

Young researchers

Engineering and Biotechnology for Society

Proceedings T-II

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Proceedings

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ECORFAN Young researchers Engineering and Biotechnology for Society

Volumen I

The Proceedings will offer volumes of selected contributions from researchers who contribute to the scientific dissemination activity of the Colegio de Ingenieros en Energías Renovables de Querétaro A.C in areas of Engineering and Biotechnology. In addition to having a full evaluation, in the hands of the coordinators of the Colegio de Ingenieros en Energías Renovables de Querétaro A.C, quality and punctuality in its chapters, each individual contribution was refereed to international standards [V|LEX, RESEARCH GATE, MENDELEY, GOOGLE SCHOLAR and REDIB], the Proceeding thus proposes to the academic community, recent reports on new developments in the most interesting and promising areas of Engineering and Biotechnology.

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Preface

The Proceedings, which brings together research in Engineering and Biotechnology, presents works carried out by young researchers whose interest lies in solving practical problems and contributing to the development of technologies that have a positive impact on different sectors. The works presented reflect the effort to innovate and apply scientific knowledge to improve industrial, food, safety and sustainability processes.

The first study focuses on the optimization of the packaging process in a flower company, showing how the analysis of times and movements can improve efficiency and quality in agricultural production environments. In the field of nanotechnology, another study examines the synthesis of turmeric nanoparticles with β -glucan and essential vitamins, with promising applications in the food and supplement industry, ensuring functionality and safety through advanced characterization methods.

Research on bioremediation through composting proposes an effective technique for soil decontamination, using microorganisms and natural materials, which promotes environmental restoration. Also, the development of a theft detection system for electronic devices in educational environments, using NFC technology, exemplifies how engineering can contribute to institutional security, improving the management and prevention of theft incidents.

The following projects present practical solutions for institutional management: a prototype vehicle identification system based on QR codes, which optimizes access to students and professors, and a proposal for turnstiles with access control at the entrance of a university, focused on improving pedestrian flow and minimizing crowds.

Each of these works reflects the diversity and relevance of research in the field of engineering and biotechnology, highlighting their applicability and the role of science in social innovation for the benefit of different sectors.



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Study of times and movements in the packing process of the company Flores de María



Estudio de tiempos y movimientos en el proceso de empaque de la empresa Flores de María

Oscos-Fuentes, Eduardo*^a, Lara-Álvarez, Daniel Emiliano^b, Castañeda-Romero, Alberto Fernando^c and García-Castillo, Karla Yazmín^d

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Key Proceeding

El iniciar a los alumnos a la parte de investigación aplicada en el sector industrial promueve su curiosidad y su capacidad por querer innovar, mejorar o crear un nuevo proceso en pro de la sociedad y un claro ejemplo, fue esta investigación ya que se analizó la industria florícola local de la región sur del Estado de México, para realizar un diagnóstico empresarial que ayudara a mejorar la productividad con técnicas propias de la ingeniería industrial, motivando a los productores y empresarios a reconocer que los procesos de automatización pueden ayudar al crecimiento de la competitividad en este sector. El hecho de utilizar herramientas propias de la metodología de estudios de tiempo y movimientos, como el cronometraje tradicional, software para diagramas de Pareto, diagramas de Ishikawa y VSM, se pudo comprobar que en el área de empaque de la empresa Florícola Flor de María, se registró un incremento del 37.95% en eficiencia, un aumento del 218.03% en productividad y un incremento del 93.25% en la eficacia de las herramientas de tiempo. La reducción del tiempo inactivo fue del 40.24%, resaltando la importancia del estudio de tiempos y movimientos en la eficiencia del área de empaque. En el contexto específico de la empresa Flores De María, se identificaron desafíos asociados a variaciones estacionales de la demanda. La falta de control técnico/práctico de tiempos y movimientos en los procesos y el empaque ha resultado en pérdida de ventas y clientes. Se propone que la implementación de estudios de tiempos y movimientos puede ser una solución para mejorar la productividad.

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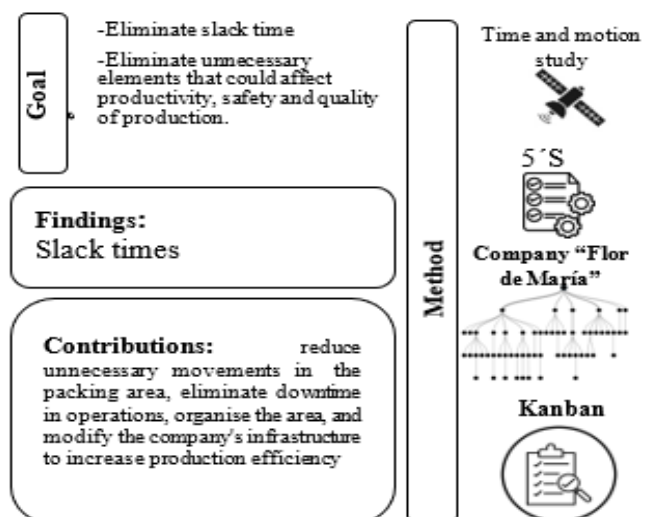
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Peer Review under the responsibility of the Scientific Committee MARVID®- in contribution to the scientific, technological and innovation Peer Review Process by training Human Resources for the continuity in the Critical Analysis of International Research.



Abstract

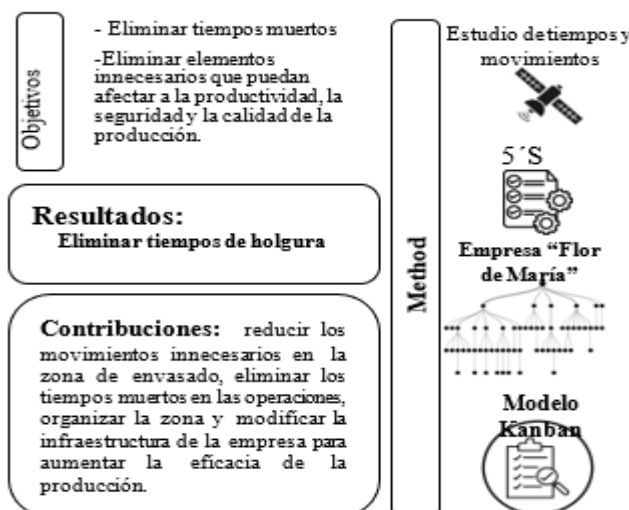
The importance of the study of times and movements in the various industries lies in explaining that the work is organised according to the main techniques of work measurement; time study with stopwatch, work sampling and predetermined time standards. Through the application of quality tools, it is determined which areas of work represent a problem in production in order to have a better performance, efficiency, effectiveness and improvement of the operators for the realisation of certain processes. Such is the case of the flower sector in the municipality of Villa Guerrero, Mexico, where demand is seasonal, which means that companies dedicated to the production of roses on a large scale do not have an adequate organisation in various processes, causing inefficiency and a series of delays in production. Therefore, the importance of this research work lies in carrying out a time and motion study to eliminate slack time and eliminate unnecessary elements that could affect productivity, safety and quality of production in the company Flor de María, where it was hypothesised that the time and motion study will help the company Flores de María to improve the working methods of the packaging process in the activities of rehydration, calibration, stem selection, labelling (Kanban) in this area to increase the efficiency of the production process.



