Article **Journal-Health Education and Welfare**
December 2021, Vol.5 No.9 23-34

Study of graduates of the engineering career in industrial maintenance of the Universidad Tecnológica del Norte de Aguascalientes

Estudio de egresados de la carrera de ingeniería en mantenimiento industrial de la Universidad Tecnológica del Norte de Aguascalientes

VAZQUEZ-GUTIERREZ, Rosa Inés†* & MÉNDEZ-MACÍAS, Gerardo

Universidad Tecnologica del Norte de Aguascalientes. Mexico

ID 1st Author: *Rosa Inés, Vazquez-Gutierrez* / **ORC ID:** 0000-0001-8774-7737, **Researcher ID Thomson:** X-2867-2018

ID 1st Co-author: *Gerardo, Méndez-Macías* / **ORC ID:** 0000-0001-9141-656X

DOI: 10.35429/JHEW.2021.9.5.23.34 Received July 25, 2021; Accepted December 30, 2021

Abstract

The present study of Graduates of the Industrial Maintenance Engineering career of the Universidad Tecnológica del Norte de Aguascalientes seeks to show a panorama of the situation of the graduates of this University. A study of graduates allows us to obtain the necessary information on the impact that the education that graduates acquired while they were students has had, likewise allows us to know specific problems in the market and find areas for improvement in the educational system of our university. The analysis of a graduate study will allow to have a strategic vision in the short, medium, and long term for the competent authorities of our institution, as well as to show current and future students the validity of their career through the opinion of our graduates.

Education, graduates, UTNA, Quality, Maintenance engineering

Resumen

El presente estudio de Egresados de la carrera de Ingeniería en Mantenimiento Industrial de la Universidad Tecnológica del Norte de Aguascalientes busca mostrar un panorama de la situación de los egresados de esta Universidad. Un estudio de egresados permite obtener la información necesaria del impacto que ha tenido la educación que los egresados adquirieron mientras fueron estudiantes, así mismo nos permite conocer problemas específicos en el mercado y encontrar áreas de mejora en el sistema educativo de nuestra Universidad. El análisis de un estudio de egresado permitirá tener una visión estratégica a corto, mediano y largo plazo para las autoridades competentes de nuestra institución, así como permite mostrar a los estudiantes actuales y a los futuros la validez de su carrera por medio de la opinión de nuestros egresados

Educación, Egresados, UTNA, Calidad, Ingeniería en mantenimiento

Citation: VAZQUEZ-GUTIERREZ, Rosa Inés & MÉNDEZ-MACÍAS, Gerardo. Study of graduates of the engineering career in industrial maintenance of the Universidad Tecnológica del Norte de Aguascalientes. Journal-Health Education and Welfare. 2021. 5-6:23-34.

* Author Correspondence (Email: rosa.vazquez@utna.edu.mx)
† Researcher contributing as first author.

Introduction

This report presents a study of Graduates of the Industrial Maintenance Engineering Career of the Universidad Tecnológica del Norte de Aguascalientes.

A survey was conducted to determine the most important parameters to measure on the information of the graduates.

The areas that were considered during this study were:

- General data.
- Employment situation.
- Aspects of the Industrial Maintenance Engineering career.

The results of the survey applied to a sample of 36 students from the generations 2015 to 2019 are shown below.

This project benefits the Universidad Tecnologica del Norte de Aguascalientes since it allows it to know the most important information about its graduates.

Methodology

According to Hernández Sampieri (2010), the study that was applied was a "Quantitative Exploratory" study where a survey-type data recovery tool was used where a series of questions about the IME career were specified and the survey was applied to a large number of our alumni in order to gather data or to detect public opinion on a given matter.

The objective is to evaluate labor-related information regarding the conditions and needs of the program graduates, through applied surveys.

The aim is to interview graduate students using the information obtained in the surveys and interviews carried out by the aforementioned teachers to the students of public and private companies.

