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The works must be unpublished and refer to topics of Microeconomics, Macroeconomics, Econometrics, Quantitative studies, Socialist, Marxist, Historical, Institutional, Evolutionary; History of thought, Economic methodology, Current heterodox approaches and other topics related to Social Sciences.

Presentation of the content

In the first article we present, *Reliability Centered Maintenance Management in the laboratory area of a Higher Education Institution*, by FORNES-RIVERA, René, OCHOA-ESPINOZA, Luis, CANO-CARRASCO, Adolfo and GONZALES-VALENZUELA, Elizabeth, with adscription in the Instituto Tecnológico de Sonora, in the next article we present, *Sustainable University: Towards the energy transition through photovoltaic electricity generation and energy efficiency*, by VENEGAS-TRUJILLO, Tiberio, CONTRERAS-AGUILAR, Luis, VILLAGRAN-VILLEGAS, Luz and LAGUNA-CAMACHO, Juan, with adscription in the Universidad de Colima, in the next article we present, I*nnovation and technology to strengthen the learning of Calculus*, by SÁNCHEZ, Bertha, JIMÉNEZ, Guadalupe, MONTOYA, Javier and HERNÁNDEZ, Samuel, with adscription in the Instituto Tecnológico de Nuevo Laredo, in the last article we present, *Proposal of a tool to prevent dropouts at a higher level*, by GARCIA, Francisco, ARROYO, Jorge, VALDERRABANO, Jonny and IBARRA, Mayra, with adscription in the Universidad Tecnológica Metropolotina

Content

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Reliability Centered Maintenance Management in the laboratory area of a Higher Education Institution

Gestión de Mantenimiento Centrado en Confiabilidad en el área de laboratorios de una Institución de Educación Superior

FORNES-RIVERA, René†*, OCHOA-ESPINOZA, Luis, CANO-CARRASCO, Adolfo and GONZALES-VALENZUELA, Elizabeth

Instituto Tecnológico de Sonora, 5 De Febrero 818 Sur, Centro, 85000 Cd Obregón, Son., México.

ID 1st Author: *René, Fornes-Rivera*

ID 1st Coauthor: *Luis, Ochoa-Espinoza*

ID 2nd Coauthor: *Adolfo, Cano-Carrasco*

ID 3rd Coauthor: *Elizabeth, Gonzales-Valenzuela*

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Abstract

Maintaining that waits for failure to intervene to occur resulting in production losses, high costs and decreased life cycle of the asset. In the Head of Department of Laboratories and Audiovisual Resources institution of higher education, it requires teams with opportunity for improvement in terms of reliability, maintainability and availability are identified. The objective was: proposal for implementation of maintenance through the methodology of Reliability Centered Maintenance to manage equipment availability; which consists of seven steps: 1) define the system and determine the criticality of equipment, 2) identify and define their functions; 3) determine failures; 4) establish failure modes; 5) determine the effects of failures; 6) assess consequences; 7) and develop a plan for equipment maintenance. As a result seven critical to equipment failure analysis were obtained; technical specifications; recommendations for use; Application forms and work orders; schedule of activities, maintenance strategies and indicators for the area. It is concluded that the objective to make a proposal for implementation of maintenance measures that support generating increasing the availability previously compliance with reliability and maintainability fulfilled.

Maintenance, Asset management, Reliability, Availability, Maintainability

Resumen

El mantenimiento que espera a que se produzca la falla para intervenir se traduce en pérdidas de producción, costos elevados y disminución en ciclo de vida del activo. En la Jefatura del Departamento de Laboratorios y Recursos Audiovisuales de la institución de educación superior, se requiere que se identifiquen los equipos con oportunidad de mejora en aspectos de confiabilidad, mantenibilidad y disponibilidad. El objetivo fue: propuesta de implantación de mantenimiento a través de la metodología de Mantenimiento Centrado en Confiabilidad para gestionar la disponibilidad de los equipos; la cual consta de siete pasos: 1) definir el sistema y determinar la criticidad de equipos, 2) identificar y definir sus funciones; 3) determinar fallas; 4) establecer los modos de falla; 5) determinar los efectos de fallas; 6) valorar consecuencias; 7), y elaborar un plan de mantenimiento de equipos. Como resultados se obtuvieron siete equipos críticos al análisis de fallas; fichas técnicas; recomendaciones de uso; formatos de solicitud y Ordenes de Trabajo; cronograma de actividades, estrategias de mantenimiento e indicadores para el área. Se concluye que se cumplió el objetivo al realizar una propuesta de implantación de mantenimiento generando medidas que den soporte aumentando la disponibilidad cumpliendo previamente con la confiabilidad y mantenibilidad.

Mantenimiento, Gestión de activos, Confiabilidad, Disponibilidad, Mantenibilidad

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* Correspondence to Author (email: rene.fornes@itson.edu.mx)
† Researcher contributing as first author.

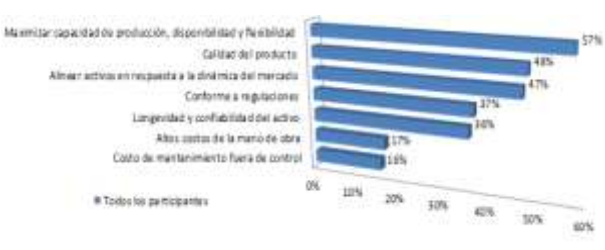
Introduction

According to Sánchez (2010), technological and scientific development, including transportation and communications, have determined changes that emphasize competitiveness and sustainability, causing business activity and its form of administration to be constantly evolving. Therefore, according to Pérez (2011), organizations seek efforts, actions and decisions aimed at guaranteeing systems and assets operating efficiently and effectively; satisfied customers and users; reduced risks; minimal environmental incidents and optimal costs.

For Arata and Furlanetto (2005), this panorama has led to the management of physical assets and maintenance assuming an increasingly important role within industrial activities, since the diversity and complexity of production systems require ensuring the reliability of their facilities and equipment to meet production plans without neglecting quality and the environment. For this reason, physical assets such as real estate, basic technological systems and specialized production and service systems, play a fundamental role (Sánchez, 2010).

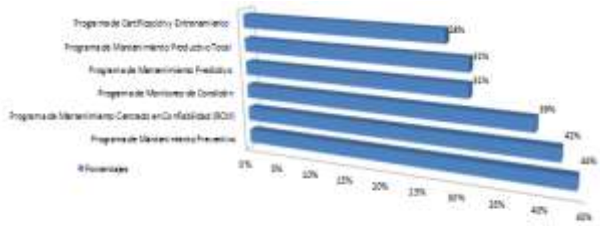
In accordance with previous ideas, Aberdeen Group (2006) refers to the fact that the volatility of the world economy and the austerity policies adopted by the various governments are the greatest threats to growth. In a study carried out by this service firm, 66% of Chief Executive Officers (CEOs) from various industries see that it is necessary to make changes through firm strategies.

With these conditions on the near horizon, asset management and maintenance are presented as important allies, since there are factors that must be addressed in the short term and in the years to come to ensure optimal performance in the manufacturing sector (see Figure 1).



Graphic 1 Factors targeting asset management

In addition to the study, it was requested to mention or identify the action strategies that lead to achieving its goals in terms of the efficient management of its assets. In Graph 2, you can see the responses with their respective percentage to which they were referred by the CEOs.



Graphic 2 Best asset management strategies

It is said that the RCM has been conceived as a process that provides benefits for the determination of maintenance requirements of all machines in their operating context, which allows determining each of the activities in order to ensure that the equipment fulfills its function.

For this reason, it is planned as a tool that allows determining the performance of the system in terms of the impact of a failure and the mitigation of the results through design, detection or effective maintenance (Barros, Valencia and Vargas, 2014). In recent years, maintenance has received brilliant contributions from the field of statistics and reliability theory.

According to Hung (2009), RCM is seen as a process used to determine the maintenance requirements of physical assets in their operational context, characterized by: a) considering the inherent or proper reliability of the equipment / installation; b) ensure the continuity of the performance of its function and c) maintain quality and productive capacity. This approach represents a radical change in the historical development of maintenance; because before this, the preventive and planned focused on the assets and the RCM focused on the locations and production processes (Gardella, 2010).

According to Quintero (2011), increasing asset productivity by 10 to 15 percent can often translate into profits and shareholder value of 30 to 40 percent.

In the same vein, Amendola (2012) mentions that the application of Asset Management supposes at least a 10% savings in production and maintenance costs, up to a 50% improvement in deviations from the maintenance plans of active or 15% reduction of errors in the finished product (Trujillo, 2013).

In such a scenario, Higher Education Institutions (HEIs) are called upon to fulfill an extremely important role to favor the development of the country and contribute to the well-being of people, through public and private HEIs (CACEI, 2014). Among the institutions accredited by organizations such as the Engineering Teaching Accreditation Council (CACEI) and reported in the National Association of Universities and Institutions of Higher Education (ANUIES), is the Technological Institute of Sonora (ITSON).

As part of the support process, and related to the Management of Infrastructure and Support Services (GISA), there is the Head of the Department of Laboratories and Audiovisual Resources (JDLRA). Among its functions is the support for teaching with laboratories equipped with instruments, materials, reagents and with classrooms equipped with audiovisual equipment, as well as support for research with the installation and maintenance of specialized equipment. The infrastructure that the department has is the following: Veterinary Laboratory; of chemistry; Biological and Food Sciences; of Civil Engineering; Chemical Engineering; of Electrical and Electronic Engineering; of Industrial Engineering; of food and beverages; and Graphic Design.