Productivity, Time and Motion Study, Efficiency, Floriculture Sector

Resumen

La importancia del estudio de tiempos y movimientos en las diversas industrias radica en explicar que el trabajo se encuentra organizado según las técnicas principales de la medición del trabajo; estudio de tiempos con cronometro, muestreo del trabajo y estándares de tiempos predeterminados. Pues mediante la aplicación de herramientas de calidad se determina que áreas de trabajo nos representan un problema en producción para poder tener un mejor rendimiento, eficiencia, efectividad y mejora de los operadores para la realización de ciertos procesos. Tal es el caso del sector florícola en el municipio de Villa Guerrero, México donde la demanda se presenta de manera estacional, lo que ocasiona que las empresas que se dedican a la producción de rosa a grandes escalas no llevan una organización adecuada en diversos procesos lo que ocasiona ineficiencia y provoca una serie de retrasos en la producción. Por lo anterior, la importancia de este trabajo de investigación radica en realizar un estudio de tiempos y movimientos eliminando tiempos de holgura y eliminar los elementos innecesarios que podrían afectar la productividad, seguridad y calidad de la producción en la empresa Flor de María, donde se estableció como hipótesis que el estudio de tiempos y movimientos ayudará a la empresa Flores de María, a mejorar los métodos de trabajo del proceso de empaquetado en las actividades de rehidratación, calibración, selección de tallo, etiquetado (Kanban) de dicha área para elevar la eficiencia y efectividad en la producción utilizando una método mixto con un diseño cuasi – experimental, con la aplicación de una metodología de 5 s y de seguridad industrial, donde se resaltó que existen tiempos muertos entre cada proceso y se diseñó una propuesta que ayudará a la empresa a mejorar su productividad reduciendo costos.



Productividad, Estudio Tiempos y Movimientos, Eficiencia, Sector Florícola

Introduction

The optimisation of production processes in the flower industry has become a strategic imperative to improve efficiency and competitiveness in a globalised market. This industry represents a key sector in the Mexican economy, with sustained growth in recent decades. In this context, the optimisation of processes has become a determining factor for the competitiveness of companies, highlighting the importance of the study of times and movements.

The study of times and movements is a methodology used in various industries where quality control tools are used, time studies are used with stopwatch and its objective is to eliminate and improve unnecessary elements that could and can affect productivity, safety and quality of production where 5 levels are usually used to perform the corresponding analysis: workstation, worker, operation cycle, work item and unit movement (Andrade, Adrián M., A. Del Río, César, & Alvear, Daissy L.. 2019).

This study is used in various industries to achieve greater productivity and efficiency and consequently reduce production costs, which are the main objectives of a corporation to achieve a maximization in profits, however in the flower industry are very marked certain seasons where peaks are generated quantity demanded flower in which more are sold, This is the reason why some companies lose sales and clients, since most of the companies do not have a technical/practical control of time and movements in each one of the processes and in the packaging.

This research focused on this critical area, focusing specifically on the company 'Flores de Maria', located in Villa Guerrero, State of Mexico, a company dedicated to the flower industry within the national and international market of roses and sub-variables where roses, flowers and foliage are produced and marketed; where an analysis of times and movements was carried out as a valuable and pertinent contribution to the optimisation of processes in Flores de María, through a deep analysis and the proposal of specific strategies, where it was aspired to contribute to the sustainable growth of the company and, therefore, to the strengthening of the floriculture industry in the region.

Development of headings and subheadings of the chapter with subsequent numbers

1.1 Time and Motion Study

The study of time and motion has been defined by several authors over time, however one of the best known approaches is that provided by Frederick W. Taylor, considered the father of Scientific Management, who described the study of time and motion as a methodology to analyse and standardise work methods with the aim of increasing efficiency and productivity.

It should be noted that time and motion study is an essential tool in business management that helps to increase efficiency, reduce costs, improve quality, ensure safety and promote continuous improvement in an organisation and to increase productivity Frank B. Gilbreth and Lillian M. Gilbreth, pioneers in the field, argued that time and motion study can help eliminate inefficient movements and reduce the time required to complete a task. This in turn increases the productivity of workers and the organisation as a whole.

1.1.1 Main Objectives of Time and Motion Studies

Time and motion analysis is a technique used in operations management and industrial engineering to analyse and improve the efficiency of work processes.

One of the central objectives of time and motion studies is to increase the productivity of a process or operation. This involves finding ways to perform tasks more efficiently, reducing the time required to complete them.

According to Igor Ansoff in his book 'Strategic Management' (1965), the objectives of time and motion studies focus on optimising processes and resources to achieve a competitive advantage. This is particularly relevant in the flower industry, where competition is intense.

1.1.2 Key Concepts Related to Time and Motion Studies

1.1.2.1 Efficiency

Efficiency refers to the ability to perform a task or achieve a goal using the least possible amount of resources, such as time, energy, money or materials. In other words, it is about achieving optimal results with efficient use of available resources. Efficiency is a fundamental concept in a variety of contexts, from economics and engineering to business management and everyday life.

Adam Smith, considered the father of modern economics, defined efficiency in his work 'The Wealth of Nations' (1776) by arguing that efficiency is achieved when resources are allocated optimally in a competitive market economy, so that production and consumption are maximised. In other words, efficiency is achieved when individuals and firms can pursue their own economic self-interest without excessive government intervention.

1.1.2.2 Effectiveness

Effectiveness, on the other hand, refers to the ability to achieve desired results or to meet a specific objective successfully. It is the extent to which a person, organisation, process or system can perform a task or achieve a result effectively and successfully. Effectiveness involves doing things the right way to achieve a given result.

In the flower industry, effectiveness relates to the ability to meet quality standards and satisfy market demands.

Another author, Stephen R. Covey in his book 'The 7 Habits of Highly Effective People' (2003), defines effectiveness as 'the ability to achieve desired results through a combination of personal effectiveness (doing the right thing) and efficiency (doing it right)'.

1.1.2.3. Productivity

Productivity refers to the efficiency with which resources are used to produce outputs, services or outcomes. In a broader context, productivity relates to the relationship between the amount of output or work done and the resources used in that process. In other words, it is about doing more with less. Productivity can be applied to different areas, such as industrial production, agriculture, services, the economy in general and even at the personal level. In each of these cases, the aim is to maximise production or output by making optimal use of available resources.

George E. Monahan, in 'Management Planning and Control Systems' (1984), argued that productivity is essential for the growth of organisations and in the flower industry, increasing productivity is key to maintaining competitiveness.

1.1.2.4. Continuous Improvement

Continuous improvement is a business concept and approach that refers to the constant and systematic process of seeking and implementing improvements in all aspects of an organisation, its processes, products or services. The main objective of continuous improvement is to increase the efficiency, quality and overall performance of a company or entity, in order to better meet the needs of its customers, reduce costs, minimise waste and remain competitive in a constantly evolving marketplace.

2. Traditional and Modern Methods of Time and Motion Studies

Time and motion analysis is a technique used in operations management and productivity improvement in a variety of industrial and commercial environments. Over time, both traditional and modern methods of time and motion studies have emerged. Some of the most common traditional and modern methods are described below:

Traditional Methods:

- Manual timing
- Therbligs movement studies

- Process flow diagrams
- Work sampling.

Contemporary authors such as Michael R. Losey in 'Making Quality Work' (1995) have discussed the evolution of traditional methods towards more modern approaches, such as the use of advanced technology, simulation software and process analysis.

Modern Methods:

- Time and motion study software.
- Time study by automatic observation
- Process simulation
- Predetermined time studies
- Lean Manufacturing and Six Sigma

3. Factors Affecting Efficiency in the Floriculture Industry

The adoption of advanced technologies and automation systems can increase efficiency by improving the accuracy and speed of production. Authors such as Frederick W. Taylor and his focus on 'scientific management' highlighted the importance of technology in industrial efficiency. Efficiency in the floriculture industry can be influenced by a number of factors that affect production, product quality and profitability of operations. Some of the key factors that can affect efficiency in the floriculture industry include:

1. Climate and weather conditions
2. Crop and variety selection
3. Technology and equipment
4. Resource management
5. Labour
6. Logistics and distribution
7. Pest and disease control
8. Soil quality
9. Market and demand
10. Regulations and standards
11. Innovation and new product development

4.- Standards and Regulations Applicable to the Floriculture Sector

The floriculture sector is subject to a number of rules and regulations that vary from country to country and region to region. These regulations are implemented to ensure product quality, consumer safety and environmental protection. Here is a list of some of the common rules and regulations that may apply to the floricultural sector:

- Quality and Labelling Regulations
- Phytosanitary Regulations
- International Trade Regulations
- Labour Regulations
- Environmental Regulations
- Transport and Logistics Regulations
- Import and Export Regulations
- Consumer Protection Regulations
- Intellectual Property Regulations

It is important to note that regulations can change over time and may vary by geographic location. Therefore, it is essential to keep up to date and comply with all applicable regulations in your geographic area and in the markets to which you export your products. Consulting with local legal experts and phytosanitary authorities is a good practice to ensure regulatory compliance in the floriculture sector.