The survey is divided into 3 sections:

I) General data

II) Employment situation

III) Aspects of the Industrial Maintenance Engineering career.

It consists of a total of 34 questions.

Sampling

The type of sampling that was carried out was stratified.

The advantage of this type of sampling is that it tends to ensure that the sample adequately represents the population based on selected variables. It also allows more precise estimates to be obtained and its objective is to obtain a sample as similar as possible to the population in terms of the stratified variable (s). The result was a sample of 36 students from the generations 2015 to 2019. The survey was applied from April to June 2020.

Background

The Universidad Tecnológica del Norte de Aguascalientes is part of the Subsystem of Technological Universities (UUTT). It was created in 2000 and is located in the Municipality of Rincón de Romos, in Aguascalientes, Mexico. It has two fundamental purposes:

a) Relocate the higher education services of the State of Aguascalientes, adapting them to the geographic distribution of the population.

b) Contribute to the diversification of the higher education offer in the entity.

Currently, apart from its programs at TSU, the university increased its educational offer by opening the Bachelor level in four of its programs:

- Accountancy
- Productive Systems
- Mechatronic
- Industrial maintenance
- Software Development and Management

ISSN 2524-2075

- Virtual Environments and Digital Businesses
- Sustainable and Protected Agriculture / Plans and objectives
- Human Capital Management
- Business and Marketing Innovation
- Metal Mechanics
- Business and Project Management
- Design and Management of Logistics Networks [1]

The objective of the career in Industrial Maintenance Engineering is to provide a quality education to train Industrial Maintenance Engineers with leadership skills, communication and collaborative work; with skills to design strategies to optimize maintenance activities through reliability tools and the integration of new technologies in the implementation of maintenance projects and / or technological and / or social entrepreneurship; committed to their professional and work development, with a high sense of social responsibility. The degree has a duration of 3.8 years [2].

According to Cabrero, E. "The new world economy is characterized by having an important component related to the knowledge economy. In other words, it is based on its dynamics in the creation of markets where ideas, processes and diverse knowledge are offered around the systems of production of goods and services ". Hence the importance of carrying out a study of graduates of the UTNA, as it is important to have knowledge of what the progress of the graduates of this university is. [3] The student was the one who received the education in the teaching institution, he is the main actor of the learning process. [4]

Education varies according to the conception of the world and of man, therefore it must be considered that education is proposed, fundamentally to transmit to the new generations a certain culture and specific knowledge and prepare them, in addition to the assimilation of new techniques, generally the result of technological changes[5].

For this reason, during this study a comparison was made on the real application of some subjects in the work life of graduates.

The industrial maintenance according to Navarro, L. has to ensure the operation at any cost. Faults and their solutions are being studied, leading to a great technical advance. [6]

According to López, M. the quality has 3 supports:

- Evaluation, in terms of prior, simultaneous and subsequent knowledge. Reliable action support in the right direction.
- Planning, as a resource that systematizes those aimed at improvement. Essential requirement of a job well done.
- Innovation as new values are incorporated or existing ones are improved, in the direction of the improvement learned[7].

Therefore, considering the last three quality supports, it is considered that this study of graduates is important for the UTNA because it will allow it to evaluate its graduates in order to plan and subsequently carry out an innovation in their teaching processes.

Background of the career in industrial maintenance engineering

Mission

Provide a quality education to train Industrial Maintenance Engineers with leadership, communication and collaborative work skills; with skills to design strategies to optimize maintenance activities through reliability tools and the integration of new technologies in the implementation of maintenance projects and / or technological and / or social entrepreneurship; committed to their professional and work development, with a high sense of social responsibility.

ISSN 2524-2075

Vision

To be an educational program in the area of Industrial Maintenance, recognized for its relevance and quality standards with a high level of acceptance of its graduates in the labor field; for being a pioneer in the implementation of new technologies; be strongly linked to the business sector and offer a comprehensive training proposal for its students under a sustainable approach and social responsibility, aligned to the needs of specialized human resources demanded by the social, productive and services sector, with the skills to generate solutions innovative solutions to the problems faced by organizations as a result of globalization and technological changes.