The JDLRA is made up of supervisors for specific areas such as Chemical and Biological Sciences, Maintenance, Engineering and Safety and Hygiene, who have people in their charge. Speaking specifically of the maintenance area, equipment with pneumatic, hydraulic, mechanical, electronic and optical characteristics is contemplated; supported by the knowledge and experience of the seven members that make it up. According to ITSON (2014) as part of its daily activities, the JDLRA attended 7,215 practices programmed by the various academies; of these 2,748 (38.08%) were for engineering and 4,467 (61.91%) for the areas of chemical, biological and veterinary sciences.

To ensure the operation of the laboratory equipment in the different areas, a total of 1,113 work requests were attended by the maintenance area personnel, of which 532 were corrective and 581 preventive. By 2015, in the area of Natural Resources there were 6,075 practices distributed in 405 groups. It is important to highlight that the TOs that were fulfilled to support both the teaching area and the research in the year by the maintenance area were 540 corrective and 355 preventive. Of this total of OT's, there were 244 corrective (45.18%) and 340 preventive (95.7%) for the Natural Resources area.

Through unstructured interviews with the responsible personnel and the Head of the Laboratory Department, gaps or opportunities are presented: a) comments by users on the insufficiency, condition and modernity of equipment; b) absence of performance indicators of the equipment in the maintenance area and corresponding laboratory areas; c) non-existence of classifications based on criticality, urgency and optimization of resources and equipment; and d) lack of documentation and follow-up on the causes that originate the malfunction of the reported equipment.

According to the JDLRA (2016) and as part of the analysis of information contained in the JD Edwards system on the failures of the equipment under study, it was determined as relevant data that during the period 2015 and until March 2016; 385 OT's were executed for the engineering areas, while in natural resources there were a total of 1,297 OT's.

An interesting fact is that there is an increase or difference of 337% of the OT's of the latter with respect to the engineering areas, so it can be said that during that period of time approximately 65% of the total of maintenance work to attend to situations related to natural resources, 20% to engineering and the remaining 15% to other needs or audiovisual equipment.

The JDLRA would hope to improve the use of resources assigned to the maintenance area, analyze the root cause of failures, generate measures to facilitate the care of assets, preserve the reliability of the equipment for as long as possible, take advantage of the information contained in the JD Edwards system database and increase area performance and asset life cycle time.

Therefore, the need arises for the critical points of the Maintenance Area to be identified and improvements in aspects of reliability, maintainability and availability at least of the equipment considered as critical due to its risk of failure. Based on the above, the following research question is generated: What type of methodological tool is relevant to the maintenance area to improve the reliability, availability and maintainability of the equipment in the Laboratories under study?

Therefore, the objective was defined, which consists of making a maintenance implementation proposal through the RCM methodology to manage the availability of laboratory equipment.

Methodology to be developed

The object under study was the equipment available in the Veterinary, Biotechnology and Chemical Engineering Laboratories of the Itson Campus Náinari. It was decided to work with the procedure proposed by Moubray (2004) that breaks down the development of an RCM into seven phases. The seven steps considered are defined below: 1) Define the system and criticality of the equipment; 2) Define the functions of the teams; 3) Determine the failure modes of the equipment; 4) Determine the effects of equipment failure; 5) Determine the causes of equipment failure; 6) Assess consequences of failures detected in the equipment; and 7) Prepare a maintenance plan for the equipment.

Results

In this section, the results obtained from each of the steps considered as part of the methodology were analyzed.

Definition of the system and criticality of the equipment

A complete list of equipment was generated (magnetic stirrer, autoclaves, incubator, muffle, thermobath, centrifuge, stoves, grills, water bath, compressor, muffles, cold rooms, mass, volume, density, specific gravity, etc. temperature, speed and flow rate Among the most important equipment are: autoclave, vacuum pump, boiler, still, spectrophotometer and pH meter.

In order to have a more representative sample, it was necessary to reduce the number of computers, and it was determined that those that should be kept available for as long as possible for user service were included. To this second list, another filter was applied taking as a reference an analysis by risk weighting, which considered different values for aspects of: a) failure frequency; b) operational impact; c) operational flexibility; d) maintenance cost; e) impact on safety, hygiene and environment. Remaining a definitive list which were: 1) autoclaves; 2) microscopes, 3) refrigerators; 4) scales; 5) incubators and 6) Ph meters (potentiometers) and 7) boiler; corresponding to the values that were found close to or greater than 100 in the risk weighting analysis.

Afterwards, a query was made in the JD Edwards system to know the amount of OT's generated for the equipment under study between January 2014 - March 2016 (see Table 1).

Equipment under study	Number of OT's executed per period		
	2014	2015	2016
Microscopes	238 preventive OT's 42 corrective OT's	222 preventive OT's 33 corrective OT's	No preventive 30 corrective OT's
Incubators	1 preventive OT 3 corrective OT's	1 preventive OT 2 corrective OT's	No preventive 2 corrective OT's
Autoclaves	30 preventive OT's 29 corrective OT's	30 preventive OT's 28 corrective OT's	No preventive 16 corrective OT's
Balances	1 preventive OT 20 corrective OT's	1 preventive OT 27 corrective OT's	No preventive 9 corrective OT's
Refrigerators	20 preventive OT's 17 corrective OT's	20 preventive OT's 11 corrective OT's	No preventive 2 corrective OT's
Potentiometer	No preventive 3 corrective OT's	No preventive 5 corrective OT's	No preventive No corrective
Boiler	No preventive 5 corrective OT's	No preventive 5 corrective OT's	No preventive 2 corrective OT's

Table 1 Amount of OT's teams under study
Source: JDLRA (2016)

Similarly, as part of a more detailed analysis and based on the OT's record of the JD Edwards system, the failures associated with the equipment under question were established (see Table 2), which are entered as a requirement at the time of that the order is requested by the laboratory worker (only one part)

Equipment	Failures associated with the equipment according to corrective OT's
Microscope	Missing pieces; damaged switch; does not turn on; out of focus; short in cable; it does not rise or fall correctly; does not focus; macro metric corrupted; loose knob; lamp blinks; The light goes out; it looks fuzzy.
Incubator	Engine does not start; overheats; it is not calibrated; trouble regulating temperature.

Table 2 Associated failures
Source: JDLRA (2016)

Defining the functions of the teams

Once the teams were established, each one was described considering its function within the process, description of its characteristics, among other relevant aspects.

Determination of equipment failure modes

Once the above was done, for the Failure Mode and Effect Analysis (FMEA) a generic format was defined where information regarding the number, name and components of each team began to be included in the corresponding columns. Afterwards, the potential or functional failure modes registered at the time of satisfying the purpose were defined for the established components according to their design / process, performance requirements and user expectations during their commissioning. As a result, a list of mode variables was obtained, a starting point to understand the behavior of the team and integrate the FMEA (see Annex 1).

Determination of the effects of equipment failures

By considering the failure modes attributable to each equipment, the effects were determined for each one.These were seen as the symptoms detected by the user when exposed to the failure mode and that affect the service provided by the JDLRA. This stage was tried to be carried out with the greatest possible care, since the information provided was used and subsequently evaluated, an aspect that represented a direct impact on the expected results (see Annex 1).

Determination of causes of equipment failure

When establishing the failure modes and their effects / consequences, it was necessary to include the causes that led to such situations. In a special column previously established in the FMEA format, the potential reasons, measures or actions that were ignored and that caused it to manifest itself as weakness at a certain time, translated as a potential failure - functional towards the user, were included. In general, the causes were attributed to design and process factors, the first inherent in the specifications of each piece of equipment and the second corresponding to the type of use given to it by the user. As a complement, in another column the current controls or actions carried out by the maintenance area were added in the event of such failures, in response to a later solution (see Annex 1).

Assessment of the consequences of failures detected in the equipment

Considering that not all the failures presented by the equipment have the same impact, we proceeded to include in table three of annex 1, columns considering Severity, Occurrence and Detectability.

Severity took the effect as a reference, while the Occurrence with which they could manifest themselves was taken for causes. Finally, the weighting of Detectability was based on the current capacity or controls available to address the failures that were presented and considered in the FMEA. The values of these three parameters, when multiplied by each other, generated a Risk Weighting Number (NPR). If its value was ≥ 100, it was indicated that this failure mode-maintained priority over the others, it was indicated with a red color, indicating the need to focus efforts to eradicate it or mitigate its impact on user service. If its value ranged from 80 to 99, it was set to yellow as it is considered intermediate priority. Finally, in values ≤ 79, the color green was assigned, representing that your attention can be delayed a little in order to work on those activities that require immediate actions. To obtain the necessary information when assembling the FMEA, the manufacturer's data, generic lists of failure modes, information found in the OT's of the JD Edwards system, people who operate and maintain the equipment were used.

Preparation of equipment maintenance plan

It was necessary for the information obtained from the equipment through the implementation of an FMEA to be used and translated into relevant actions or measures to mitigate the occurrence and effects of failures, in such a way that it would allow adequate planning, programming and execution of activities by the maintenance area.

In the document called maintenance plan, in its first version, technical formats (technical sheets, recommendations for use), as well as management formats (service request, work order, resume), protocols of maintenance (autonomous maintenance file, preventive activity schedule) and aspects to take into account for predictive maintenance. A schedule was used within the maintenance plan (See Figure 1), where the maintenance activities to be carried out on the equipment under study were grouped. In addition, a group of tasks, their procedures, indicators and other considerations applicable to the maintenance area were integrated.

Figure 1 Schedule for preventive maintenance

Annexes

You can see in Annex 1 the FMEA of the equipment called balance, which includes what is mentioned in the previous steps of the methodology developed.