5.- Floriculture in Villa Guerrero

Villa Guerrero is a municipality in the State of Mexico, Mexico, which has excelled in the floriculture industry. Floriculture is an important economic activity in this region due to its favourable climate and geographical conditions that make it favourable for the cultivation of various species of flowers. The varieties of flowers grown in this area include roses, carnations, chrysanthemums, tulips, lilies, gladiolus and sunflowers, among others. The diversity of species allows producers to serve a wide range of markets and demands. All this has been possible because Villa Guerrero has a favourable climate, as the geographical location of Villa Guerrero provides a suitable climate for floriculture. The moderate temperatures and altitude are key factors that favour the growth of flowers.

Floriculture in Villa Guerrero is an important source of employment in the region. The production and harvesting of flowers requires labour, which benefits the local community. In addition to supplying the local and national market, many producers in Villa Guerrero export their flowers to countries such as the United States and Canada, which contributes significantly to the local and national economy.

5.1 Floriculture Company ‘Flor de María’.

The flower company, ‘Flor de María’, is a business specialising in the production, sale and distribution and export of fresh flowers and flower arrangements. Its main objective is to provide its customers with a wide variety of high quality flowers and design options to meet various needs and occasions.

5.1.2 Vision

To be recognised worldwide as the leading supplier of fresh flowers, offering the highest quality and sustainable products, maintaining a close relationship with our customers and contributing to the development of our communities.

5.1.3 Mission

At Flores De Maria we are dedicated to growing flowers in a responsible and sustainable way, meeting the highest quality standards. We export our flowers to different countries, bringing beauty and joy through our products.

5.1.4. Products

At ‘Flores De Maria’ we grow a wide variety of flowers, including roses, carnations, lilies, tulips, sunflowers, and many more. We work with modern and environmentally friendly cultivation techniques, which allows us to offer fresh, beautiful and long lasting flowers.

5.1.5 Location

The company ‘Flor de Maria’ is located in the municipality of Villa Guerrero, Mexico on the road km 55 Tenancingo - Ixtapan de la Sal.

Box 1



Figure 1
Company Flores de María

Source: Image captured by the authors

Methodology

The careful selection of an appropriate methodological approach is essential to ensure the validity and reliability of the results. In this sense, a quantitative approach was adopted that will allow the systematic collection of data related to the execution times of specific tasks and the movements involved in the flower production processes in the Flor de María company. In addition, qualitative techniques were used to capture contextual information and workers' perceptions, bringing a holistic perspective to the research.

The study population consisted of various flower production units of the Flor de María company, which were representatively selected to ensure the generalisability of the results. The use of instruments such as stopwatches and video cameras facilitated the accurate capture of time and movement information, allowing for a detailed analysis of the production processes. In addition to the use of questionnaires addressed to the workers focused on the study variables for the correct diagnosis of the rose packaging area focused on the analysis of continuous improvement.

In addition to the implementation of methodologies such as the 5S, carrying out a Layout (representation of a plan on which the distribution of a specific or determined space was drawn) made in AutoCad (design software) that showed the work area that the company currently has and also the desired future state, the standardisation of work methods, The training of personnel, due to the fact that it was intended to carry out the implementation of the recommended changes by measuring and monitoring to evaluate the company's capacity to carry out these activities, as well as including data on the time it takes to carry out a series of processes in the packaging area.

On the other hand, analyses were carried out for the implementation of the forklift, which was subsequently worked on in Solidworks (mechanical design software), complemented in turn with the following analyses:

- Analysis of existing packaging processes: An exhaustive review of the packaging processes currently used in the Flores De Maria company was carried out, including the selection of packaging materials, packaging techniques, packaging times, and quality control systems.
- Needs assessment: First, an analysis was conducted to determine the specific needs and determine the purpose of the forklift, such as the type of load to be transported, the maximum height needed, the required load capacity, among others. This allowed the selection of the appropriate type of forklift to be applied in the company.

Results

The company Flores de María currently has 30 employees, who are responsible for the production of flowers/roses and their derivatives. In the packaging area there are 15 employees who carry out the various tasks described in the packaging area. And in the administrative area there are 3 employees who are in charge of keeping each of the areas of this company in order. On the other hand, there are the truck operators (drivers).

Packing process of the company 'Flor de María'.

The flower packaging process is a crucial part of the supply chain of the flower industry, as it ensures that the flowers arrive at their final destination in optimal and attractive condition. Here is an overview of the flower packaging process carried out by 'Flor de Maria':

1. Harvesting: The process starts with harvesting the flowers at the right time, when they are in full bloom, but have not yet reached their maximum opening. This is done to ensure that the flowers have a longer shelf life once they are delivered.
2. Sorting and grading: After harvesting, the flowers are sorted and graded according to their type, size and quality. Damaged or wilted flowers are discarded, and only the best are used in the packaging process.

3. **Cleaning and preparation:** Selected flowers are cleaned of unwanted leaves and thorns, and stems are trimmed to uniform length. This facilitates the handling and packaging of the flowers.
4. **Hydration:** To ensure that the flowers maintain their freshness during transport, they are soaked in water to absorb moisture before packing. This helps prevent dehydration.
5. **Individual packaging:** Flowers are individually wrapped in paper or plastic to protect them and maintain their shape. This also helps prevent damage during transport and prevents the flowers from rubbing against each other.
6. **Packing in boxes:** After being individually packed, the flowers are grouped in batches and placed in special boxes designed for transporting flowers. These boxes are usually perforated to allow air circulation and prevent the flowers from overheating.
7. **Adding additional elements:** Depending on the occasion, additional elements can be added to the packaging, such as cards with personalised messages, ribbons, or even decorative paper wrappings.
8. **Labelling:** Each box of flowers is usually labelled with important information, such as the type of flowers, number of stems, harvest date and care instructions. This facilitates identification and proper handling of the flowers.
9. **Proper storage conditions:** Packed flower boxes are stored in a temperature and humidity controlled area until ready for shipment.
10. **Transport:** Flower boxes are transported in refrigerated or temperature-controlled trucks to keep them cool during transport.
11. **Delivery to the recipient:** Finally, the packaged flowers are delivered to the final recipient, either at a flower shop, an event or directly to a customer. It is important that the recipient follows the care instructions provided to ensure the longevity of the flowers.

The flower packaging process is critical to maintaining the freshness and beauty of the flowers during their journey from the field to their final destination, whether in a bouquet of fresh flowers or in a floral arrangement.

Box 2



Figure 2
Rose selection

Source: Image captured by the authors

Box 3



Figure 3
Rose hydration

Source: Image captured by the authors

Box 4



Figure 4
Hydration of flowers

Source: Image captured by the authors

- Once the rose packaging process had been identified, three questionnaires were applied to the workers in order to identify their knowledge of the processes carried out during the packaging of the rose, as well as some elements of the 5s and industrial safety methodologies.
- During the packaging of the rose, as well as some elements of the 5s and industrial safety methodologies.