General Objectives of the Educational Program:

Prepare industrial maintenance engineers for the successful practice of conservation, comprehensive optimization of equipment and facilities through their ability to analyze, manage, control and evaluate the master maintenance plan, increasing reliability, availability and maintainability of equipment and the efficient use of economic, technological and human resources.

Educational Objectives:

EO1. The graduates evaluate the information of the technological factors by means of protocols and maintenance techniques to guarantee the availability of the equipment.

EO2. The graduates apply predictive maintenance techniques to increase availability and guarantee the correct operation of the company's equipment and facilities.

EO3. The graduates manage the efficient use of energy, technological and / or human resources, based on industrial and environmental safety standards, contributing to the optimization of processes.

EO4. The graduates analyze, design, manage and control the maintenance master plan by establishing maintenance policies and protocols.

Egress Attributes:

EA1. Identify, formulate and solve engineering problems in industrial maintenance applying the principles of basic science and engineering

EA2. Apply, analyze and synthesize production processes by designing maintenance strategies considering technical and economic factors and by managing quality systems.

EA3. Experiment, analyze and interpret data using engineering judgment for decision making.

EA4. Communicate effectively in a clear and detailed way, on concrete and abstract topics in their professional and sociocultural context.

EA5. Act with proactive values and attitudes of excellence in their personal, social and organizational development, in harmony with their environment.

EA6. Recognize the permanent need for updating and training to locate, evaluate, integrate and apply this knowledge in areas of maintenance engineering.

EA7. Directs and / or participates in work teams by defining their characteristics, coordinating efforts and evaluating their achievements, to contribute to the development of the organization.

Admission profile

1. Design maintenance strategies through the analysis of human, technological, economic and financial factors, for the preparation and administration of the maintenance master plan that guarantees the availability and reliability of the plant, contributing to the competitiveness of the company.

2. Optimize maintenance activities and equipment operating conditions through reliability techniques and tools to increase the overall efficiency of equipment and reduce maintenance costs to support the sustainability and competitiveness of the company.

ISSN 2524-2075

Graduate Profile

1. Manage maintenance activities by integrating the master plan, to ensure operation and contribute to the productivity of the organization.

2. Supervise the replacement or manufacture of parts of electromechanical systems in machinery, equipment and industrial distribution networks, using standards to maintain the systems in optimal conditions.

Professional Occupations

Plant manager

Maintenance manager

Maintenance leader

Maintenance manager

Supervisor or Maintenance Manager

Maintenance engineer

Performance Scenarios

- Dedicated public and private companies from the primary, secondary and tertiary sectors such as: Mining, Fishing and Agriculture.

- Metalworking, food, plastic, chemical, clothing, aeronautical, automotive, electrical appliance, pharmaceutical companies, among others.

- Service companies such as hotels, hospitals, etc.

- Your own Industrial Maintenance company.

Syllabus

First quarter	**Second quarter**	**Third quarter**
Linear algebra	Mathematical functions	Diferential calculus
Basic chemistry	Physical	Probability and statistics
Introduction to maintenance	Electricity and magnetism	Thermodynamics
Security and environment	Maintenance management	Electric systems
Technologies for digitalization	Quality in maintenance	Machines and mechanisms
Personnel administration	Industrial drawing	Electronic analogue
English i	Working methods and systems	Integrator i
Oral and written expression i	Costs and budgets	English iii
Sociocultural training i	English ii	Sociocultural training ii

Fourth quarter	**Fifth quarter**	**Sixth quarter**
Integral calculus	Electrical installations	Industry intership
Structure and properties of materials	Thermal machines	
Electric machines	Manufacturing process maintenance	
Industrial services networks	Automation and robotics	
Digital electronic	Materials engineering	
Programming principles	Integrator ii	
Pneumatic and hydraulic systems	English v	
English iv	Oral and written expression ii	
Sociocultural training iii	Sociocultural training iv	

