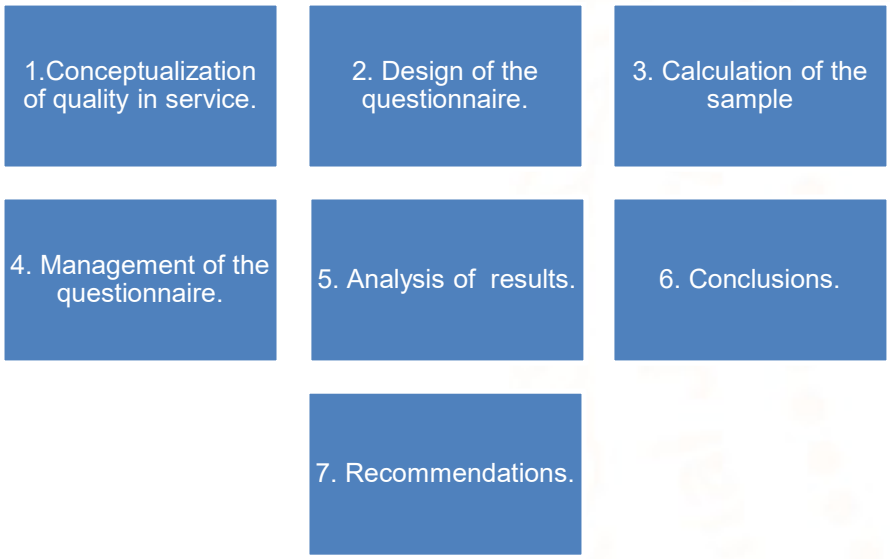
Talking about quality in services is more complicated than it seems, because it involves several aspects and dimensions such as culture and values that dominate the population and are attributed to these activities, in addition, the provision of a service must be adequate the context and preferences of the provider and focus on meeting the needs of those who use it, but in an optimal way.

In order to provide quality services, it is necessary to develop the people (Human talent) who are providing the service, however, it is extremely important to find a way to evaluate the perception of quality in the service that users of the same have. In this way we can train and develop human talent to provide a quality service and have satisfied customers, which will determine the increase of them.

It is necessary then to know what the expectations of our users are and compare them with their perceptions of the service received to determine the level of quality in the service and obtain an indicator of improvement, i.e., determine the specific dissatisfaction gaps to design strategies of improvement and to be able to offer the users a truly quality service. It is for all of the above, that it becomes necessary to have an analysis that allows us to determine our areas of opportunity and to be able to improve them to achieve an optimal development of human talent, which in turn will derive in the economic development of the organization, which will impact on the development of the country.

Method Description

The study was carried out in 7 stages as shown in Figure 1.



Graph 1. Methodological steps

1. Conceptualization of quality in the service. A bibliographic review of the topic was carried out.

2. Design of the questionnaire. A booklet was elaborated in which general data of the respondents were drawn up and the 22 questions that form the Servqual tool were integrated. Table 1 shows how the dimensions are distributed with the queries of the Servqual model.

Table 1. Example of distribution of questions and their dimension

Dimension	Questions
Tangible elements	1 a la 4
Reliability	5 a la 9
Answer's capacity	10 a la 13
Security	14 a la 17
Empathy	18 a la 22

3. Calculation of the sample. The sample of the client population of the organization was determined. The formula used was the one proposed by Dr. Bolaños (2012), which is used for finite or known populations. The formula is as follows:

$$n = \left[\frac{Z_{\alpha}^2 * N * p * q}{i^2 (N-1) + Z_{\alpha}^2 * p * q} \right]$$

Where:

n: sample size
N: population size
Z: value corresponding to the gauss distribution, for the investigation Z = 95%, which is equal to 1.96.

p: expected prevalence of the parameter to be evaluated, if not known (p = 0.5), which makes the sample size larger.
q: 1 - p (if p = 70%, q = 30%)
i: error expected to be committed if it is 5%, i = 0.05

The development of the formula is as follows:

$$n = \left[\frac{(1.96)^2 * 30 * 0.5 * 0.5}{(0.05)^2 (30-1) + (1.96)^2 * 0.5 * 0.5} \right] = \frac{28.81}{0.0725 + 0.9604} = \frac{28.81}{1.0329} = 27.89 \approx 28$$

The study indicated that of a population of 30 clients with which the organization counts, using a 95% reliability and a 5% error allowed, will require 28 clients for the investigation.

4. Management of the questionnaire. The questionnaire was applied from an intentional non-probabilistic sampling and the questionnaire was administered through Microsoft Excel®.

5. Analysis of results. We proceeded to perform a database in Excel with the information obtained and plotted the results.

6. Conclusions. After analyzing the data obtained from the representative sample, both general and specific conclusions were taken, in the conclusions section the above is stated.