Figure 2 FMEA of a balance

Conclusions

From the functional analysis and FMEA that was carried out on the equipment, it was determined that it is necessary to take advantage of the maintenance history contained in the JD Edwards system, as well as the experience of those responsible for maintenance and laboratory in order to offer a service quality to the user. It was concluded that documentation must be available containing adequate information to understand the events presented during the use of the equipment and the source of the cause of the failures must be identified to maintain the reliability projected by the equipment supplier.

It was possible to determine by means of a risk weighting analysis, that seven teams of all those considered are critical for the laboratories under study. Due to the approach used by RCM and FMEA, it was possible to include new types of failure and equipment for analysis in the maintenance plan.

The objective proposed as part of the maintenance management was fulfilled, strategies and measures could be established to increase the reliability, maintainability and availability of the equipment referred to as critical.

Among the recommendations, measures such as: a) consider the economic part because it has a direct impact on the Department's budget; b) involve staff in the maintenance process through training, relevant talks, knowledge transfer, and more efficient communication.

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Sustainable University: Towards the energy transition through photovoltaic electricity generation and energy efficiency

Universidad Sustentable: Hacia la transición energética mediante generación de energía eléctrica fotovoltaica y eficiencia energética

VENEGAS-TRUJILLO, Tiberio†*, CONTRERAS-AGUILAR, Luis, VILLAGRAN-VILLEGAS, Luz and LAGUNA-CAMACHO, Juan

Universidad de Colima, campus Coquimatlán, Facultad de Ingeniería Mecánica y Eléctrica, Km 9 carretera Colima-Coquimatlán, Coquimatlán, Colima, México, C.P. 28400

ID 1st Author: *Tiberio, Venegas-Trujillo*

ID 1st Coauthor: *Luis, Contreras-Aguilar*

ID 2nd Coauthor: *Luz, Villagran-Villegas*

ID 3rd Coauthor: *Juan, Laguna-Camacho*

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Abstract

The Higher Education Institutions have the challenge for becoming in sustainables universities. Nowadays, it has been implemented many policies and actions in order to innovate in strategic areas. The main goal is integrating social responsible and this means acting as a leader in the social context. The environmental and energy areas have become the keystone to impulse substantial changes. Concern to electricity, the University of Colima has increased its consume in 3% per year, this has impacted in the payments to the electric utility in 9%. Consume of energy has been divided in four groups of users. Air conditioners represent 50%, lighting 20%, electronic devices 20% and services 10%. This project focuses in replacing inefficient air conditioners and lighting systems, this will impact on reducing 13% of the total amount of energy consumed by the university. Besides, this project takes into account to generate electricity by using five Photovoltaic Interconnected Systems. These changes will reduce the consume 13% of the total amount of energy. The Photovoltaic Interconnected Systems will have a capacity of 2.3 MWp distributed in five campus of the university. These PV Interconnected Systems will produce 34.61% of the total electricity demanded by the university. This project will avoid emitting 3,968 Ton CO_2 to the atmosphere.

Energy Efficiency, Renewable Energy, Sustainable University

Resumen

Las Instituciones de Educación Superior tienen el reto de converstirse en universidades sustentable. Recientemente, se han implementado varias políticas y acciones con el fin de innovar en áreas estrategicas. El objetivo principal integrar la responsabilidad social y esto significa actuar como líder en el contexto social. Las áreas de energía y medio ambiente se han convertido en la base para impulsar cambios sustanciales. En materia energética, la Universidad de Colima ha incrementado su consumo en un 3% cada año, esto ha impactado significativamente en los pagos por facturación en 9%. El consumo de energía se ha clasificado en cuatro grupos de usuarios. Aire acondicionado representa 50%, iluminación 20%, dispositivos electrónicos 20% y equipos de servicios generales 10%. Este proyecto se enfoca en el reemplazo de sistemas ineficiencientes de aire acondicionado e iluminación. Esto impactará en una reducción del 13% del consumo total de la energía eléctrica consumida en la universidad. Además, este proyecto considera la generación de energía eléctrica mediante cinco sistemas fotovoltaicos interconectados. Los sistemas en conjunto tendrán una capacidad de 2.3 MWp y serán distribuidos en cinco campus de la universidad. Estos sistemas fotovoltaicos interconectados producirán 34.61% de la energía total demandada por la institución. Se evitarán la emisión de 3,968 Toneladas de CO2 a la atmosfera.

Eficiencia Energética, Energías Renovables, Universidad Sustentable

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* Correspondence to Author (email: tvenegas@ucol.mx)
† Researcher contributing as first author.

Introduction

The possibility of generating electrical energy for self-consumption and delivery of surpluses to the electricity supplier company in Mexico, has caused several companies to begin to consider investing in the development of energy projects to increase their competitiveness (PND, 2013). The main reason lies in the increase in the costs of fossil fuels necessary to satisfy consumers' demand for electricity. With increases in electricity costs for the HM rate of 18.49% during the period from January to September 2016, the operating conditions for the companies contracted in said rate represent an additional expense to satisfy the committed production (Federal Commission of Electricity, 2016).

In Mexico at the end of 2014, professors from Higher Education Institutions oriented to projects and academic activities on Renewable Energies and Energy Efficiency were summoned to participate in the Applied Leadership Program in Renewable Energies and Energy Efficiency (SENER, 2014), (Sectorial Energy Program, 2012) and (National Energy Strategy, 2013).

This program was taught by Harvard Professors, coordinated by the Center for Health and Environment of the Harvard University School of Public Health, as well as by the InTrust Global Investments organization, in alliance with the Ministry of Energy, the Autonomous Universities State and Federal Technological Institutes. With this program it was sought to implement a "democratizing" model of access to knowledge and effective development of renewable projects in Mexico, optimizing public and private resources, and giving effective access to Mexican Universities, so that they are allies and convenors of the application. true of the energy transition in Mexico.

The objective of the Program was to professionalize academics from various regions of the country, mainly in the development of renewable energy and energy efficiency projects and to promote specific projects in the field. Also, related to adaptations on climate change applications and mitigation of the same.

Upon completion of this program, a Certificate of Completion in Applied Leadership in Renewable Energy and Energy Efficiency was awarded and certified by the Center for Health and Environment at the Harvard School of Public Health (Certificate of Completion. Center). of Health and the Global Environment, School of Public Health, Harvard).

As a result of the participation of professors in this national training program on energy, professors from the universities of Colima and Veracruzana began a working collaboration on energy efficiency and renewable energies to demonstrate the social, energy and environmental impact that can provide Public Education Institutions in the development of society. The project corresponds to the University of Colima, in which an energy diagnosis and a feasibility study for the use of solar energy through Interconnected Photovoltaic Systems were prepared.

Current operational situation

The University of Colima is under an HM rate contract with the Federal Electricity Commission. In 2014, the university invoiced a total of $ 30'629,308.39 for this concept, which represented an increase of 9.09% compared to 2013. Regarding electricity consumption, this was 13'940,989 kWh and presented an increase of 2.86 % compared to 2013. The growth rate is positive to date and has remained so for the last 10 years. This article shows two main goals: the first is the generation of electrical energy in the five university campuses distributed throughout the state, contributing to 30.11% of current consumption. The second goal was to integrate technology to move towards energy efficiency in the air conditioning and lighting systems, the energy saving for this case is 13.01% of the total consumption.

As a whole, the Renewable Energy and Energy Efficiency generation project will reduce electricity consumption and will depend on the supplying company with 65.39% of current consumption, the rest will be generated with renewable energy.

The hourly HM rate in medium voltage is based on categorizing energy consumption in three schedules: base, intermediate and peak; the tip being the one with the highest cost per kWh.

In addition, the rate includes the measurement of the maximum demand in the three schedules and by means of a simple calculation a billable demand is obtained, which is used to determine the cost for this concept. Finally, the measurement includes the monitoring of reactive energy in kVArh, which makes it possible to identify the degree of use of the energy consumed by the company, also known as the power factor. If this value is within the 90-100% range, then the consumer receives a bonus, otherwise a penalty. The description of the HM rate allows us to point out two very important things that companies contracted under this rate can take advantage of by having generation from a renewable source.

Power generation will be installed on the five campuses of the University of Colima and will have the following capacities: 1) Manzanillo Campus: 400 kWp, 2) Tecomán Campus: 300 kWp, 3) Colima Campus: 800 kWp, 4) Coquimatlán Campus: 500 kWp and 5) Villa de Alvarez Campus: 300 kWp. Figures 1 - 5 present the location of each of the interconnected photovoltaic systems in Manzanillo, Tecóman, Colima, Coquimatlón and Villa de Alvarez, respectively.

The distribution of electricity generation in the five campuses is due to the fact that the University of Colima provides care throughout the state of Colima, in addition to the fact that the state is rich in solar potential with a daily average of 5.4 kWh / m2 / day (GIS et al, 2009). The replacement of air conditioning and lighting equipment operating inefficiently was determined after having made an energy and environmental diagnosis throughout the institution, concluding that more than 75 percent of the lighting equipment installed did not meet the energy efficiency conditions. in non-residential real estate and lighting levels in work centers NOM-007-ENER-2014 and NOM-025-STPS-2008, respectively. In the case of air conditioning equipment, they represented 50% of the institution's total energy consumption and were 12 years old on average. With this information, an energy, operational and economic impact study was carried out for the replacement of these inefficient equipment for this project.

Figure 1 Campus Manzanillo, 400 kWp

Figure 2 Tecóman Campus, 300 kWp

Figure 3 Campus Colima, 800 kWp

Figure 4 Campus Coquimatlón, 500 kWp

Figure 5 Villa de Alvarez Campus, 300 kWp

In order to simulate the effect of replacing inefficient equipment and take into account load changes, a program was developed capable of evaluating the impact of energy and demand on the HM tariff over time and determining billing costs.