In the first survey, which consisted of 15 closed questions, the following results were obtained:

- All employees have an idea of what continuous improvement is, they know the totality of the operation processes that the company Flor de María carries out and they think that there are problems to carry out these, however, talking with the management, they do not agree with what the employees perceive, besides 47% of the employees believe that the operation processes are not standardised in all areas of the company.
- All employees stated that they were informed in a transparent manner about the activities to be carried out in the packing area.
- It was emphasised that the supervision carries out a daily review of activities,
- The employees stated that they were not aware of the 5s methodology,
- 33% of the employees stated that the supervision does not carry out frequent cleaning in the work areas and coincided with the fact that 100% of them believe that the cleaning is inadequate and that it makes them feel uncomfortable carrying out their activities. This indicates that the cleaning is not adequate and that it makes them feel uncomfortable performing their activities.
- It should be noted that 60% of the employees feel a hostile work environment, and 100% of them stated that there is a problem of organisational culture in the company, as it is likely that employees are experiencing conflict or tension among themselves, which is affecting their ability to work together effectively.

The second questionnaire was carried out with a test-type design to prioritise the causes of operational problems in the work area of the company flores de maría, as the objective of this was to gather important information that would help to detect the problems that exist within the company flores de María, problems that have caused imbalance within the processes that are carried out within the company, where the following was discovered:

- Lack of continuous administration, which can be interpreted as a problem with the management of employees. This is because the number of employees who have a low or medium level of satisfaction with management.
- The majority of employees (7 out of 15) rate the shortcomings in the operations area as 'low' (1 on the scale). This suggests that a significant portion of your employees perceive that the operations department is performing well in terms of avoiding defects.
- Most employees view the quality of operations as good or acceptable.
- All employees consider that the use of resources in the company is efficient and that there are no serious problems of misuse. This suggests proper management of resources in your company, which is a positive sign in terms of efficiency and profitability.
- All employees consider relations with external operators to be good or acceptable.
- Employee perceptions vary in relation to workplace safety and the risk of accidents. The majority consider that there are areas for improvement in safety and recognise a moderate risk, but a minority perceive safety to be poor and the risk of accidents to be high. It is important to address these concerns to ensure a safe and healthy working environment for all employees.
- Most employees consider the company to be efficient in terms of lost time and short response times.
- Employee perceptions vary in relation to the lack of organisational culture and personal discipline. The majority consider that there are areas for improvement, but a minority group perceives that there are significant problems in these areas.

Questionnaire 3, also applied to the employees of the company 'Flor de María', was applied as a test with the 5s methodology approach, where it was classified into 5 sections, each referring to an S of the methodology, starting with Seiri (Select) and ending with Shitsuke (Follow-up).

- The majority of employees rated the cleanliness of their workplace as 'bad' (2 on the scale), suggesting widespread dissatisfaction in this area. A smaller group rated it as 'excellent' (5).
- The majority of employees rated waste separation at their workplace as 'very bad' (1 on the scale).
- The majority of employees rated the maintenance of tools, machinery and equipment at their workplace as 'poor'. It is important to consider improvements in maintenance to ensure that tools and equipment are in optimal and safe condition for use.
- The fact that all employees rated the signage as 'very bad' suggests a serious problem with the organisation and signage in the workplace in relation to the location of tools. This can hinder efficiency and productivity, as employees may waste time searching for tools instead of performing their tasks effectively.
- The 66.67% who responded affirmatively indicate that the majority of employees are aware of the existence of a method or guide for the arrangement of equipment and tools in their workplace. This suggests that procedures or criteria are in place to maintain order and organisation in the workplace, which can contribute to efficiency and safety.

The fact that 100% of employees responded that there is no consistent compliance with occupational health, safety and hygiene standards is a serious concern. This suggests that, in the perception of employees, rules and practices related to safety, hygiene and health in the workplace are not being adequately or consistently followed.

Time measurement of processes

Box 5

Table 1

Time study of the operations carried out in the packaging area of the company Flores De María

ESTUDIO DE TIEMPOS																
OPERACION		Empaque de Rosa														
DEPARTAMENTO	Universitario del trabajo			Inicio		12:00 p. m.		Fecha		21/06/2023		Operador	Team Gordis			
# DE PARTE				Detención		15:20		Turno: Primero				Analista	Diter Gabriel			
TAMAÑO				Eficiencia (Tiempo transcurrido)				Estudio: 1								
				Producción				Hoja: 1								
				Tiempo estimado.		4 días		6%								
OBSERVACIONES																
ELEMENTOS		CICLOS										Suma	Media	Calificación	Normal	
		1	2	3	4	5	6	7	8	9	10					
1.-	Defoliación/Rehidratación	4.7	3.9	7	5.1	1.8	5.2	6.6	5.4	2.6	3.9			1.00		
2.-	Calibración	25.6	24.28	30.28	28.4	37.52	32.28	40.6	30.8	21.6	25.84	46.2	4.62	1.00	4.62	
3.-	Empaque/Despetalado	33	26.08	26.94	38.6	27	31.6	29.6	37.6	32.1	29.8	296.7	29.67	1.00	29.67	
4.-	Corte de tallo/Etiquetado	0.7	0.6	0.8	0.8	0.8	0.9	0.8	0.9	0.6	0.3	7.2	0.72	1.00	0.72	
5.-	Estibo	10.82	14.9	13.2	16.8	17.3	9.3	11.2	15.4	8.2	16.9	134.02	13.4	1.00	13.402	
												935.882				

Source: Own elaboration

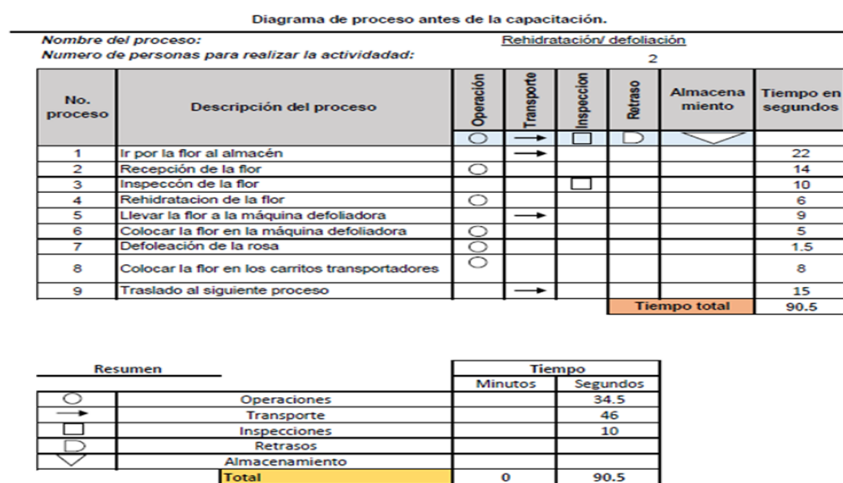
On the left side of the table, each of the operations carried out in the packaging area of the company "Flores De María" can be seen. On the cycle side; are the observations that were taken from each of these processes, which were 10 for each process and measured the time it takes each operator to perform them, these were measured in seconds. And on the right hand side we have the results that will be described as follows:

- Sum: This is the sum of the times taken by each operator to carry out the tasks described above, from the 10 observations for each of the processes.
- Mean: From the sum of the observations per process carried out, the mean of that time is obtained.
- Rating: This is provided personally to each operator who carries out the processes, depending on the performance observed by the person in charge of carrying out the time study.
- Normal: The normal is simply obtained by multiplying the rating of each operator by the average of this same operator.

Box 6

Table 2

Process diagram before training (rehydration/defoliation)



This is the first process carried out in the packing area, where the operators receive the rose from the raw material warehouse and carry out certain activities mentioned in the diagram above; these are described as simply as possible in order to understand the movements and time involved in this process.