7. Design of proposals for action. From the analysis of the results and conclusions obtained, lines of action are proposed to improve the quality of the service.

Analysis of results

The first analysis that was carried out was the general data of the organization's clients. Table 2 shows that the majority of clients are women between the ages of 30 and 40.

Table 2. Example of general data analysis

Age	Total	Gender	Total
20-30	7	Male	18
30-40	12	Female	20
>40	9		

Regarding the analysis of the results of the representative sample to evaluate service quality, a general customer satisfaction index of 0.825 was found, indicating acceptable satisfaction with areas for improvement. The highest dimensions were: reliability and responsiveness both with 85%; otherwise, the dimensions with lower scores were: empathy and tangible elements both with 80%. Figure 2 shows an example of the results obtained.

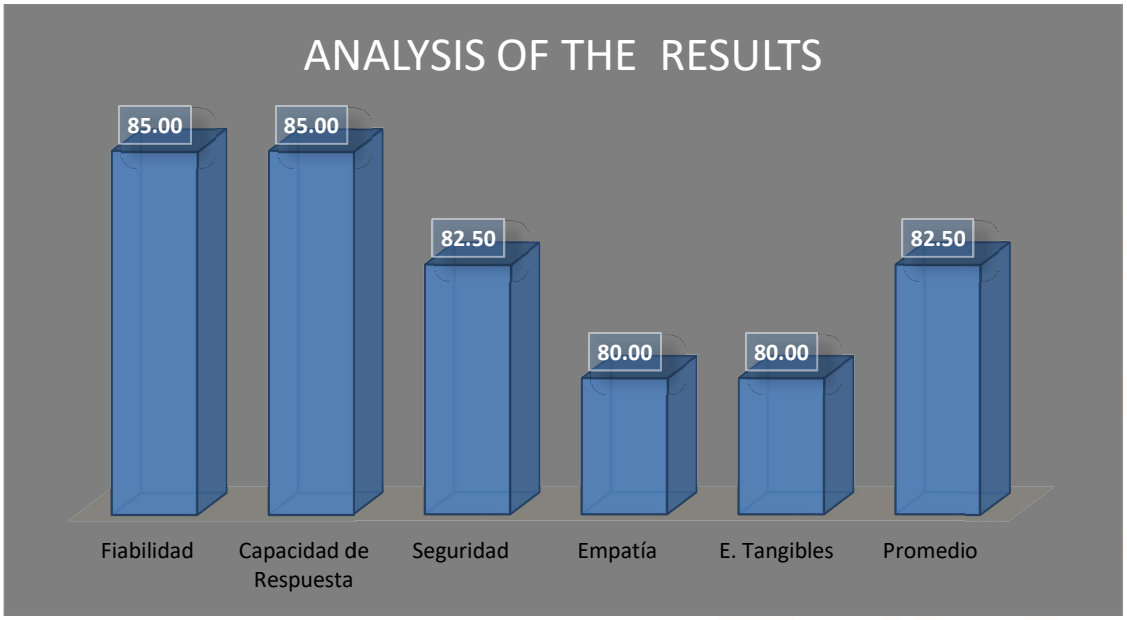


Figure 2. Example of the analysis of the results.

For the dimension of tangible elements, which is one of the lowest, the questions that had the lowest score with the representative sample of clients were question two and question four. Question two refers to whether the physical facilities of the company look visually appealing. While Question 4 has to do with whether the material elements of the business related to the service (brochures, statements, etc.) are visually appealing.

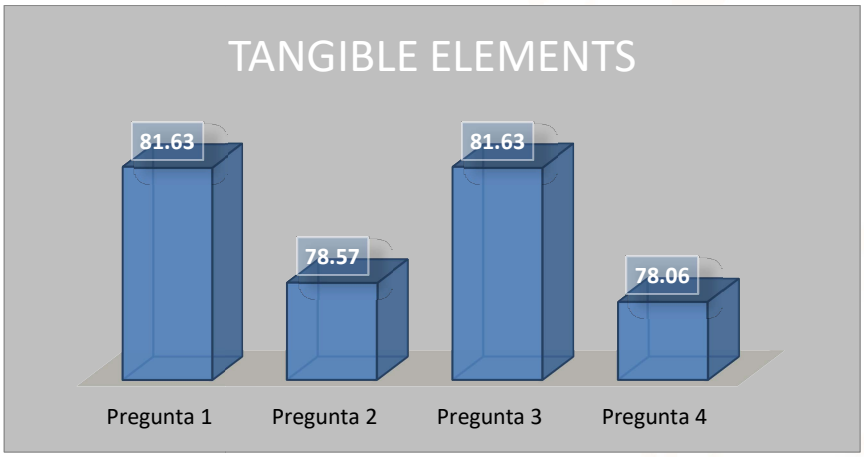


Figure 3. Example of the results obtained for the dimension of tangible elements.