The Federal Electricity Commission provided historical consumption profiles every 15 minutes for the last five years. The photovoltaic generation profiles were obtained by monitoring small-scale interconnected photovoltaic systems that the institution itself has and where their history is every 5 minutes and for more than 2 years.

Tables I to V show the impact on billing before and after carrying out the energy efficiency project and the use of solar energy through the installation of interconnected photovoltaic systems.

Photovoltaic + Energy Efficiency			Manzanillo
	Billing in MX pesos		
Month	Current	Proposed	Saved
January	168,116.67	63,406.64	104,710.03
February	222,255.18	112,209.25	110,045.93
March	221,862.17	114,804.31	107,057.86
April	152,668.42	36,766.32	115,902.10
May	248,906.23	134,825.21	114,081.02
June	250,352.26	136,080.53	114,271.72
July	180,597.26	64,508.08	116,089.18
August	259,421.00	143,081.94	116,339.06
September	226,838.29	113,655.23	113,183.05
October	124,991.97	16,759.82	108,232.15
November	203,523.88	98,484.12	105,039.76
December	152,856.40	48,480.35	104,376.05
Total	2,412,389.72	1,083,061.81	1,329,327.91

Table 1 Impact on the billing of the Mazanillo campus by the 400 kWp interconnected photovoltaic system

Photovoltaic + Energy Efficiency			Tecoman
	Billing in MX pesos		
Month	Current	Proposed	Saved
January	218,686.52	115,917.89	102,768.63
February	252,210.21	147,572.47	104,637.74
March	252,935.43	152,890.48	100,044.94
April	168,397.18	66,513.93	101,883.25
May	265,491.83	166,000.97	99,490.86
June	244,373.99	142,817.87	101,556.12
July	226,160.28	123,873.97	102,286.31
August	262,119.88	157,524.65	104,595.23
September	229,890.09	125,762.58	104,127.52
October	114,548.73	14,013.23	100,535.50
November	223,434.26	125,656.46	97,777.79
December	189,318.91	92,154.65	97,164.26
Total	2,647,567.30	1,430,699.15	1,216,868.15

Table 2 Impact on the billing of the Tecomán campus by the 300 kWp interconnected photovoltaic system

Photovoltaic + Energy Efficiency			Colima
	Billing in MX pesos		
Month	Current	Proposed	Saved
January	851,034.97	591,872.10	259,162.87
February	996,972.00	732,810.24	264,161.76
March	1,094,744.66	833,488.09	261,256.57
April	697,262.74	429,752.40	267,510.35
May	1,027,564.42	766,121.90	261,442.52
June	1,001,697.98	737,502.42	264,195.56
July	817,589.69	550,454.45	267,135.24
August	1,104,548.60	831,440.91	273,107.68
September	991,726.12	724,126.56	267,599.56
October	507,091.92	245,455.93	261,635.99
November	956,087.28	705,334.74	250,752.54
December	757,500.36	518,062.86	239,437.50
Total	10,803,820.75	7,666,422.62	3,137,398.13

Table 3 Impact on the turnover of the Colima campus by the 800 kWp interconnected photovoltaic system

Photovoltaic + Energy Efficiency			Coquimatlán
	Billing in MX pesos		
Month	Current	Proposed	Saved
January	229,341.56	95,586.65	133,754.91
February	274,778.57	137,595.61	137,182.96
March	295,093.52	162,438.26	132,655.25
April	186,535.08	51,271.31	135,263.78
May	281,325.45	151,595.77	129,729.69
June	279,411.78	149,328.30	130,083.47
July	224,590.59	90,234.47	134,356.11
August	320,786.10	185,165.91	135,620.19
September	294,725.02	161,282.57	133,442.45
October	144,052.90	16,146.04	127,906.86
November	271,711.83	143,519.77	128,192.06
December	227,564.27	99,098.78	128,465.49
Total	3,029,916.68	1,443,263.45	1,586,653.23

Table 4 Impact on the billing of the Coquimatlán campus by the 500 kWp interconnected photovoltaic system

Photovoltaic + Energy Efficiency			VdeA
	Billing in MX pesos		
Month	Current	Proposed	Saved
January	126,239.24	43,813.79	82,425.45
February	171,792.26	88,540.19	83,252.07
March	189,882.67	108,938.62	80,944.05
April	116,300.24	30,914.61	85,385.63
May	174,191.65	89,361.73	84,829.92
June	146,703.47	61,705.84	84,997.62
July	94,953.52	7,044.83	87,908.70
August	185,657.94	96,239.73	89,418.22
September	175,108.82	87,904.74	87,204.08
October	96,121.00	14,226.17	81,894.83
November	158,836.13	80,075.23	78,760.90
December	109,565.22	33,728.44	75,836.78
Total	1,745,352.17	742,493.92	1,002,858.26

Table 5 Impact on the billing of the Villa de Alvarez campus by the 400 kWp interconnected photovoltaic system

The evaluation of the simple internal rate of return considering the generation of electrical energy through photovoltaic systems from 300 to 800 kWp and the energy efficiency in the air conditioning and lighting systems are shown in tables VI to X. It is observed that the total amounts invested for the campus range between $ 9, 436,995 and $ 25, 165,320 Mexican pesos. While the internal rates of return are with ranges of 8.02 and 9.91 years. These values correspond to a useful life of photovoltaic systems of 30 years and a replacement of air conditioning and lighting equipment every 12 years. It is planned to replace these last systems at the end of their useful life and with the savings achieved during the 2.09 years of life, to replace these systems with equal or greater efficiency found in the market.

Campus Manzanillo	
Investment description	Amount ($)
Photovoltaic system 400 kWp	11,022,660.00
Samsung Inverter Air Conditioner	1,040,000.00
LED lighting and T5 Magg	520,000.00
Total	12,582,660.00
Annual savings	1,329,327.91
IRR (years)	9.47

Table 6 Economic balance of the 400 kWp interconnected photovoltaic system for the Manzanillo campus

Campus Tecoman	
Investment description	Amount ($)
Photovoltaic system 400 kWp	8,266,995.00
Samsung Inverter Air Conditioner	780,000.00
LED lighting and T5 Magg	390,000.00
Total	9,436,995.00
Annual savings	1,216,868.15
IRR (years)	7.76

Table 7 Economic balance of the 300 kWp interconnected photovoltaic system for the Tecomán campus

Campus Colima	
Investment description	Amount ($)
Photovoltaic system 400 kWp	22,045,320.00
Samsung Inverter Air Conditioner	2,080,000.00
LED lighting and T5 Magg	1,040,000.00
Total	25,165,320.00
Annual savings	3,137,398.13
IRR (years)	8.02

Table 8 Economic balance of the 800 kWp interconnected photovoltaic system for the Colima campus

Campus Coquimatlán	
Investment description	Amount ($)
Photovoltaic system 400 kWp	13,778,325.00
Samsung Inverter Air Conditioner	1,300,000.00
LED lighting and T5 Magg	650,000.00
Total	15,728,325.00
Annual savings	1,586,653.23
IRR (years)	9.91

Table 9 Economic balance of the 500 kWp interconnected photovoltaic system for the Coquimatlán campus

Campus Villa de Alvarez	
Investment description	Amount ($)
Photovoltaic system 400 kWp	8,266,995.00
Samsung Inverter Air Conditioner	780,000.00
LED lighting and T5 Magg	390,000.00
Total	9,436,995.00
Annual savings	1,002,858.26
IRR (years)	9.41

Table 10 Economic balance of the 300 kWp interconnected photovoltaic system for the Villa de Alvarez campus

Technical considerations

The total energy produced is estimated at 4'197,500 kWh per year. The photovoltaic systems will be made up of 250Wp modules - Solartec, while the inverters will be Fronius. The systems will be mounted on aluminum structures and will be interconnected to the medium voltage distribution systems by means of a step-up transformer with the required capacity of 13.8 kV. 80% of the air conditioning units will be replaced by more efficient units with inverter technology. The adopatos luminaires for this Project will be with T5 and LED technology.

By concept of energy efficiency, both have contemplated a saving of 1,814,404 kWh per year. In summary, the entire project will reduce electricity consumption by the utility company by 43.12%.

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The University of Colima will reduce energy consumption by using efficient equipment by 13.01% for the first time in its history and will produce 34.61% of all energy consumed taking advantage of solar energy. The cost of these components is $ 4'823,353 USD and the return on investment is 8.75 years.

The useful life is 30 years and the University of Colima will reduce the unit cost of electrical energy from $ 0.1464 to $ 0.1134 USD for each kWh consumed. This represents 22.54 less than the current one.

Table XI shows the comprehensive economic benefits of the project, while Table XII indicates the final contribution of electricity generation at the University of Coima.

Investment description	Amount ($)
Photovoltaic system 400 kWp	63,380,295.00
Samsung Inverter Air Conditioner	5,980,000.00
LED lighting and T5 Magg	2,990,000.00
Total	72,350,295.00
Annual savings	8,273,105.68
Investment description	8.75

Table 11 List of economic benefits of the project

Stage	Energy Consumption (kWh)	Contribution (kWh) CFE	Photovoltaic system
Current	13,940,989	13,940,989	0
	100.00%	100.00%	0.00%
Draft	12,126,586	7,929,086	4,197,500
	100.00%	65.39%	34.61%

Table 12 Comparison of total energy contributions

Comparison of total energy contributions

The environmental impact of generating electricity through photovoltaic systems in generating 4.1975 MWh and energy savings due to energy efficiency of 1.814404 MWh, will prevent the University of Colima from emitting 3,962 tons of CO2 into the atmosphere, these tons of CO2 are equivalent to filling 1,836 Olympic pools. The economic benefits to health for the photovoltaic systems total 2.3 MWp $ 239,304.45 USD / year. In addition to the reduction of particles in 862.71 Kg of PM2.5 / year by this intervention.