ISSN 2524-2075

Seventh quarter	Eighth quarter	Ninth quarter
Math for engineering i	Math for engineering ii	Strategic management for maintenance
Physics for engineering	Tpm and rcm techniques	Mechanical predictive maintenance
Operation and maintenance protocols	Destructive tests	Automated systems and industrial networks
Tribology	Integrator i	English viii
English vi	Environmental management	High performance team management
Planning and organization of work	English vii	Ninth semester
Time management	Eighth quarter	Strategic management for maintenance

Tenth quarter	Eleventh Quarter
Non destructive essays	Industry intership
Visualization and control of processes	
Integrator ii	
Technology and service projects	
English ix	
Business negotiation	

Figure 1 Syllabus

Results

The results of the survey that was applied to our graduates are shown below in order to determine the characteristics of their jobs and with this to determine actions to improve the design of the study plan and the areas of opportunity that exist in the subjects that have been taught to them, likewise you can see a more complete picture of what the real situation of our graduates is like when they go out to work.

I) General data

The follow-up of graduates allows the university to obtain concise and accurate information about the job placement process, both about their job performance and their professional career.

In this section, age, sex, marital status, name and email were considered as questions, only that due to confidentiality of the data the name and email will not be published.

a. Age

The age of the surveyed students ranges between 22 and 25 years.

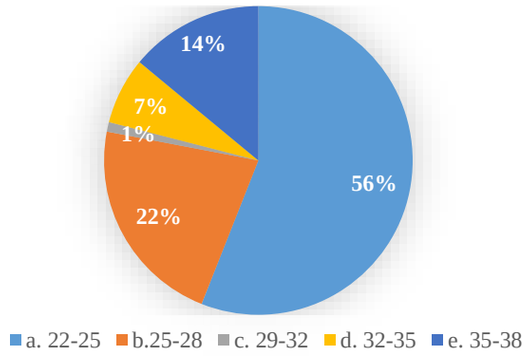

Figure 2 Age of the surveyed graduates

b. Sex

The composition by gender of the degree in Industrial Maintenance Engineering surveyed corresponds to 22% female and 78% male.

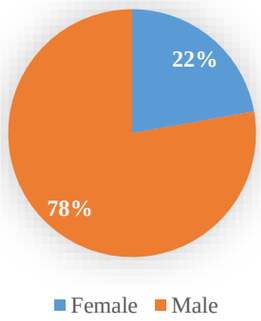

Figure 3 Sex of the graduates surveyed

c. Marital status

Regarding the marital status of the graduates surveyed, the single category stands out with 61%; while 28% are married and 8% are in common law union.

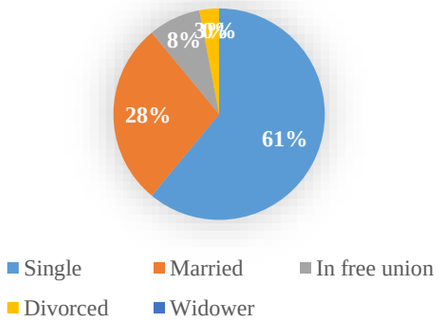

Figure 4 Marital Status of the graduates

II) Employment situation

The most important items on the current situation of our graduates are shown below. In this area, they were asked if they worked, monthly income, number of hours worked per week, duration of work, as well as their current job position.

a. Current job

During the survey, the students reported that 94% were working.

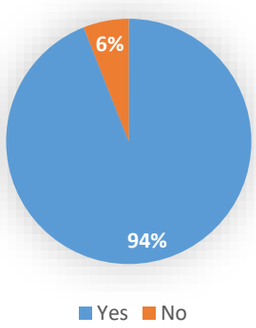

Figure 5 Employment situation

b. Monthly income

The item that stands out in the monthly income is $ 10,001 to $ 15,000 with a percentage of 36 %, while there is also a percentage of 14% that mentions earning more than $ 20,000. Likewise, there is a 22% earning from $ 15,001 to $ 20,000.