For the dimension of empathy, which is the other dimension with the lowest score, the questions that had the lowest score with the representative sample of clients were question twenty and question twenty-two. Question twenty refers to whether the company has employees who offer personalized attention to their customers. While question twenty-two has to do with whether employees in the company understand the specific needs of their customers.

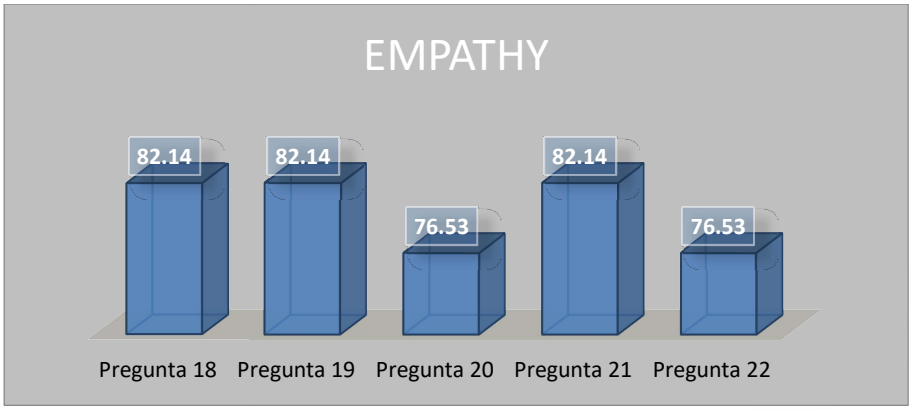


Figure 4. Example of the results obtained for the empathy dimension.

Conclusiones

Although companies expect greater investment in customer service, only 38% of organizations view this area as a company-wide priority, while the rest consider it only a post-sale function (Forbes Mexico, 2015).

The present research reached the general objective set. It was possible to evaluate the quality of customer service within the Industrial Corporate by applying the SERVQUAL tool.

It is deduced using a 95% reliability and 55 error in the investigation, that the quality of the service is of 82.50%. Also the understanding of the contextualization of service quality and the knowledge of the existing models to evaluate the quality of the service was achieved.

Recommendations

With the results obtained in the present investigation, the following is recommended:

- For the empathy dimension, it is advisable to train the organization's employees in customer service, as well as to train employees on topics such as motivation and communication strategies.
- For the dimension of tangible elements, it is recommended to create an audit plan where each week an evaluation of the tangible elements is recorded; in addition, it proposes the creation of visual controls of modern and fresh appearance. In the medium term, an evaluation is recommended using ergonomics to make future changes in the distribution of furniture within the company.

Acknowledgment

- Marrón Ramos Domingo Noé for his advice on the project.
- Pliego Martínez Odette Alejandra for her advice on the project.
- Ramírez Castillejo Rosa Isela for her advice on the project.
- Reyes Mérida César P.A. for his advice on the project.
- Ramírez Castillejo Griselda for her advice on the project.

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International Journal of Trend in Scientific Research and Development (IJTSRD)
2nd International Congress of Engineering
ISSN No: 2456 - 6470 | www.ijtsrd.com | Special Issue Publication

Diagnosis of the factors involved in apathy in students in industrial engineering

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ABSTRACT

The present research presents the results obtained from a study carried out at a university located in Mexico City, regarding apathy. A 95% reliability and 5% error were used in the study. For the analysis a questionnaire was adapted, this instrument was proposed by Lopez and Sánchez (2010). As a result, the objective of research was achieved, the first cause of apathy in young people is the content of the subject and the teacher who teaches his subject. In addition, it was reached to know that students have more apathy are those of algebra and probability and statistics. In addition, approximately 35% of the students surveyed indicated that they chose to study this course because they had not stayed in the university they wanted.

Keywords: *Apathy, causes, reliability.*

INTRODUCTION

The apathy school implies lack of interest in learning. The student is physically present in the classroom, but his / her mind is blank or focused on his / her own concerns, or aimed at disturbing the development of the class, of which he / she feels alien and uncomfortable (Fingermann, 2010).

Apathy is thus defined as the impassibility of the mood and neglect, indolence, lack of vigor or energy (Abbagnano, 2004). For example, the apathy of Mexican society and its lack of interest in political issues when it comes to demanding transparency in corruption cases, limits young people to organize to undertake demonstrations in Spain, France and Brussels (Ceballos, 2011). Levy, Cummings and Fairbanks (1998) indicate that it is a quantitative reduction of voluntary behaviors, which consists of an emotional and cognitive deficit that can arise and be reversed from internal (self-activation) or external (heteroactivation) stimuli. In addition, Marín (1996) and Cabrera, Peral, y Barajas (2012) argue that apathy is a behavioral syndrome or a dysfunction of the process that originates the actions induced by external stimuli or by their own; therefore, apathy occurs when the systems that generate and control the will are altered. Lurgal (1976) mentions that students' apathy or lack of interest in studies may be due to the absence of motivation, which may also be the negative effect of the proposed models and even a relation to the lack of an explicit link between the models social and school contents. Rivera (2007) mentions that apathy can be defined as a state of indifference or suppression. Panimboza (2015) mentions that apathy or school disinterest is the absence of passion to learn or acquire knowledge.