In economic terms, the Project itself represents a great opportunity as an investment strategy due to the savings generated each year. The Project requires an investment of $ 72,350,295.00 pesos and will have a saving of $ 8,273,105.68 pesos each year. The return on investment is 8.75 years with an internal rate of return of 10%

The social impact of this Project is to awaken awareness in the community and to contribute to renewable energies being increasingly positioned by society. The development of sustainable projects by Higher Education Institutions can contribute to the paradigm shift of citizens and society, while at the same time maintaining a healthy ecosystem for the development of society.

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Conclusions

The development of energy projects of high impact in Institutions of Public Education in a reality. Integrating renewable sources of energy as part of the social responsibility that these institutions have with society is a duty in the transition to a sustainable university.

With the start-up of the photovoltaic electricity generation project and energy efficiency in the air conditioning and lighting systems, there is a reduction in electricity consumption of 1,814,404 kWh, equivalent to 13.01% of current consumption. The total consumption of the university will be 12'126,586 kWh, of which 34.61% will be generated by the institution itself through the proposed photovoltaic system, the rest will be delivered by the Federal Electricity Commission.

There are economic needs for these institutions, so it is necessary that within the budget for the universities, budgetary allocations are generated for the adoption of renewable technologies. The development of sustainable projects by Higher Education Institutions can contribute to the paradigm shift of citizens and society, while at the same time maintaining a healthy ecosystem for the development of society.

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Innovation and technology to strengthen the learning of Calculus

Innovación y tecnología para fortalecer el aprendizaje del Cálculo

SÁNCHEZ, Bertha†, JIMÉNEZ, Guadalupe, MONTOYA, Javier and HERNÁNDEZ, Samuel

Instituto Tecnológico de Nuevo Laredo, Reforma Sur 2007, C.P. 88250, Nuevo Laredo, Tam.

ID 1st Author: *Bertha, Sánchez*

ID 1st Coauthor: *Guadalupe, Jiménez*

ID 2nd Coauthor: *Javier, Montoya*

ID 3rd Coauthor: *Samuel, Hernández*

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Abstract

The proposal aims to improve the learning process of differential and integral calculus by applying dynamic teaching strategies and the use of technological resources. Participatory methodology in a space where meaningful content are managed, updated, space and the environment with different spatial distributions depending on the type of work is controlled, posters theorems and formulas alluding to the subject are presented. The work can be individual or collective. It represents an intellectually complex work applying various skills in real world situations. Multiple elements are integrated: A server, internal network WiFi, electronic whiteboard, projector, mobile devices.

Calculus, Technological innovation, Educational technology

Resumen

La propuesta pretende mejorar el proceso de aprendizaje del Cálculo Diferencial e Integral mediante la aplicación de estrategias de enseñanza dinámica y la utilización de recursos tecnológicos. Metodología de carácter participativo en un espacio donde se manejan contenidos significativos, actualizados, se controla el espacio y el ambiente con diversas distribuciones espaciales dependiendo del tipo de trabajo, se exponen carteles con teoremas y fórmulas alusivos al tema. El trabajo puede ser individual o colectivo. Representa un trabajo intelectualmente complejo que aplica diversas competencias en situaciones del mundo real. Se integran diversos elementos: un servidor, red interna WiFi, pizarrón electrónico, cañón proyector, dispositivos móviles y pueden apoyarse en apps de smartphone, Tablet y/o pc en cualquier momento de la clase.

Cálculo, Innovaciones tecnológicas, Tecnología educativa

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† Researcher contributing as first author.

Introducción

A problem faced by Higher Education Institutions in Mexico is the low terminal efficiency index; linked to dropout and student lag. In Mexico, of the total number of students who enter higher education, more than 40% do not complete their studies, and of the rest, only 18% manage to obtain their degree (INEGI, 2005; SEP, 2014), while the failure rates at this level, they are higher than 39% (OECD, 2010). Mathematics subjects have low achievement rates, which contributes to some students dropping out. Situation that becomes critical in the area of mathematics due to the low preparation of students, a consequence of teaching based on memory and algorithmic practices, devoid of any meaning. Students face great challenges during their first semester or year of studies: to assimilate in a short time, a series of new knowledge. They need to have certain skills that have not necessarily been developed previously, eg, ability to carry out processes of analysis and interpretation of mathematical results, the ability to graphically analyze solutions.

The training of engineers requires a constant use of mathematical tools, however, students no longer "learn" as they did some years ago; technological and educational advances provide us with various elements that previously did not exist. Students are no longer so passive, so teachers or facilitators should strive to integrate modern and commonly used elements into the classroom to reinforce school achievement. The use of mobile technologies is current, more than 80% of students have a mobile device, they are continuously connected, so the proposal is to use this means of communication for learning.

Background

The innovation of the educational process with the introduction of the Gavilán Classroom (named after the institution's mascot), began in September 2013 in a Differential Calculus group, which continued with the project in the Integral Calculus subject in the January-June 2014 semester, some elements have been added at the suggestion of the same student users and proponents, other components have been reinforced, such as the graphing machine and the mobile application to retrieve the class images automatically just by connecting to the internal network.

"All educators want to help their students succeed in life. What was considered a good education 50 years ago, however, is no longer enough to succeed in college, career, and citizenship in the 20th century. XXI "(NEA, 2012).

Therefore, a new framework for learning was developed in 2002, and timely adjustments in 2012, calling it the "Four Cs", which encapsulates the skills that are most important to an education in a global era: critical thinking, communication, collaboration and creativity.

Critical Thinking - the ability to make decisions, solve problems, and take appropriate action.

Communication - the ability to synthesize and transmit ideas both in written and oral form.

Collaboration - the ability to work effectively with others, including those of diverse groups and opposing views on a particular topic.

Creativity - the ability to see what is not there and make something happen.

According to Robledo (2014): “A great challenge for students and educators is deciding what type of devices will be used in the classroom”.

It also establishes 3 tips to start the implementation of mobile teaching.

- Ask yourself what you are trying to achieve.
- ""Ask your students which mobile devices they have."
- "Ask your students to make suggestions."

Aula Gavilán effectively complies with these four points of the NEA (2012) as well as with the suggestions of Robledo (2014) and uses them in the development of knowledge / power in the learning of mathematics.

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Existing technologies and competitors

Nearpod:

This application allows the teacher to project his presentation on all the devices of his students in a very simple way. The teacher searches his library for the presentation, the system gives him a PIN and the students, with that PIN, access it. Students have the explanation at their fingertips to be able to take notes and follow it without missing any detail. It allows you to save, buy applications, access exams and display graphs of responses. However, free access is very restricted, it is paid and necessarily requires the use of the internet.

Symbaloo

It is a page where it is possible to have all the material of the classes, share any type of files even in an entire institution. Disadvantages: it requires the use of the internet, and it is paid. There are various applications that can be incorporated through the use of technologies, the difference in Aula Gavilán is the didactic use of all those tools, the proposal consists of the incorporation of various elements that are constantly being evaluated and may vary according to the characteristics of the group of students, that is, innovation is in the use of existing resources, the generation of strategies with problems of daily life, not the resources themselves.

Aula Gavilán uses free access resources or those created by the students themselves (such as Celmath). Which do not require internet for use in the classroom. Social groups are manipulated outside the classroom. It has no monetary price, it is to use free resources and applicable to teaching.

Methodology and description

Participatory methodology, since the students themselves were involved in the execution of the project, their suggestions were taken into account to incorporate or eliminate work elements, evaluations and opportunities for improvement were continuously made.

The main axis of the project is the creativity and innovation applied in each of the strategies and works that are integrated during the course, Imbernón (1996) defines educational innovation as “the attitude and the process of inquiry of new ideas, proposals and contributions carried out collectively, for the solution of problematic situations of practice, which will entail a change in the contexts and in the institutional practice of education ”.

Etymologically, innovate comes from "innovatio", derived from the Latin "novus" which means new or novelty; the prefix “in” provides it with an internal meaning, from the inside, so it can be considered as “introducing something new” (Font, Díaz Godino & Planas, 2011)

"Creativity is the human ability to produce mental content of any kind, which can essentially be considered as new and unknown to those who produce it" (Serrano, 2004)

In this sense, a classroom was designed in which students, with the help of different tools, achieve learning and improve their performance; In this classroom, some technological resources were used, including a computer, an e-Beam electronic board, a projector, etc.

In the same way the didactic resources and strategies both didactic and rearrangement of the physical space. The application was in Differential Calculus followed by Integral Calculus in this semester, however, the proposal is valid for any subject.

Technology as an Educational Resource

“The pedagogical use of new technologies makes it possible to make learning more effective and enhance the capacities of teachers and students.

The advancement and penetration of technologies lead us to reflect not only on how we better use them to educate, but even to rethink the processes and the contents of education ”(Guadamud, Montanero, Velásquez, & Intriago, 2010). E-Beam electronic whiteboard: it is a system capable of converting any whiteboard into a digital whiteboard with all the features and functions of special whiteboard digital screens.

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Create a group on a social network (Facebook): It was created with the aim of having a space for interaction between the students themselves and the teacher, during hours outside of class, when students have any questions regarding the tasks or assignments commissioned , the teacher can solve them instead of looking for it in the institution facilitates accessibility to the answers. It is a way of sharing videos that will be useful in class to complement it, forms, links to specialized pages on a topic, example or problem that will be or was seen in class; reasoning questions, and documents with content that will be useful in class.