Box 7**Table 3**

Process diagram before training (calibration)

Diagrama de proceso antes de la capacitación.

Nombre del proceso: Calibración
 Numero de personas para realizar la actividad: 2

No. paso	Descripción del proceso	Operación	Transporte	Inspeccion	Retraso	Almacenamiento	Tiempo en segundos
1	Ir al carrito transportador la rosa	○	→	□	▷	▽	12
2	Recepción de la flor	○	→				7
3	Selección de la flor	○					18
4	Medición del tallo de la rosa	○					10
5	Se clasifica la rosa al tamaño del tallo	○					7
6	Se coloca la rosa en los carritos tranpostadores según su tamaño	○					11
7	Se hace el traslado hacia el siguiente proceso		→				18
Tiempo total							83

Resumen		Tiempo	
		Minutos	Segundos
○	Operaciones		53
→	Transporte		30
□	Inspecciones		
▷	Retrasos		
▽	Almacenamiento		
Total		0	83

Source: Own elaboration

A problem that we observed in the field research carried out in the packaging area of the company Flores de María was the lack of organisation and the distribution of its areas was not the most adequate because the operators collided with each other when transporting the product, which was the main bottleneck in this process.

Box 8**Table 4**

Process diagram before training (packaging/de-palletising)

Diagrama de proceso antes de la capacitación.

Nombre del proceso: Empaque/despetalado
 Numero de personas para realizar la actividad: 7

No. paso	Descripción del proceso	Operación	Transporte	Inspeccion	Retraso	Almacenamiento	Tiempo en segundos
1	Los operadores van por la rosa al carrito transportador	○	→	□	▷	▽	23
2	Se hace la selección de la rosa	○					15
3	Se empaqueta la rosa	○					118
4	Se colocan las grapas al paquete	○					8
5	Se colocan las ligas a los tallos	○					23
6	Se procede a colocar el paquete en la banda transportadora	○					6
7	Traslado de la rosa sobre la banda transportadora	○					16
Tiempo total							209

Resumen		Tiempo	
		Minutos	Segundos
○	Operaciones	3	6
→	Transporte		23
□	Inspecciones		
▷	Retrasos		
▽	Almacenamiento		
Total		3	29

Similarly, the lack of flow for the transfer of products leaves much to be desired and this was the most time consuming aspect when carrying out the operations of these processes, we must mitigate this aspect.

Box 9**Table 5**

Process flow chart before training (stem cutting/labelling)

Diagrama de proceso antes de la capacitación.

Nombre del proceso: Corte de tallo/etiquetado
 Numero de personas para realizar la actividad: 2

No. paso	Descripción del proceso	Operación	Transporte	Inspección	Retraso	Almacenamiento	Tiempo en segundos
1	El operador recibe la los paquetes de rosa	○	→	□	⏸	▽	11
2	Inspección de los paquetes de rosa	○		□			5
3	Elaboración de las etiquetas (según el tipo de rosa)	○					18
4	Colocar etiquetas	○					2
5	Medir los tallos	○					9
6	Cortar el tallo sobrante	○					5
7	Registrar el código de barras de las etiquetas	○					14
8	Colocar en la mesa de producto terminado	○					15
Tiempo total							79

Resumen		Tiempo	
		Minutos	Segundos
○	Operaciones		74
→	Transporte		
□	Inspecciones		5
⏸	Retrasos		
▽	Almacenamiento		
Total		0	79

In this process, the main aim is to train the operators on how their work areas should be organised, they should learn to classify which tools/materials are most used and those that are not, to place them elsewhere to avoid unnecessary movements.

Box 10**Table 6**

Process diagram before training (stowage)

Diagrama de proceso antes de la capacitación.

Nombre del proceso: Estibo
 Numero de personas para realizar la actividad: 2

No. paso	Descripción del proceso	Operación	Transporte	Inspección	Retraso	Almacenamiento	Tiempo en segundos
1	El operador recibe los paquetes	○	→	□	⏸	▽	5
2	El operador revisa el número de lote			□			4
3	El operador clasifica los paquetes por lote	○					12
4	El operador se dirige hacia las proconas con los paquetes		→				21
5	El operador acomoda los paquetes en las proconas	○					30
6	Llena las proconas con cada lote (lote, color o calidad de la rosa)	○				
7	Acomoda las proconas en los racks transportables	○					25
8	Se lleva los racks al almacén de producto terminado		→				40
9	Acomoda los racks en el almacén	○					20
Tiempo total							157

Resumen		Tiempo	
		Minutos	Segundos
○	Operaciones	1	32
→	Transporte		61
□	Inspecciones		4
⏸	Retrasos		
▽	Almacenamiento		
Total		1	97

This process was the one that consumed the most time when moving the products, due to the lack of signs in the work area; this caused confusion for the operators, as they did not know where they had to pass and they got in each other's way, and the excessive use of proconas had to be mitigated, as it also caused a bottleneck at the time of accommodating the production.

Box 11

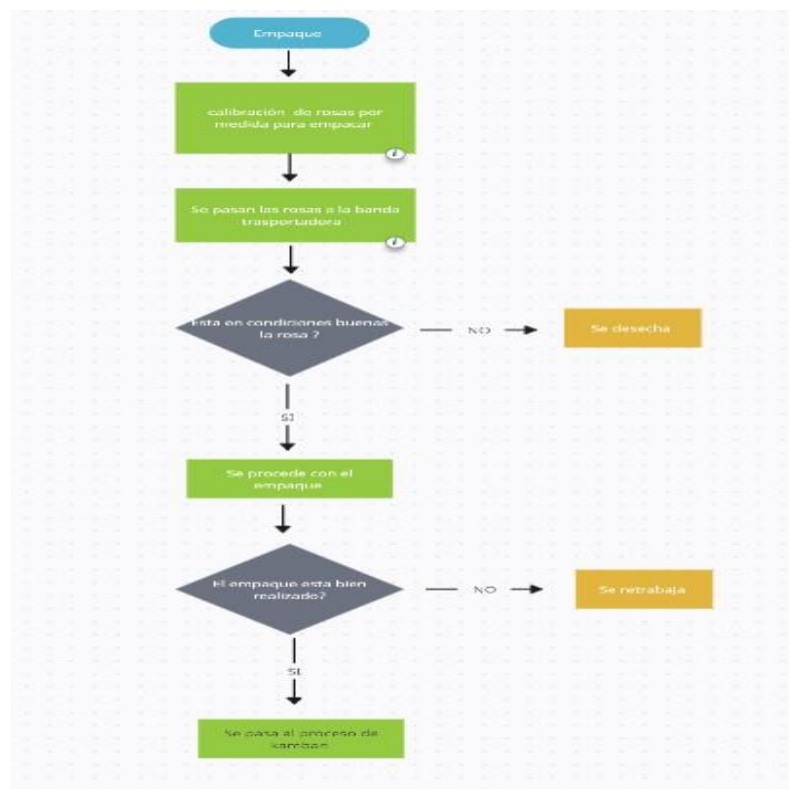


Figure 5

Flow chart of the Flores De Maria company

The flow chart in the picture shows the process of selecting roses for packaging. The process starts with the reception of the roses, which are sorted according to size, colour and quality. Roses that meet the quality standards are moved to the conveyor belt, where they are rotated to check their condition. Roses that are not in suitable condition are removed. Roses that pass inspection are packaged and shipped to customers.

Below are some additional comments on the flow chart:

- The diagram is clear and concise.
- The diagram is easy to follow.
- The diagram includes all steps of the process.

Overall, the flow chart is a useful tool to document and improve the process of selecting roses for packaging.