Sánchez (2013) mentions that the apathy of the upper-level student usually presents for various causes and in various areas, but generally where we find a greater rejection, apathy, disinterest is in the tasks that involve investigating. Teens often use discussion as a way of practicing new skills to explore the nuances of a topic and present a case from other points of view, which is why their attitude may be questioned, taking

it as something negative in the school setting instead of a possibility to generate interest and challenges in them that encourage their teaching-learning process. Another factor that has been perceived today is that students who enter college, many of them do not know the career they will study, are influenced by their peers to choose a career or their parents choose what their children will study in the university. college. A predominant factor in Mexico City, is that many students fail to enter the university that they want.

GENERAL OBJECTIVE

Diagnose the factors involved in the apathy of industrial engineering students.

Specific objectives

- Understand the contextualization of apathy in school.
- Know relevant facts about the causes and consequences of apathy in school.
- Calculate the representative sample using 95% confidence.
- Adapt the questionnaire proposed by Lopez and Sánchez (2010) in the representative sample.
- Analyze the results obtained from the questionnaires applied to the representative sample.
- Evaluate the results obtained from the analysis of the questionnaires.

JUSTIFICATION

In the investigation, apathy was taken as the object of study in the young people who have just entered the industrial engineering career, due to the fact that they have noticed a great lack of interest in learning, it has also been possible to see desertion rates, which is seen reflected in low academic performance from the first semester of admission to their study. The student is apathetic to any circumstance in the classroom, does not make the least effort to increase his grades, to study subjects assigned, to participate in activities. This research aims to reach the causes that originate this phenomenon, and with this to make known to university teachers the causes of the apathy of young first-come.

THEORETICAL FRAMEWORK

One of the main factors that shows the society and that is the cause of the apathy is the personal demotivation which causes a disinterest to participate in the joint activities. Flores, González and Rodríguez (2013) point out that anxiety in classes and especially in mathematics is everywhere, taking into account all the countries of the Organization for Economic Growth and Development (OECD), in half of children age 15 and over 60% of girls are concerned that they will find their math classes very difficult and will get low grades.

Pérez (S / A) points out that higher education in Mexico faces very important challenges: The inequality between supply and demand, lack of resources in a large part of the population to access private education, low educational level in the upper middle level, socioeconomic conditions, among many others, have determined a difficult panorama for the young people of our country.

According to Cabrera, Peral and Barajas (2012) indicate that the concept of apathy was more accepted in popular culture after the First World War, being described as one of several forms of war neurosis characterized by a feeling of emotional numbness and indifference to normal social interaction. Valentini (2008) points out that apathy in school settings is not a static phenomenon to be studied in a laboratory; has a dynamic destiny: it is born, develops, leads to disinterest, disinterest engenders boredom and it shows many faces: passivity, inertia, sadness and even anger and from there begins to approach the other pole of apathy: rebel aggression. Panimboza (2015) points out that school disinterest is a fact that comes 50 years ago. In spite of the technological advance, the neglect of learning is a social factor that has increased. Poor performance is one of the factors that is caused by the poor qualifications that adolescents have obtained.

The analysis of apathy by studies necessarily leads to absenteeism in general, absence may be due to factors due to socioeconomic problems (for example, lack of money for transport, clothes, shoes, etc.), so that they

take care of their other little brothers and sisters to help with household chores or illness (Heredia, 2000).

According to data from INEGI (2015), school attendance among young people aged 14 to 24 in 2000 was 33%, while for the year 2015 it was 44%. The difference by sex is slightly more than one percentage point with 45% of men and 44% of women. Tinto (2001) reports that 50% of all dropouts occur before the second year, and that 40% of all students fail to graduate. On the other hand, it has been detected that a student who arrives at the university with high expectations
personal demonstrates a lack of motivation because it was not what they expected.

The Economist (2014) indicated that the Ministry of Public Education (SEP) has the goal of reducing from 15 to 9 percent the dropout rate in high school by 2018. On the other hand, Anguiano (2015) points out that family violence, a personal or social decision, but, above all, poverty, are the reasons, among others, that led to one million 470 thousand 718 children and young people to abandon their studies; is a phenomenon that goes up, which means a strong economic impact that, according to figures from the Secretary of Public Education, represented a cost of 34 billion pesos for the country. Negrete and Leyva (2013) and Valdez and Aguilar (2014) suggest that this social phenomenon may be due to several factors, such as lack of job opportunities, limited educational access, lack of economic resources, personal dissatisfaction, insecurity and loss of the adolescents' sense of life.