To interest them in the class, one of the strategies used via Facebook is to "launch" questions regarding the topic being studied at that time and "award" points to those who give the correct answer.

Another advantage is the ease of sending "information capsules" of the matter, which are seen almost immediately by most of the members of the group, in addition to the possibility of interacting.

Figure 1 Mathematics group

Open Sankoré: it is a free access software which allows that through the use of a special pen on a tablet, the teacher write the class to be projected and this is saved in pdf format, and then share it through celmath or Web page. The writing can be freehand or with the text editor that the application contains, it handles different colors and thickness of the lines, which allows the main ideas to be highlighted or to emphasize some points.

Location of furniture and equipment

The arrangement of furniture and equipment is constantly monitored to identify the optimal way in which students have: the best visibility, the most adequate way of working and comfort.

It changes depending on the way in which the development of the class requires it: teacher presentation, teamwork, individual work, student exposition, video projection, etc.

Printed Canvases: Printed canvases are recommended as they can be easily stored and exchanged, the canvases contain the formulas used in class and their location is strategic so that everyone can visualize them properly. Some change according to the topic discussed, others are maintained throughout the semester due to their algebraic utility.

Collaboration in the generation of alternative teaching resources

Cell phone application:

Due to the need to support mathematics students to improve their learning and take advantage of the opportunity on the wide availability of a Smartphone (8 out of 10 students). CelMath arises as a didactic proposal that allows the student to perform graphing of functions (in its first version), with the ease of sharing it in real time with their facilitator and analyzing in a group way, thus reinforcing their learning, using a manual graphing method as verification. , in order to create a scenario by creating a need to be solved by the student (problem-based learning).

"Educators and developers (of Applications) can support students by developing more readable content with formats that can be accessible from mobile devices" (Kraut, 2013).

CELMATH is a mobile application in which students can download the daily classes (figure 2); this in order that they are attentive to the class without being distracted by passing notes. Optimizing class time to increase class time making it more effective.

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Figure 2 Students using CELMATH

Graphing of functions; the user enters the function (observing syntax rules), then with a click on the graph button, the corresponding graph will be displayed on the screen (figure 3).

Figure 3 Celmath App for Android

Blackboard to image: The user enters the name of the class in the text box and clicks on get, the application shows a preview of the class, and stores a copy of the original file directly in the SD of the mobile or on the laptop or pc (figure 4).

Figure 4 Student giving support in capturing images in class

Ongoing evaluation of classroom design and resources

The design of the classroom is constantly evaluated in order to monitor the activities carried out, and in this way verify which strategies or resources are necessary or not in the development of the project.

Videos

Every day videos were projected alluding to the subject: algebraic content, limits, methods of solving derivatives, application of various formulas and topics of daily life with some mathematical application, in order to complement the activities. The videos were projected at any time during the class

Conceptual development of the class

Regarding the content, a point that is important to clarify is the type of applications of mathematics in everyday life situations, with the aim of extending the concepts and knowledge acquired through the investigation of various problems that arise. This can be done individually or in teams so that certain learning tasks can be carried out. The result is a flexible product suitable for each study group, thus transforming the conception that the teacher is the only one who knows and students enter the path of "learning to learn", increasing their negotiation capacity where they are they show the knowledge and skills acquired. Exercises that do not present the same type of difficulties are proposed, with the aim that students integrate intra and extra-mathematical knowledge, to avoid mechanization in solving them.

Results

The development and implementation of the proposal was carried out in the subjects of Differential Calculus (2013) and Integral Calculus (2014) at the engineering level, this can be implemented in any subject of the various careers with some adjustments, for example: in Chemistry it would be convenient have an app that supports the balancing of reactions; change the forms for the periodic table, valency tables, basic formulas, etc., find or create videos that support the learning of chemistry, perhaps a virtual laboratory. The other elements of the proposal are valid for this and other subjects.

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Students are continuously connected, for them, it is more interesting to be on Facebook or the news than in the classroom, so you have to learn to channel those digital impulses in an effective and current learning environment.

By incorporating technology into classes, students see them as attractive, current and that corresponds to their reality. It is a process of adjusting the way we pay attention and learn. What makes the proposal applicable in any matter.

Math (Facebook)

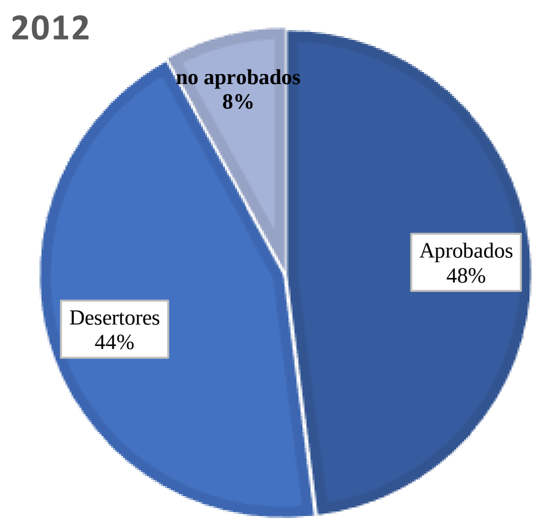
It was constantly evaluated through the visits of the students to the page, since the page itself contains a counter of visits per publication, that is, when "uploading" an image shows how many and which people have seen the publication regardless of the “I like it”, in this way the impact of each comment or image was evaluated, obtaining between 70 and 90% acceptance.

The comments made by the participants indicate that the learning process was significantly improved through didactic interaction with technological equipment, transforming a traditional classroom into an active, dynamic and functional classroom.

The strategies that were applied such as the projection of videos helped the students to complement the classes by facilitating the resolution of exercises; the “Matemagicas” group demonstrated a new form of interaction between Teacher-Student that can be amplified beyond the classroom; As for the posters, it helped them to memorize the formulas, theorems and laws applied in the matter, in the location of the furniture, the most appropriate way to take the class was found

The student beneficiaries of this work showed their satisfaction with the furniture and technological resources received as well as a positive response to the different jobs that were asked of them during the semester.

Regarding figures, the data of the Differential Calculus group taught by the same teacher in 2012 were obtained without applying the strategies described in this project (Graph 1).



Graph 1 Percentages 2012 without including technologies

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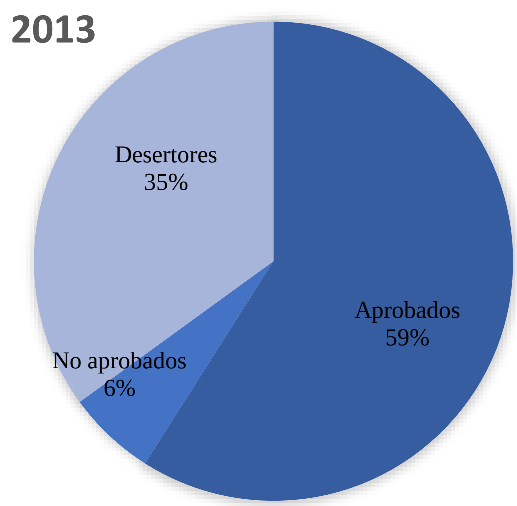
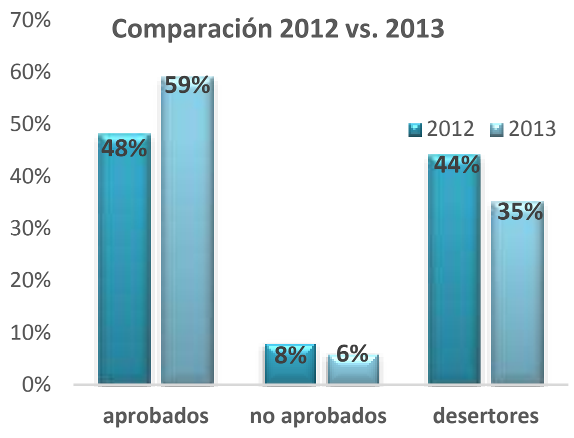
Graph 2 contains the percentages for the year 2013 after the application of the strategies mentioned above.



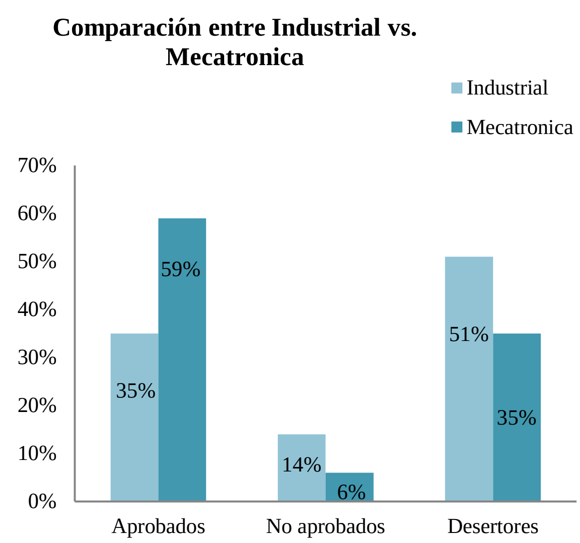
Graph 2 Percentages of students passed, failed and dropped out 2013

In Graph 3 it can be seen that the percentage of failures is slightly lower during the application of the strategies. The dropout percentage decreased by 9% and the approval rate increased by 11%, which translates into a benefit for students through the application of the classroom project.



Graph 3 Comparison between the years 2012-2013

Graph 4 shows the comparison between groups in 2013 in the Mechatronics Engineering group (in which technological tools were included) presented better progress than Industrial Engineering (without technological tools) since there were more failures and more students than they dropped out of the subject during the semester, resulting in students dropping their grades and showing a certain apathy towards class activities.