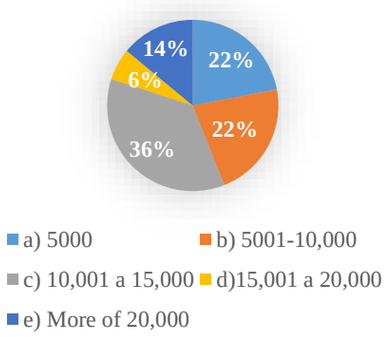

Figure 6 Monthly income

c. Number of hours worked per week

The average number of hours worked per week is 50 hours, followed by 30.6%, 45 hours per week.

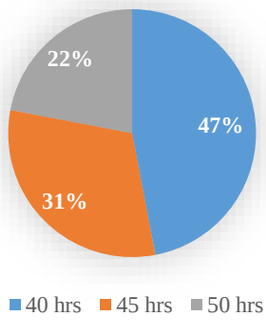

Figure 7 Number of hours worked

d. Working time

The length of work that graduates have varies is highly variable, stands out with 22% from 6 months to 1 year. However, there is a percentage of 19% who have worked in the same place for more than 5 years.

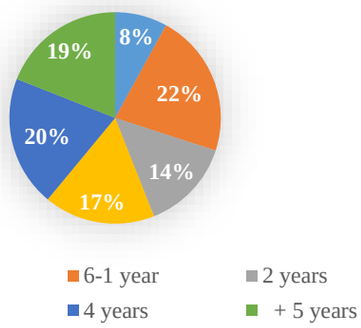

Figure 8 Working time

e. Main activity done at work

The area in which most of our graduates work is as Maintenance Technician, this is 50%, while 28% are working as Maintenance Administrators, and 19% are working as Maintenance Supervisor and only one 3% have achieved a management.

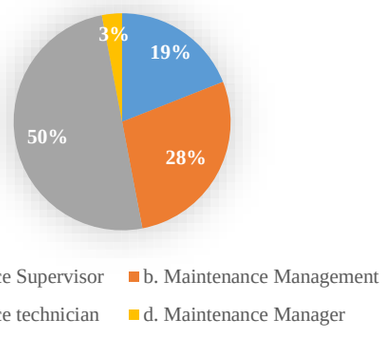

Figure 9 Main activity done at work

ISSN 2524-2075

f. Primary means through which you found current employment

The graduates found work in 47% by sending CV, while in 31% the students found work after having made their stay in the company, likewise 22% found work by recommendation.

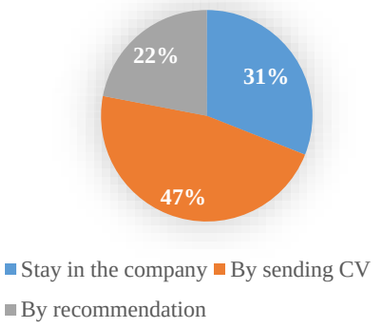

Figure 10 Primary means through which you found current employment

g. In addition to your job, do you have any other paid activity?

83% of graduates have an extra exit to their normal job.

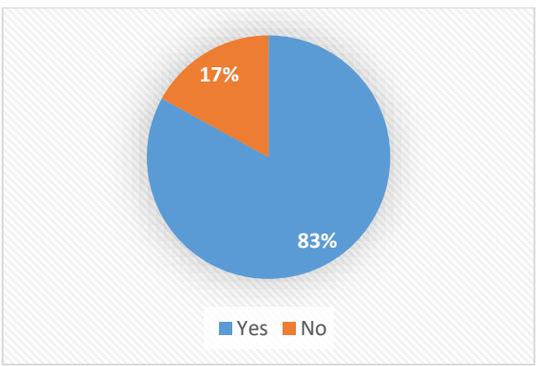

Figure 11 Extra paid activity

h. Coincidence of work with what you studied

86% of the graduates surveyed mentioned that their career coincides with their work, however 14 % stated that their work does not coincide with what they studied.