In the university environment, it is no exception. According to Gracia (2015) studies conducted by the OECD, the countries that make up the Organization for Cooperation and Development), our country along with Turkey are the countries that have the most university dropout. Montes de Oca (2015) points out in its article, according to INEGI data in the same year, through the Ministry of Public Education (SEP), about 45 thousand students enter the university annually; only 7 thousand 200 finish the race and 5 thousand 600 are titled.

Mendoza (S / A) points out that in Mexico only 16% of young people and adults have a bachelor's degree or degree, the lowest percentage among the 34 countries that make up the Organization for Economic Cooperation and Development (OECD). The situation is so serious that only 21% of Mexicans aged 25-34 have a university degree, a number that falls to 12% when it comes to the population between 55 and 64 years.

Miranda and Balcazar (2010) point out that the lack of illusions and ambitions affects the young person in all spheres of life, including the work aspect, where he considers that he has few opportunities for growth, success and professional development. It lacks clarity and recognition of its own worth. Universia Mexico (2015) mentions that apathy, disinterest, conformity, little solidarity and little commitment to society, that is the radiography of young university students and this is a reality that institutions of higher education have also paid for not counting with appropriate instances to boost values among youth. De la Cruz, Sánchez, y Urrutia (2008) mentions that an engineering has the objective of developing a logical thinking in the students to solve problems with ingenuity. They are said to be harsh engineering because of high failure rates in mathematics-related subjects.

METHODOLOGY

Instrument

The instrument of data collection that was used was the one proposed by Lopez and Sánchez (2010). Once this instrument was analyzed, a new one was adapted, which consisted of only 9 questions.

Population and sample

The research was carried out in a university located in the Iztapalapa delegation. We studied 3 groups of the first semester of the Industrial Engineering career, the population was a total of 65 students. The sample of the student population was determined. The formula used was the one proposed by Dr. Bolaños (2012), this formula is used for finite or known populations. The formula is as follows:

$$n = \left[\frac{Z_{\alpha}^{2} * N * p * q}{i^{2}(N-1) + Z_{\alpha}^{2} * p * q} \right]$$

Where:
n: sample size
N: population size
Z: value corresponding to the gauss distribution, for the investigation Z = 95%, which is equal to 1.96.
p: expected prevalence of the parameter to be evaluated, if not known (p = 0.5), which makes the sample size larger.
q: 1 - p (if p = 70%, q = 30%)
i: error expected to be committed if it is 5%, i = 0.05.
The development of the formula is as follows:

$$n = \left[\frac{(1.96)^2 * 65 * 0.5 * 0.5}{(0.05)^2 (65-1) + (1.96)^2 * 0.5 * 0.5} \right] = \frac{62.42}{0.16 + 0.9604} = \frac{62.42}{1.1204} = 55.71 \approx 56$$

The study indicated that of a population of 65 students, using 95% confidence and 5% of error allowed, the study will require 56 students.

ANALYSIS OF RESULTS

As a first observation, Table 1 is shown, this table represents the number of students evaluated by age and their gender. The results show that the age that proliferated between the representative sample was 15 and 20 years. Because it is the first semester, this age is the average age at which a student enters college. Also, the gender that excelled more was the feminine gender.

Table 1. Example of number of students evaluated by age and gender.

AGE				GENDER	
15 - 20	21-25	26-30	More than 30	M	F
29	19	5	3	32	24

For the first question of the adapted questionnaire, Figure 1 represents an example of the results obtained.

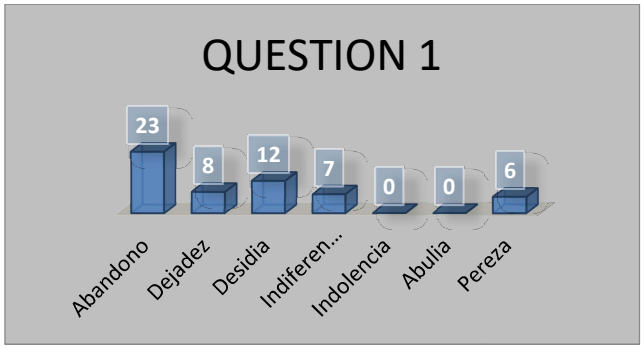

Figure 1. Example of the results for question 1.

The previous figure shows that the majority of first semester students associate apathy with abandonment. This result may be that if a student is apathetic in his studies, he is likely to drop them.

For the second questionnaire of the adapted questionnaire, Figure 2 represents an example of the weights obtained.