2. Cause and effect diagram of fleur de merie

Box 12

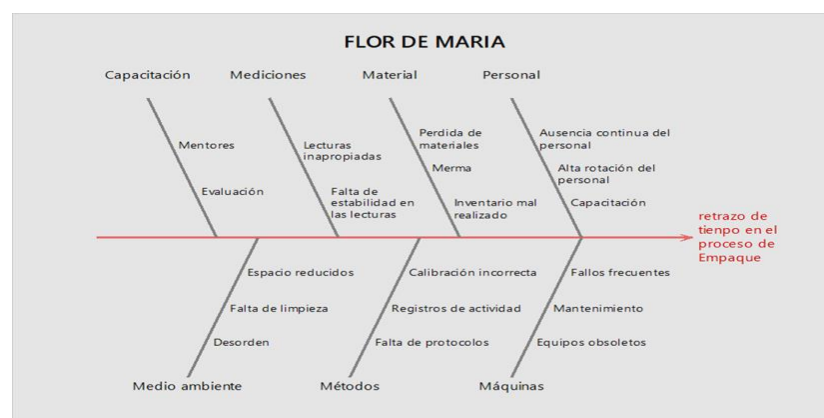


Figure 6

Ishikawa Diagram of the company Flores de María

Source: Own elaboration

The cause and effect diagram in the picture shows the potential causes of a decrease in the quality of the products of a company called "FLOR DE MARIA". The diagram is divided into five main categories:

- Training: Staff are not adequately trained to do their job properly.
- Measurements: The measurements taken are not accurate or are not representative of the quality of the product.
- Material: The material used is not of adequate quality.
- Personnel: Personnel are unreliable or unmotivated.
- Methods: Production methods are not efficient or are not followed correctly.

Within each category, there are specific causes that may be contributing to the decline in quality. For example, in the "Training" category, specific causes may be:

- Lack of initial training
- Lack of ongoing training
- Inadequate training

Flor de María's current state VSM diagram

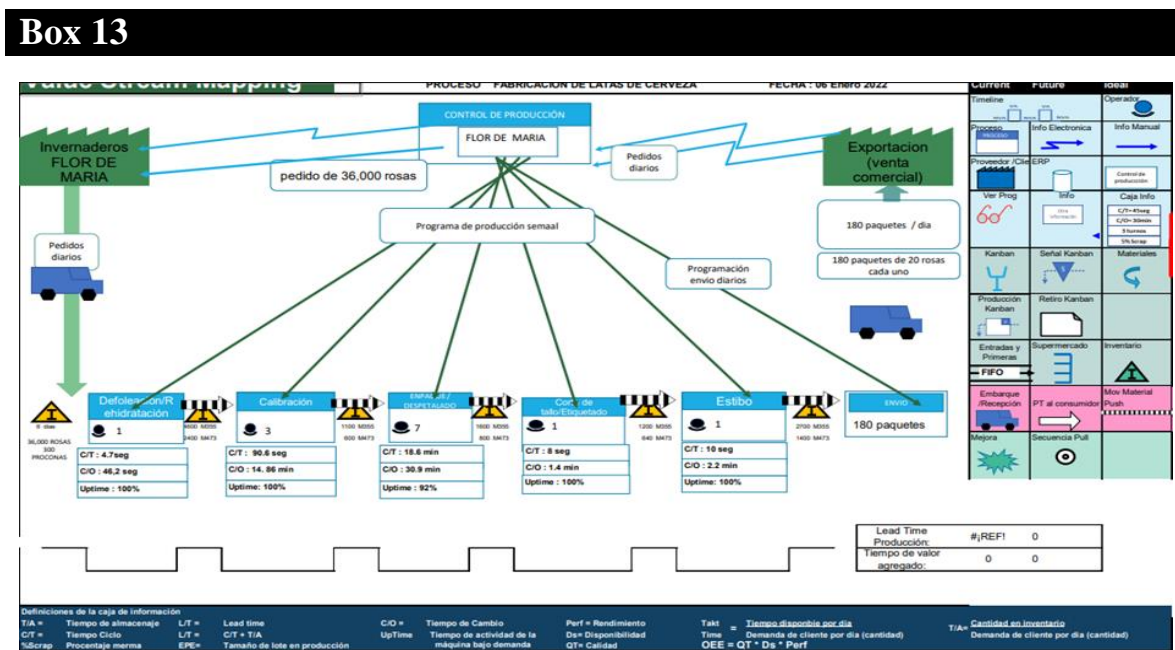


Figure 7

VSM of the company Flores de María

Source: Own elaboration

The VSM shown in the image represents the packaging process. The process starts with the receipt of daily orders from customers. These orders are sent to Flor de Maria's greenhouses, where the flowers are grown. Once the flowers are ready, they are sent to the factory for processing. At the factory, the flowers go through a defoliation and rehydration process. They are then calibrated to the same size. After calibration, the flowers are placed in beer mugs and sent to the warehouse.

The VSM shows that the cycle time of the process is 30.9 minutes. The value-added time is 18.6 minutes, which represents the time it takes to process the flowers. The non-value added time is 12.3 minutes, representing the time taken to transport the flowers and waiting times. The VSM also shows that the shrinkage rate is 0%. This means that no flowers are wasted during the production process.

Conclusions

In the specific context of the floriculture company Flores De Maria, challenges associated with seasonal variations in demand are identified. The lack of technical/practical control of timing and movements in processes and packaging has resulted in loss of sales and customers. It is proposed that the implementation of time and motion studies can be a solution to improve productivity.

Based on the general objective and the expected results, it is affirmed that the implementation of the methodology has satisfactorily fulfilled the established objectives, contributing positively to the optimisation of the processes in Flores De María.

Verifying the working hypothesis, which was that the time and motion study will help the company Flores de María to improve the working methods of the packaging process in the activities of rehydration, calibration, stem selection, labelling (kamban) in this area to increase the efficiency and effectiveness of its production. After carrying out an exhaustive analysis and application of an improved time and motion system in the rose packaging area, it is confirmed that its implementation has had a positive impact on the efficiency of the process. The optimisation has led to a significant reduction in packing times, improving productivity and reducing operating costs. This conclusion supports the original hypothesis, demonstrating that time and motion optimisation is fundamental to improve efficiency in the rose packing process.

Research on time and motion in the rose packing area has revealed valuable insights into the need to optimise these processes to achieve higher levels of efficiency and competitiveness in the industry. A thorough understanding of the importance of each step in rose packing and the effective management of the time involved is fundamental to improving the quality of the final product and reducing operating times and costs.

The implementation of strategic solutions, such as the introduction of continuous staff training and constant process improvement, emerges as an essential approach to achieve optimal levels of efficiency in the packaging area. These actions will not only have a positive impact on productivity, but will also contribute to strengthening Flor de María's market position, adapting it to changing demands and ensuring customer satisfaction.

Ultimately, the optimisation of times and movements in the rose packaging area represents not only an operational advance, but also a continuous commitment to improvement and excellence in the delivery of quality products. This research serves as the basis for the development of future strategies and the ongoing evolution of practices that will ensure Flor de Maria's continued success in the competitive floriculture sector.

Declarations

Conflict of interest

The authors declare that they have no conflicts of interest. They have no known competing financial interests or personal relationships that could have influenced this chapter.

Author contribution

Oscos-Fuentes, Eduardo: Contributed to the research technique, as well as to the design of future recommendations to the company under study.

Lara-Álvarez, Daniel Emiliano: Contributed to carrying out the research method within the company, object of study.

Castañeda-Romero, Alberto Fernando: Contributed to the project idea, research method and technique.

García-Castillo, Karla Yazmín: Contributed to the design of the research techniques, as well as field work and advice on data processing.