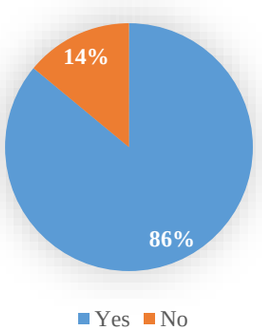

Figure 12 Coincidence of work with what you studied

i. Below is a comparative table of the level of satisfaction of the respondents with their work

Entry	Totally satisfied	Regular	Little
a) Put into practice the knowledge acquired in the bachelor's degree.	56.4%	28.2%	15.4%
b) The possibility of making your own ideas	76.9%	20.5%	2.6%
c) Professional recognition achieved	64.1%	28.2%	7.7%
d) Teamwork	76.9%	20.5%	2.6%
e) Possibility of coordinating a work team.	79.5%	17.9%	2.6%
f) Possibility of responding to work problems.	79.5%	17.9%	2.6%
g) The content of your work.	71.8%	23.1%	5.1%
f) Work environment	79.5%	15.4%	5.1%
g) Salary (income and benefits)	53.8%	38.5%	7.7%
h) Actual position	61.5%	35.9%	2.6%

Figure 13 Work satisfaction

III) Aspects of the Industrial Maintenance Engineering career

In this area, the most important aspects of the graduate's perception of their career are considered and likewise it seeks to detect areas of opportunity in order to be improved.

a. His career was his first choice

In the degree in Industrial Maintenance Engineering, 86% of the graduates surveyed from the UTNA was their first choice while 14% was not their first choice at our university.

ISSN 2524-2075

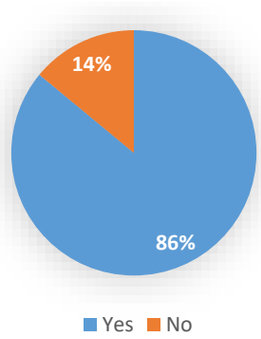

Figure 14 Career Option

b. Reason for choosing the UTNA

The highest percentage in which our students choose to study at the Universidad Tecnológica del Norte de Aguascalientes is for the career with 33%. It is followed by the location with 25% and with 14% each the cost of fees, family council and academic model.

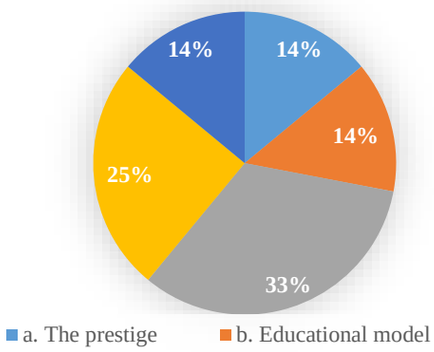

Figure 15 Reason for choosing the UTNA

c. His financial life improved after graduating from college

84% of our students affirm that their life improved after graduating from the degree, however 14% affirmed that it remained the same.

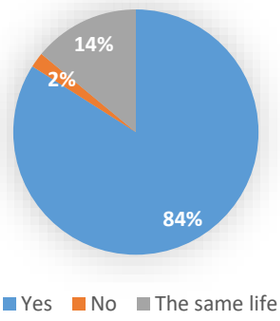

Figure 16 Improves after having studied at UTNA

d. When did you get a job after graduation?

48% of our graduated students affirm that they already had a job before graduating. 40% affirm that they found a job in less than 6 months after graduating, while 9% took more than a year to find a job and 3% took more than six months to find a job.