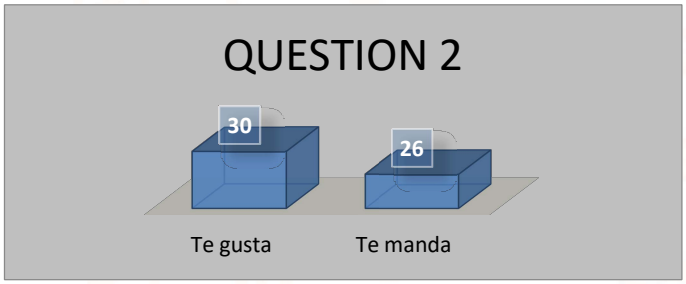

Figure 2. Example of the results for question 2.

The above figure shows that a little more than the average first-semester students like to attend school. But, alarming, is that a little less the average students, attend school because they send them.

For the third question of the adapted questionnaire, Figure 3 represents an example of the results obtained.

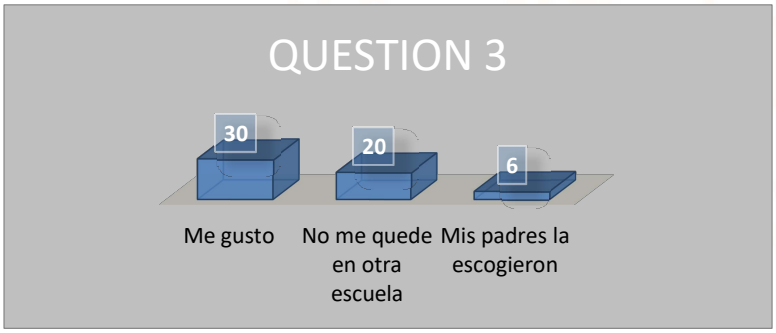

Figure 3. Example of the results for question 3.

The above figure indicates that most of the representative sample of students chose their career because they liked it. On the other hand, slightly less than the average student chose his career because he did not stay in another school. And a few students responded that they chose their career because their parents chose the race.

For the fourth question of the adapted questionnaire, the figure represents an example of the weights obtained.

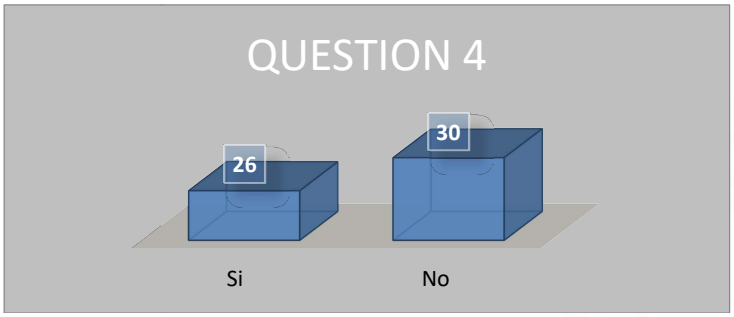

Figure 4. Example of the results for question 4.

The above figure indicates that the majority of the representative sample of students do not like their career, which is worrying. Likewise, slightly less than the average number of students surveyed do like their careers.

For the fifth question of the adapted questionnaire, the figure represents an example of the results obtained.

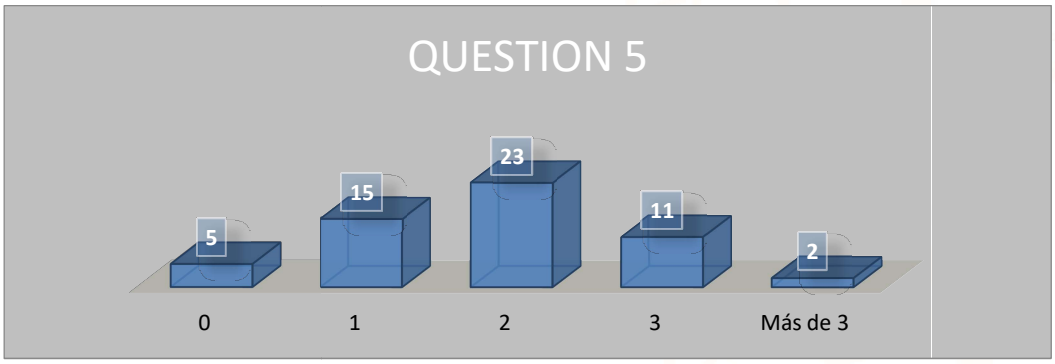

Figure 5. Example of the results for question 5.

The above figure shows that the majority of students surveyed in two subjects feel apathetic. Likewise, a less than average percentage of the representative sample feels apathetic in a subject. In addition, there are students who feel apathetic with three subjects and, to make matters worse, there are students who feel apathetic with more than three subjects. these results are worrying, since, of the representative sample, only five students do not feel apathetic.