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Turmeric nanoparticles with β -glucan and vitamins C, D3 and zinc

Nanopartículas de cúrcuma con β -glucano y vitaminas C, D3 y zinc

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Subdiscipline: Food Technology

Key Proceeding

The main contributions of this research to generating science and technology lie in its innovative approach to synthesizing turmeric nanoparticles loaded with β -glucan, vitamins C, D3, and zinc, specifically designed for food supplement applications. This advancement showcases how nanotechnology can enhance the nutritional and functional value of dietary products. The integration of various characterization techniques, such as UV-VIS spectroscopy, FTIR, and SEM, along with the emphasis on cytotoxicity tests, highlights a rigorous methodology that ensures the nanoparticles' effectiveness and safety. These contributions represent a step forward in the development of functional foods and supplements, opening new possibilities for addressing consumer needs through nanotechnology. To apply the findings of this research to the generation of universal knowledge, it is essential to understand several key aspects:

1. **The synthesis process of turmeric nanoparticles:** Mastering the methods and conditions for combining bioactive compounds and ensuring their stability and functionality.
2. **Characterization techniques:** Grasping how tools like FTIR, UV-VIS, and SEM provide insights into the structural and chemical properties of the nanoparticles.
3. **Safety and bioavailability:** Recognizing the importance of conducting further studies, such as cytotoxicity assays, to validate the safe use of these nanoparticles in food applications.

The study concludes that the synthesis was successful, as validated by FTIR, UV-VIS, and SEM analyses. While further cytotoxicity studies are required to confirm bioavailability and safety, these findings establish turmeric nanoparticles as a viable option for next-generation dietary supplements.

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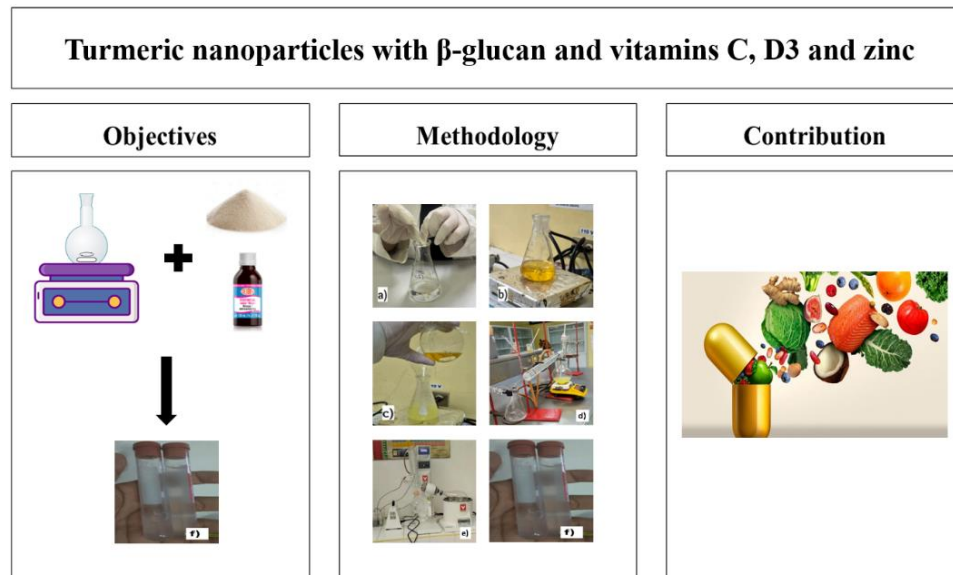
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Abstract

Nanotechnology offers extraordinary potential for its application in the food sector, focusing on meeting consumer needs. This technology enables the development of new methods to control and structure foods, enhancing their functionality and nutritional value. This study presents the methodology for synthesizing turmeric nanoparticles loaded with β -glucan and vitamins C, D3, and zinc, with the aim of using them in innovative dietary supplements. The importance of employing various characterization techniques such as UV-VIS, FTIR, and SEM, as well as conducting cytotoxicity tests, is emphasized to evaluate the properties of the nanoparticles and ensure their effectiveness and safety in food applications.



Nanoparticles, Dietary supplements, Turmeric

Resumen

La nanotecnología ofrece un potencial extraordinario para su aplicación en el sector alimentario, enfocándose en satisfacer las necesidades del consumidor. Esta tecnología permite desarrollar nuevos métodos para controlar y estructurar alimentos, mejorando su funcionalidad y valor nutritivo. En este estudio, se presenta la metodología para la síntesis de nanopartículas de cúrcuma cargadas con β -glucano y vitaminas C, D3, y zinc, con el fin de utilizarlas en suplementos alimenticios innovadores. Se subraya la importancia de emplear diversas técnicas de caracterización como UV-VIS, FTIR y SEM, además de realizar pruebas de citotoxicidad, para evaluar las propiedades de las nanopartículas y asegurar su efectividad y seguridad en aplicaciones alimenticias.



Nanopartículas, Suplementos alimenticios, Cúrcuma

Introduction

Malnutrition in Mexico is a public health issue affecting a significant portion of the population due to factors such as poverty, lack of access to healthy foods, and insufficient knowledge about a balanced diet. This context has driven a growing demand for nutritional products that are not only beneficial for health but also appetizing, novel, and cost-effective. Within this scope, natural dietary supplements have gained considerable relevance. These products, designed to complement the daily diet, contain ingredients that provide essential nutrients such as vitamins, minerals, amino acids, and other bioactive compounds that may not be present in sufficient quantities in everyday food [1].

With increasing concern for health and well-being, consumers are more interested in products that are not only effective in improving nutritional status but also environmentally friendly and sustainable. This interest has led to innovation within the dietary supplement industry, focusing on enhancing nutrient bioavailability and incorporating products that support immunity and mental health. Additionally, eco-friendly and natural products are becoming more popular as consumers seek options that align with a healthy lifestyle and environmental consciousness [2].

In this context, nanotechnology has emerged as a key tool in the evolution of dietary supplements and the food industry in general. The application of nanotechnology enables the creation of more efficient and targeted products, improving the absorption and effectiveness of nutrients in the human body [3,4]. A study by Le et al. (2016) found that combining curcumin with β -glucan 1-3/1-6 from medicinal mushrooms (*Hericium erinaceus* and *Ganoderma lucidum*) exhibits enhanced biological activity compared to free curcumin, promoting its use in developing more effective treatments for various diseases [5].

Morsy et al. (2023) investigated the use of curcumin nanoparticles as natural antioxidants and antimicrobial preservatives in processed food products, specifically chicken fingers. The research demonstrated that curcumin nanoparticles have significant potential to improve food safety and shelf life by reducing the proliferation of pathogenic microorganisms and delaying oxidative spoilage in processed chicken fingers [6].

In summary, the reviewed literature supports the use of turmeric nanoparticles as a safe material for both biomedical and nutritional applications, due to their optimal biological properties such as biocompatibility, biodegradability, and non-cytotoxicity. Therefore, the present project aims to synthesize turmeric nanoparticles loaded with β -glucan and vitamins C, D3, and zinc to evaluate their use in dietary supplements.

Methodology

The methodology used in this work is based on the studies reported by Gómez et al. (2018) and Le et al. (2016). The process employed for the synthesis of turmeric nanoparticles encapsulated in β -glucan, with the addition of vitamins C, D3, and zinc, using the chemical precipitation method is described below [5,9].

Initially, two precursor solutions were prepared. The first solution was obtained by adding 10 mg of commercial turmeric to 100 mL of ethanol. This mixture was stirred constantly at 120 RPM at room temperature for 60 minutes, ensuring a uniform dissolution of turmeric in the solvent.

Simultaneously, a second solution was prepared by adding 20 mg of a β -glucan and vitamin concentrate to 100 mL of distilled water. This solution was stirred at 140 RPM at a controlled temperature of 20°C for 90 minutes, promoting the complete dissolution of the bioactive components in the water.

Once both solutions were obtained, they were mixed under constant agitation at room temperature for 48 hours to facilitate the interaction and formation of the nanoparticles. Subsequently, the product was subjected to a distillation process for 4 hours, which promoted the chemical reaction necessary for the encapsulation of turmeric in β -glucan and the integration of the vitamins.