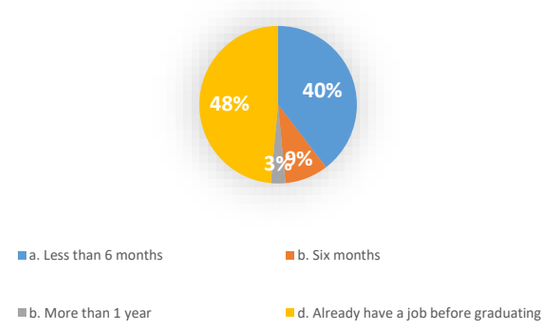

Figure 17 Time to get a job after graduation

e. Does the IME career enable you to identify, formulate and solve problems?

In 100% the students consider that the career allows them to identify, formulate and solve problems.

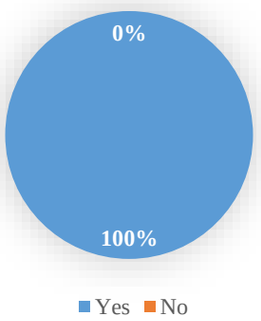

Figure 18 IMI career allows you to identify, formulate and solve problems

f. Do you consider that you have applied, analyzed and synthesized Industrial Maintenance Engineering strategies through human, technological, economic and financial factors?

81 % of the graduates consider that they have applied, analyzed and synthesized Industrial Maintenance Engineering strategies through human, technological, economic and financial factors.

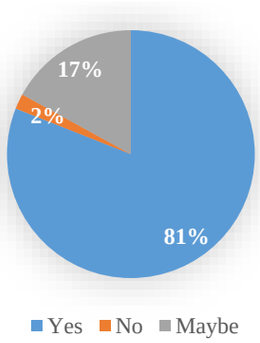

Figure 19 IME strategies

g. Do you consider that the UTNA gave you the necessary elements to communicate effectively in the development of your work?

61% of those surveyed consider that the UTNA gave them the necessary elements to communicate effectively in the development of their work, however 39% consider that perhaps it gave them the elements.

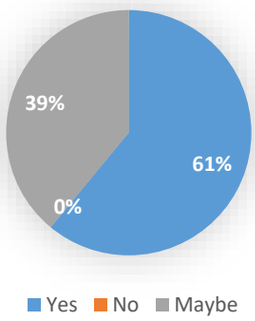

Figure 20 Communication Competence

h. Do you consider that the training that the UTNA gave you today helps you to act with values, proactive, personal, social and environmental attitudes?

78% of those surveyed consider that the training given by the UTNA currently helps them to act with values, proactive, personal, social and environmentally friendly attitudes, while 19% consider that perhaps.

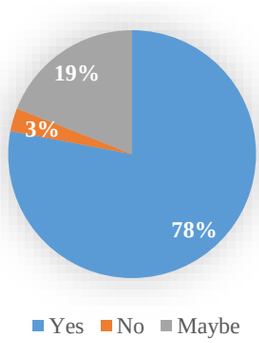

Figure 21 Values and attitudes

i. The graduates responded to what degree the following subjects contributed to the development of their work

Subject	Enough	Regular	Little
a. Chemistry	7.7%	43.6%	48.7%
b. Electricity and magnetism	64.1%	28.2%	7.7%
c. Quality in maintenance	79.5%	15.4%	5.1%
d. Machines and mechanisms	69.2%	28.2%	2.6%
e. Electronic analogue	61.5%	30.8%	7.7%
f. Structure and property of materials	51.3%	30.8%	17.9%
g. Máquinas eléctricas	69.2%	28.2%	2.6%
h. Industrial service networks	51.3%	38.5%	10.3%
i. Thermal machines	69.2%	28.2%	2.6%
j. Tribology	43.6%	46.2	10.2%
k. TPM and RCM techniques	71.8%	23.1%	5.1%
l. Predictive Maintenance	76.9%	17.9%	5.1%
m. Automated systems and industrial networks	59.0%	30.8%	10.2%
n. Strategic management for maintenance	66.7%	25.6%	7.7%
o. English	61.5%	25.6%	12.8%