For the sixth question of the adapted questionnaire, the figure represents an example of the weights obtained.

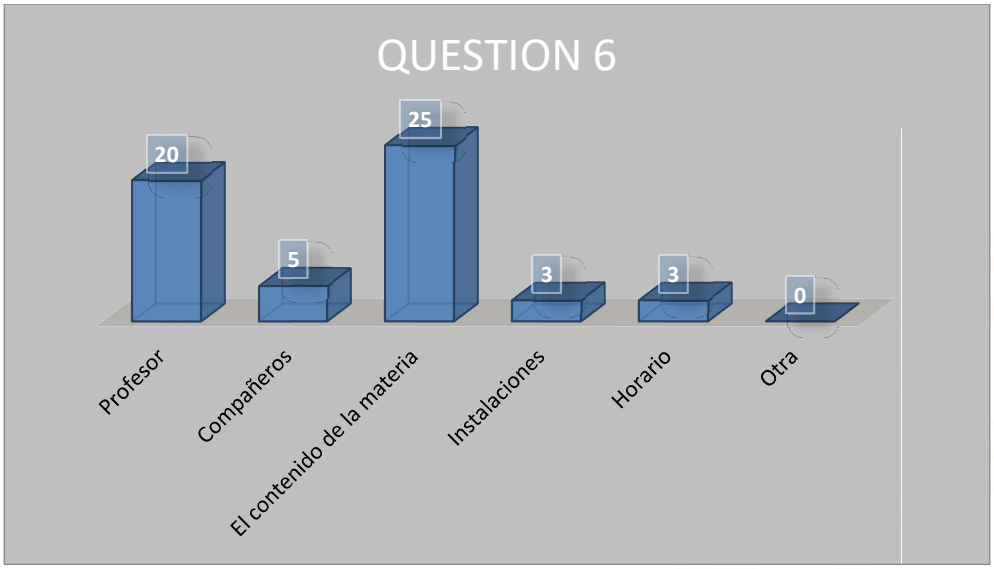

Figure 6. Example of the results for question 6.

The previous figure shows that the majority of students surveyed give as the first factor of their apathy to the content of the subject. Another factor that students attribute to their apathy is the teacher who teaches the subject. In addition, peers are another factor that the students surveyed attribute to their apathy. Less influential factors in apathy, according to the representative sample of students are school schedules and facilities.

For the seventh question of the adapted questionnaire, the figure represents an example of the results obtained.

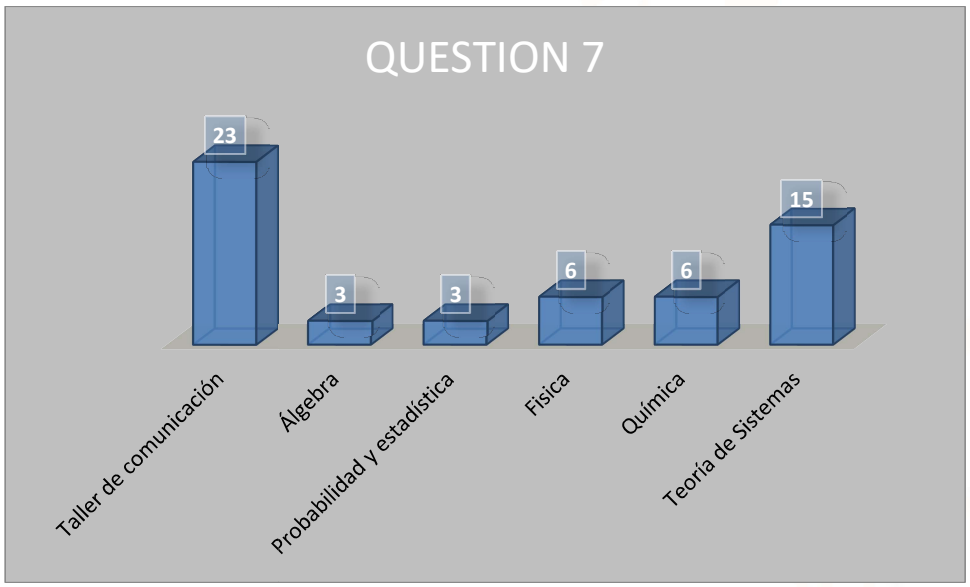

Figure 7. Example of the results for question 7.

The previous figure indicates that, according to the representative sample of students surveyed, the subject of communication workshop is the one they like most. Also, the subject of systems theory is the second most liked by students.

For the eighth question of the adapted questionnaire, the figure represents an example of the weights obtained.