Graph 4 Comparison between Industrial Engineering (without technology) -Ing Mechatronics (with technology)

Gratitude

To the Program for the Professional Development of Teachers for the Superior type (formerly the Teacher Improvement Program, Promep) for the support granted to carry out this project to strengthen Academic Bodies. Academic body recognized by Promep "Educational innovation and mathematics at the higher level" key ITCdJ-CA-1, from the Technological Institute of Cd. Jiménez.

Conclusions

The application of the participatory methodology with the inclusion of technologies is an effective pair according to the results obtained during the two semesters of the Calculus course. A decrease in the failure rate was obtained in the Mechatronics Engineering students participating in the project in the matter of Differential Calculus compared to the previous year with Mechatronics Engineering students without the application of the project.

In reference only to the year 2013, when comparing the groups of Mechatronics Engineering (with project), it presents a percentage of approved of 59% and that of Industrial Engineering (without project) of 35%, which represents a difference of 24% with the inclusion of strategies. The comparative failure rate is 8% (14% vs 6%) favoring the Mechatronics group. Dropout students show a difference of 16% in both groups (51% Mechatronics vs 35% Industrial). Therefore, it is concluded that the application of the strategies generated a positive impact on the performance of the students. As for the dropout percentage, it decreased by 9%, which has a positive impact on the permanence of students in the institution, since being in the first semester they require passing 4 subjects of the regulatory load, which translates at the same time in a social benefit.

Academic impact

It is important to emphasize the importance of the application of technology not only as a study and innovation tool, but as a way of capturing and maintaining the attention of students when using the means of everyday and common use such as mobile devices (cell phones). and Tablet), leads us to a change in attitude towards mathematics as they are attracted to the use of new technologies. In addition to developing computer skills and competencies, the ability to search and apply resources is privileged.

Technological Impact

Achievement of a harmonious and productive combination between the use of mobile devices and the generation of knowledge in secondary and higher education schools. On the other hand, mobile devices would be conceived as a tool, not just as an accessory or a distraction.

Social impact

The quality of knowledge, as well as the motivation and rediscovery of the ways to obtain it, would be higher, and consequently the decrease in failure rates would be evident. Presenting examples and projects of everyday life as a source of knowledge is very important because tolerance is developed, respect for others, their opinions. It is a complex job with application in real world situations, where various strategies of analysis and systematization of information are applied to arrive at the correct solution.

The knowledge becomes usable, to arrive at the “know-how”. The evaluation is, then, a continuous process, which allows the relevant aspects to be identified immediately and, where appropriate, to solve them. And the dual of knowledge and power is recognized in the learning of Mathematics (knowledge is knowledge, power is the student's ability to apply that knowledge in various theoretical and practical situations) (Oliveros, 2010). The logical and critical thinking of the student is promoted.

Differentiation

The innovative use that is being given to resources to obtain better results, considered as a utility model

Barriers to its implementation

Because the innovation does not have a price for itself, this is not an aspect that prevents its use.

1. Institutional barriers:
a. Lack of investment to use a projector with a tablet and pen, or
b. Lack of investment for a device (ebeam) that transforms the blackboard into electronic;
c. Not providing a physical space which is set up as a Gavilán Classroom.

2. Teaching barriers:
a. Willingness to adopt technologies inside and outside the classroom.
b. tudent barriers:
c. Lack of mobile device.
d. Previous and future stagesProject scheduling

Research and application of technologies in Differential Calculus was carried out to test the process, later it was continued in Integral Calculus, it is planned to assign it to most of the subjects.

Project needs

The need arises from the difficulty of understanding mathematics in traditional learning environments.

Project control

In case of expanding the installation of this type of technology, the control of the project would be in charge of the academic development department since it has the function of controlling the audiovisual equipment owned by the institution.

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Proposal of a tool to prevent dropouts at a higher level

Propuesta de herramienta para prevenir la deserción a nivel superior

GARCIA, Francisco†, ARROYO, Jorge, VALDERRABANO, Jonny and IBARRA, Mayra

Universidad Tecnológica Metropolotina

ID 1st Author: *Francisco, Garcia*

ID 1st Coauthor: *Jorge, Arroyo*

ID 2nd Coauthor: *Jonny, Valderrabano*

ID 3rd Coauthor: *Mayra, Ibarra*

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Abstract

Dropout and low academic performance indices are latent problems in all institutions and schools at a higher level because more than half of the students who enroll at the University truncate their studies for various reasons, which in most of the time, are not academic. Moreover, the permanence and sustainability of a program of studies depend on the indicators of retention of the student population and the good performance of students Currently, even with easy access to universities in Mexico, students have many problems during the first academic periods , ranging from personal problems to institutional factors. Analyzing the problems of desertion , this paper the authors propose the use of software tools for analysis of personality of students in order to provide a useful tool to help the teacher -tutor to prevent dropouts in universities.

Dropout, Software tools, Academic performance

Resumen

La deserción escolar y los bajos índices de desempeño académico son problemas latentes en todas las instituciones y centros de estudio a nivel superior ya que más de la mitad de los alumnos que se inscriben truncan sus estudios por diversas causas, las cuales, en la mayoría de las ocasiones, no son académicas. Por otra parte la continuación y sustentabilidad de un programa de estudios dependen de los indicadores de permanencia y buen desempeño de la población estudiantil. Actualmente, a pesar del fácil acceso a la educación superior en México, los estudiantes presentan muchos problemas durante los primeros periodos académicos, los cuales van desde situaciones personales hasta factores institucionales. Tomando como referencia lo anterior, en esta redacción se plantea el uso de una herramienta informática para análisis de personalidad de los alumnos con la finalidad de proporcionar una instrumento útil que ayude al docente-tutor a prevenir la deserción escolar.

Deserción, Herramientas informáticas, Desempeño académico

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† Researcher contributing as first author.

Introduction

This document is left for the consideration of the academic units as a proposal for the implementation of a computer tool that manages to prevent and avoid high school dropout rates in higher education institutions, helping to improve the quality of education in our country.

Dropout at the higher level is a problem that has been solved with some techniques and tools such as tutorials, consultancies, socioeconomic studies, regularization classes, among others. However, despite the implementation and monitoring of tools and strategies, it has not been possible to lower the figures for the school dropout indicator.

Within the classrooms, the teacher encounters different personalities and concerns, therefore each student may have problems of a different nature and therefore it is difficult to recognize the weaknesses and strengths of the students, coupled with this we must consider that training of the teachers at the higher level is not towards pedagogy, but towards their area of specialty, which is why it is difficult to understand and know the strategies to achieve that the student acquires meaningful learning (Diez de Tancredi, 2009).

This would help students find the teaching-learning model attractive and thus not join the ranks of school dropouts. On the other hand, there is a great variety of behaviors known by the common label of "desertion"; However, this term should not define all dropouts, nor do all dropouts deserve institutional intervention (Tinto, 1989).

For this reason, it is necessary to know the factors and causes that cause the student to leave their higher studies and, on occasions, join the labor field. By knowing the possible causes, higher education institutions will be able to propose strategies and tools to achieve the permanence of students within each educational program.

Background

In technological universities, particularly in the Technological University of Xicotepec de Juárez (UTXJ), dropout rates have been very high during the last 3 school cycles, despite the educational model that proposes tutorials as a tool to support students. that the teacher-tutor guides the student during their teaching-learning process, in addition to this, an advisory model is implemented with the aim that the student reaches all their professional competencies at the end of their higher studies.

In technological universities, the sustainability of the study program is susceptible to the permanence of students; therefore, with more enrollment and less dropout, more infrastructure and supports are granted to students through programs promoted by the federal and state governments.

The educational model proposes the course of an engineering in two stages, the first consists of studying the career of Higher University Technician in two years and then completing the Engineering in 1 year 8 months. In the UTXJ the highest dropout rates are observed in the first school periods, therefore in the university higher technician careers it is where the initial enrollment is greatly affected with respect to the final enrollment as seen in tables 1 and 2.

Programa Educativo	TÉCNICO SUPERIOR UNIVERSITARIO				
	Matricula inicial	Bajas totales	Matricula final	Indice de deserción	Aportacion institucional.
Administración Área Recursos Humanos	262	77	185	29.39%	10.98%
Química Área Biotecnología	49	18	31	36.73%	2.57%
Mecatrónica Área Automatización	117	38	79	32.48%	5.42%
Mantenimiento Área Industrial	598	237	361	39.63%	33.81%
Procesos Alimentarios	85	12	73	14.12%	1.71%
Tecnologías de la Información y Comunicación Área Sistemas Informáticos	126	40	86	31.75%	5.71%
Tecnologías de la Información y Comunicación Área Multimedia y Comercio Electrónico	50	24	26	48.00%	3.42%
Terapia Física Área Rehabilitación	370	130	240	35.14%	18.54%
Mantenimiento Industrial Área Petroleo	92	57	35	61.96%	8.13%
Fotonica	27	17	10	62.96%	2.43%
Gastronomía	75	51	24	68.00%	7.28%
Porcentaje de Deserción del Técnico Superior Universitario	37.87%				

Table 1 Dropout 2013-2014 of Higher University Technician

Programa Educativo	INGENIERÍAS				
	Matrícula inicial	Bajas totales	Matrícula final	Índice de deserción.	Aportacion institucional.
Ingeniería en Desarrollo e Innovación Empresarial	154	10	144	6.49%	14.08%
Ingeniería en Mantenimiento Industrial	217	42	175	19.35%	59.15%
Ingeniería en Mecatrónica	101	4	97	3.96%	5.63%
Ingeniería en Procesos Alimentarios	74	8	66	10.81%	11.27%
Ingeniería en Tecnologías de la Información y Comunicación	73	7	66	9.59%	9.86%
Ingeniería Profesional en Robótica Industrial	3	0	3	0.00%	0.00%
Porcentaje de Deserciónde Ingeniería	11.41%				

Table 2 Engineering Dropout 2013-2014

According to the information obtained from the statistics department of the UTXJ, it is observed that enrollment decreases by more than 37.8% during the first two years and by 11.4% the rest of the engineering career, giving a total of 49.2% school dropouts during the school year. In the same way, it can be observed that in some study areas the dropout rates are higher.