Figure 22 List of subjects and their contribution to the development of your work

j. Graduates answered in what percentage they carry out the following competencies for their professional development acquired in the UTNA

Entry	Percentage
Design maintenance strategies	33.3%
Optimize maintenance activities	27.3%
Optimize equipment operating conditions	18.2%
Validate engineering studies and technical projects	21.2%

Figure 23 Competences for your professional development acquired at the UTNA

ISSN 2524-2075

k. When asking graduates which courses they recommend should be taught in the educational program, they mentioned:

- More about CNC programming and electricity
- Pretty Digital and Analog Electronics
- PLC programming
- Administrative maintenance
- Total productive maintenance TPM and Automation
- Electronics and hydraulics and pneumatics subjects
- More training in design programs such as solidworks, autocad, etc.
- Advanced Excel
- Maintenance administration
- English
- Leadership, personal and professional development and refrigerants.
- Current methodologies

Conclusions

Carrying out a Study of Graduates of our University allows us to have a broader panorama of the current needs of the market, the real possibilities of where our graduates are working as well as having identified the areas of opportunity to improve our study plan according to the needs real of our graduates.

According to the research carried out, the following points can be highlighted:

During the survey, the students reported that 94% were working.

The item that stands out in the monthly income is $ 10,001 to $ 15,000 with a percentage of 36%, while there is also a percentage of 14% that mentions earning more than $ 20,000. Likewise, you have a 22% gain from $ 15,001 to $ 20,000.

The area in which most of our graduates work is as Maintenance Technician, this is 50%, while 28% are working as Maintenance Administrators, and 19% are working as Maintenance Supervisor and only one 3% have achieved a management.

50% of our graduated students affirm that they already had a job before graduating. 40% affirm that they found a job in less than 6 months after graduating, while 9% took more than a year to find a job and 3% took more than six months to find a job.

Likewise, 81% of the graduates consider that they have applied, analyzed and synthesized Industrial Maintenance Engineering strategies through human, technological, economic and financial factors.

61% of those surveyed consider that the UTNA gave them the necessary elements to communicate effectively in the development of their work, however, 38.9% consider that perhaps it gave them the elements.

78% of those surveyed consider that the training given by the UTNA currently helps them to act with values, proactive, personal, social and environmentally friendly attitudes, while 19% consider that perhaps.

In general, a positive aspect can be seen in the development of our graduates on the Industrial Maintenance Engineering career, since most of them have work, a job that gives them to cover their expenses and they continue to develop, likewise most of our Graduates consider that the UTNA gave them the necessary elements to be able to function in the workplace.

Acknowledgment

The support of the authorities of this University is appreciated, especially to Mtra. Erika Magalí Lazcano Ugalde, Director of the Engineering area for her support during this investigation.

References

1. UTNA. (2021). Antecedente de la UTNA. 1 de Agosto de 2021, de UTNA Sitio web: https://www.utna.edu.mx/wp/antecedentes/

2. UTNA. (2021). Mantenimiento Industrial. 1 de Agosto de 2021, de UTNA Sitio web: https://sites.google.com/utna.edu.mx/planes-y-objetivosmi/p%C3%A1gina-principal

3. Cabrero, E. (2012). La difícil vinculación universidad-empresa en México. México: CIDE. Pág. 3, 5-8.

4. De la Torre, F. (2005). 12 Lecciones de pedagogía, educación y didáctica. México: Alfaomega. Pág. 7-10.

5. Castillo, S. (2005). Enseña a estudiar... aprende a aprender. España: Pearson. Pág. 8-12.

6. Navarro, L. (1997). Gestión Integral del Mantenimiento. España: Productica. Pág. 12-16.

7. López, M. (2004). A la calidad por la evaluación. España: Praxis. Pag. 34-37.

8. Guzmán, S. (2008). Estudio de Seguimiento de Egresados: recomendaciones para su desarrollo. México: Innovación Educativa.