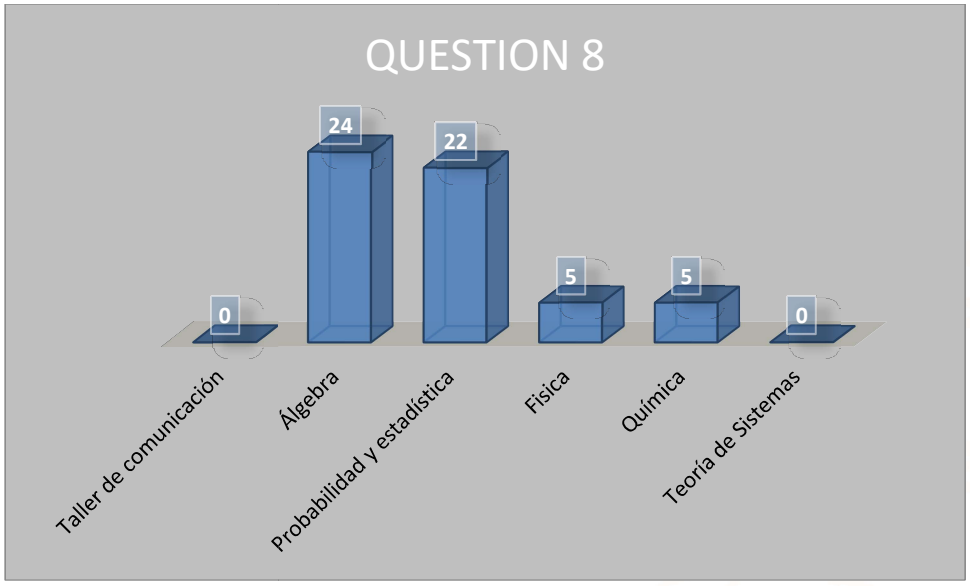

Figure 8. Example of the results for question 8.

The previous figure shows that, according to the representative sample of students surveyed, the subject of algebra is the least liked by them. Likewise, the subject of probability and statistics is the second least liked by students.

For the ninth question of the adapted questionnaire, the figure represents an example of the results obtained.

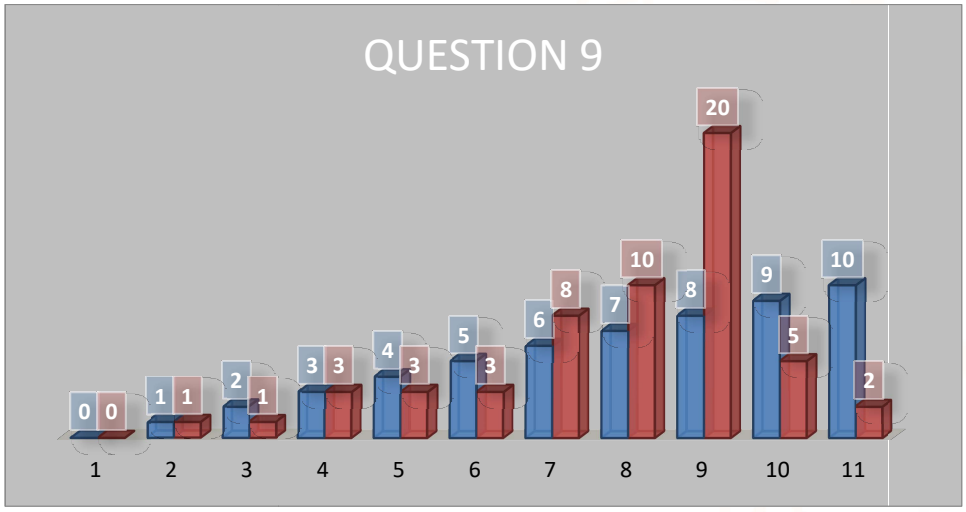

Figure 9. Example of the results for question 9.

The previous figure shows that, according to the representative sample of students surveyed, the vast majority of them feel on an apathy scale of 8. In addition, there are students who are on the apathy scale of 6 and 7. It is worrying to note that the scale of 1 to 10 in apathy, of the 56 students surveyed, only 8 students were found to be below the 5 scale.

CONCLUSIONS

The objective of the research was achieved; this objective was the diagnosis of the factors that intervene in the apathy of the students of industrial engineering of the first semester. Also in the study was learned that the first cause of apathy in young people is the content of the subject and the teacher who teaches his subject. In addition, in the investigation it was obtained to know that the students have more apathy in the subjects of algebra and probability and statistic. This is an alarming situation, since these two subjects are pillars for future subjects within the curriculum and, above all, are matters that

an industrial engineer must know and master. In addition, approximately 35% of the students surveyed indicated that they chose to study this course because they had not stayed in the university they wanted.

For future research, it is suggested that a study of the contents of all the subjects of new entry be carried out, in order to revise its content, to update said content to be comprehensible, measurable and competitive. Likewise, it is suggested to review the profile of the teachers who teach the subjects of new admission and to propose to the best ones of their area so that these teachers love the students and can understand and know the industrial engineering.

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