Justification

The application of ICTs to improve and provide solutions to the public and private sector is not a novelty, in particular, the development of applications is increasing to provide tools that help in making decisions.

The use of socioeconomic and vocational studies provide important data for the doncente-tutor to make a reference to the conditions in which students enter the university, however the information is lacking to complement the personality traits that make students unique and They provide important factors for decision-making regarding activities that are assigned and work teams that are formed during the course of the career.

By having an information system that provides personality characteristics of each student, the tutor will be able to refer information to each of the teachers in order for them to analyze the teaching and learning strategies to be implemented in each group of students.

It is known that the theory of learning styles forces teachers to reflect on their teaching practices and even review and adapt their didactic strategies based on the necessary competencies of each disciplinary field (Ventura, 2011).

Dropout depends not only on individual intentions but also on the social and intellectual processes through which people develop desired goals in a certain university, so the more information those involved in the teaching-learning process have, the easier it will be to prevent that a student leaves the university since efforts can be added to help the student achieve their goals.

Development

The proposed tool to obtain information from students once they enter the university consists of an information system that was developed based on the work of Raymond B. Cattel on the 16FP questionnaire (16 Personality Factors) which does not neglect aspects of the personality because it considers this as a total being important all its dimensions, the 16 personality factors that are considered in this questionnaire are:

A: Emotional expressiveness
B: Intelligence
C: Force of the self
E: Dominance
F: Impulsivity
G: Group Loyalty
H: Situational aptitude
I: Emotionality
L: Creativity
M: Cognitive attitude
N: Subtlety
O: Consciousness
Q1: Social position
Q2: Individual certainty
Q3: Self-esteem
Q4: State of anxiety

The questionnaire is made up of 187 questions and is evaluated according to two templates called A-B and C-D, both of which cover all factors. The score values that are handled in the responses are 2 or 1, the scores are added and a score called raw score is obtained and then standard-normalized scores are obtained from a table that is provided in the commercial version of the questionnaire. In order to implement the 16FP tool, the use of an information system is proposed in order to obtain the results quickly by applying it to groups of 30 or more people simultaneously, the system was developed as a web application with PHP, CSS, JavaScript and MySQL as database manager.

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Development process

For the development of the application, the "Basic SW Development Model" (Alpizar, Luis. Et al. 2014) was used, created in the UTXJ and which allows the creation of information systems using the agile development methodology SCRUM, the stages of development that were considered are the following:

Analysis: The software requirements were developed taking into account the opinion of the psychopedagogy area of the UTXJ, with this, a planning was achieved where the implementation of the questionnaire is projected to new students in September 2015. Currently the application of questionnaires is a process that takes approximately 3 months.

Design: The user interfaces were created considering 3 types and privileges (Psychology department, students and administrator). The idea is that more questionnaires can be added to the information system, which are currently applied by the psychopedagogy area, in order to have the results when the students finish answering.

Development: The application was programmed using the PHP and JavaScript programming language, plus CSS was used to achieve a suitable design. The algorithms were programmed according to the process that is carried out manually to obtain results.

Tests: Tests were carried out on the local server with 5 students to be able to debug the errors, after making the pertinent corrections, the application was installed on a server of the institution and currently works on the intranet. Although the questionnaire can already be applied to the student community, it is necessary to continue with the development to ensure that the psychology department and the administrator have a more friendly environment.

Implementation: The application is intended to be implemented in September 2015 and deliver results to the area of psychopedagogy in October 2015.

Results

Currently, the implementation module of the questionnaire is finished, therefore it can be used with new students. We are working on the administrator and applicator interface in order to offer a friendly environment to all users of the system. With the development of this project, it was observed that the area of psychopedagogy can apply more than one questionnaire to students with the help of information systems and obtain results instantly, with this, relevant data is provided to the tutors and there is a broad panorama of the situation in which students enter university.

Future work

Seeing the need to lower the dropout rates in the institution and improve the services offered by the psychopedagogy area, a planning will be carried out in which the automation of all the questionnaires that are given to students on their entrance to the university is projected. , in order to improve the quality of teaching and offer students more resources and tools that support their professional training and prevent their desertion.

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[Title in Times New Roman and Bold No. 14 in English and Spanish]

Surname (IN UPPERCASE), Name 1st Author†*, Surname (IN UPPERCASE), Name 1st Coauthor, Surname (IN UPPERCASE), Name 2nd Coauthor and Surname (IN UPPERCASE), Name 3rd Coauthor

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Abstract (In English, 150-200 words)

Objectives
Methodology
Contribution

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* Correspondence to Author (example@example.org)
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Introduction

Text in Times New Roman No.12, single space.

General explanation of the subject and explain why it is important.

What is your added value with respect to other techniques?

Clearly focus each of its features

Clearly explain the problem to be solved and the central hypothesis.

Explanation of sections Article.

Development of headings and subheadings of the article with subsequent numbers

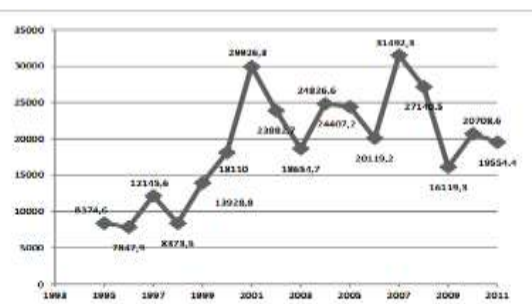
[Title No.12 in Times New Roman, single spaced and Bold]

Products in development No.12 Times New Roman, single spaced.

Including graphs, figures and tables-Editable

In the article content any graphic, table and figure should be editable formats that can change size, type and number of letter, for the purposes of edition, these must be high quality, not pixelated and should be noticeable even reducing image scale.

[Indicating the title at the bottom with No.10 and Times New Roman Bold]



Graphic 1 Title and Source (in italics).

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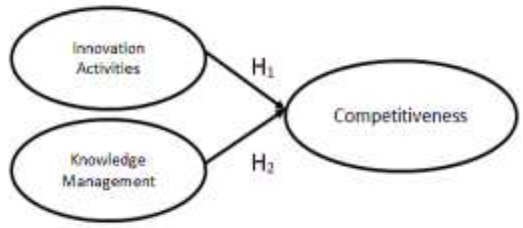

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		λ	OLS	I-OLS	IM-OLS	OLS	I-OLS	IM-OLS
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ρ = 0.0	γ = 0.0	1	−0.00011	−0.00003	0.00013	0.0267	0.0398	0.0378
		2	0.00051	0.00039	0.00015	0.0267	0.0414	0.0395
		3	−0.00091	−0.00143	−0.00065	0.0286	0.0461	0.0429
		4	0.00034	0.00041	0.00115	0.0301	0.0498	0.0471
		5	0.00011	0.00040	0.00018	0.0324	0.0537	0.0507
		10	−0.00010	−0.00079	−0.00013	0.0455	0.0861	0.0763
	γ = 0.3	1	0.01477	0.00378	0.00274	0.0342	0.0435	0.0360
		2	0.01778	0.00754	0.00618	0.0361	0.0472	0.0391
		3	0.02092	0.01064	0.00925	0.0388	0.0518	0.0438
		4	0.02340	0.01364	0.01236	0.0418	0.0555	0.0471
		5	0.02652	0.01721	0.01454	0.0448	0.0607	0.0516
		10	0.04198	0.03247	0.03146	0.0641	0.0952	0.0829
ρ = 0.3	γ = 0.0	1	−0.00085	−0.00021	−0.00073	0.0364	0.0545	0.0531
		2	0.00019	−0.00015	−0.00011	0.0374	0.0565	0.0550
		3	0.00015	0.00076	0.00046	0.0400	0.0627	0.0597
		4	0.00043	−0.00011	−0.00070	0.0417	0.0711	0.0668
		5	0.00165	0.00206	0.00213	0.0454	0.0791	0.0711
		10	0.00073	0.00136	0.00112	0.0661	0.1267	0.1128
	γ = 0.3	1	0.02299	0.00570	0.00458	0.0490	0.0643	0.0527
		2	0.02818	0.01123	0.01035	0.0523	0.0676	0.0561
		3	0.03264	0.01611	0.01445	0.0571	0.0720	0.0620
		4	0.03581	0.01957	0.01907	0.0591	0.0773	0.0690
		5	0.04081	0.02569	0.02416	0.0647	0.0872	0.0754
		10	0.06063	0.04727	0.04458	0.0914	0.1369	0.1187

Table 1 Title and Source (in italics**).**

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Each article shall present separately in **3 folders**: a) Figures, b) Charts and c) Tables in .JPG format, indicating the number and sequential Bold Title.

For the use of equations, noted as follows:

$$Y_{ij} = \alpha + \sum_{h=1}^{r} \beta_h X_{hij} + u_j + e_{ij} \qquad (1)$$

They must be editable and number aligned on the right side.

Methodology

Develop give the meaning of the variables in linear writing and important is the comparison of the used criteria.

Results

The results shall be by section of the article.

Annexes

Tables and adequate sources thanks to indicate if they were funded by any institution, University or company.

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Conclusions

Explain clearly the results and possibilities of improvement.

Explain clearly the results and possibilities of improvement.

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