After distillation, the solvent was evaporated using rotary evaporation, resulting in a viscous solution with a characteristic yellow color. Finally, the sample was centrifuged at 3,000 RPM for 30 minutes, removing the non-encapsulated free turmeric.

Characterizations

1. Ultraviolet-visible spectroscopy

The presence of curcumin in its bioactive form within the nanoparticles was confirmed using UV-VIS spectroscopy, a technique that allowed the analysis of molecular interactions between curcumin and additional components such as β -glucan, vitamins C, D3, and zinc. This analysis was conducted using a VWR® UV-6300PC UV/Vis Spectrophotometer.

2. Fourier-Transform Infrared Spectroscopy (FTIR)

The incorporation of β -glucan, vitamins, and zinc was confirmed through FTIR analysis. This analysis was conducted using a Nicolet IS50 infrared spectrophotometer from Thermo Scientific, employing the ATR (Attenuated Total Reflection) mode with 32 scans over a wavenumber range of 4000 – 400 cm^{-1} .

3. Scanning Electron Microscopy (SEM)

The surface morphology and nano particle size of nano-curcumin was determined using using Scanning Electron Microscopy (SEM) analysis, employing a high-resolution HRSEM microscope brand AURIGA.

Results

Ultraviolet-visible spectroscopy

The analysis of the UV-VIS spectrum of turmeric nanoparticles loaded with β -glucan, vitamins C, D3, and zinc shows key characteristics reflecting the interaction of these components with curcumin and their effect on optical properties. In the spectrum (Figure 1), shows a characteristic absorption peak around 350-360 nm. This peak is primarily attributed to the π - π electronic transitions within the aromatic systems of the turmeric NPs, the main active compound in turmeric.

Also a decrease in absorbance around 370 nm is observed. This indicates that the presence of β -glucan and the vitamins is slightly altering the position and intensity of the peak due to molecular interactions. Additionally, the decrease in absorbance at longer wavelengths may be related to the size of the nanoparticles and their ability to scatter light, a typical phenomenon in nanostructured systems. This behavior is consistent with the literature [7], which also reports that the functionalization of curcumin nanoparticles with compounds such as β -glucan and vitamins enhances their effectiveness in health applications.

Box 1

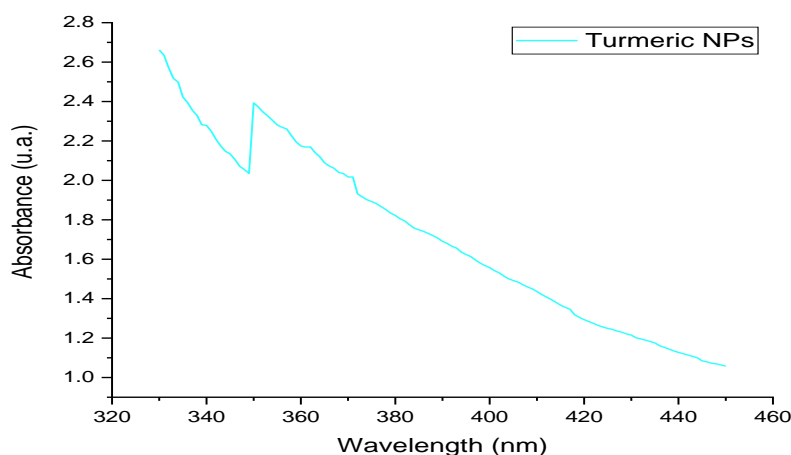


Figure 1

UV/VIS spectra of synthesized turmeric nanoparticles loaded with β -glucan and vitamins C, D3 and zinc

Fourier-Transform Infrared Spectroscopy (FTIR)

In Figure 2, the spectrum corresponding to the turmeric nanoparticles is shown. A band at 3311 cm^{-1} was observed, attributed to the vibrations of hydroxyl groups (-OH), indicating the presence of bonds related to the surface functionalization of the nanoparticles.

Additionally, a signal at 2923 cm^{-1} was recorded, characteristic of aliphatic C-H stretching vibrations, which reinforces the presence of organic components in the structure.

The signals at 1150 and 995 cm^{-1} are attributed to the vibrations of C-O-C and C-O bonds, respectively, representing the interactions present in the curcuminoid compound. Finally, a band at 1644 cm^{-1} was identified, corresponding to the vibrations of the carbonyl group (C=O), a key signal related to the chemical structure of curcumin at the nanometric scale, in accordance with the report by Kanwal et al. (2023) [8].

Box 2

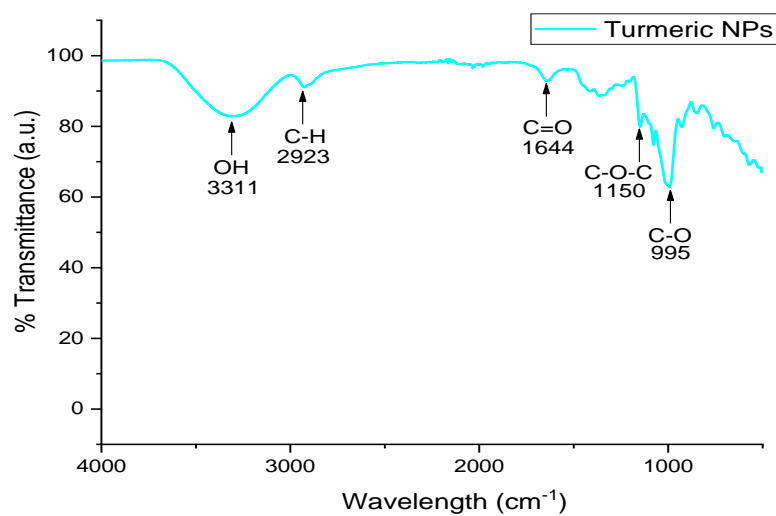


Figure 2

FTIR spectrum of turmeric NPs

Scanning Electron Microscopy (SEM)

The SEM spectrographs were recorded at 5000x magnification. According to SEM analysis the particles exhibit a semi-spherical morphology, which is consistent with the findings reported in the scientific literature [8]. Consequently, it is inferred that the particle size corresponds to the nanometric scale.

Box 3

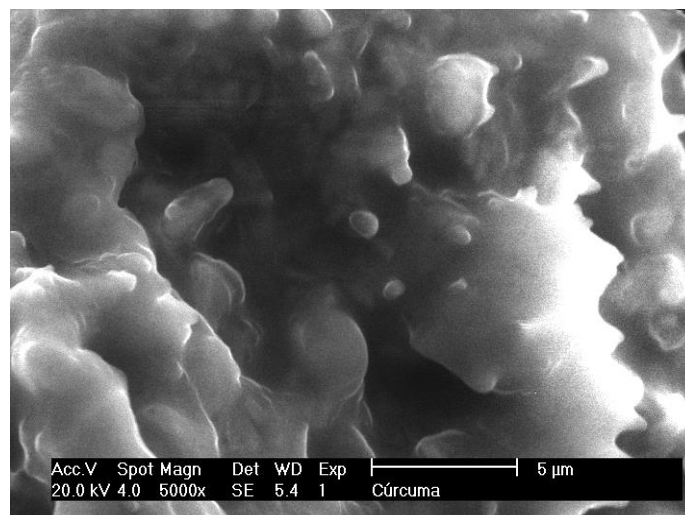


Figure 3

Scanning electron microscopic images of turmeric NPS

Final product

The samples exhibit a characteristic yellow coloration in solutions containing turmeric nanoparticles, consistent with the results reported by Gómez et al. (2018) [9]. Additionally, particle agglomeration is observed at the bottom of the container, suggesting the need for further optimization of the synthesis methodology to enhance nanoparticle stability.

Box 4

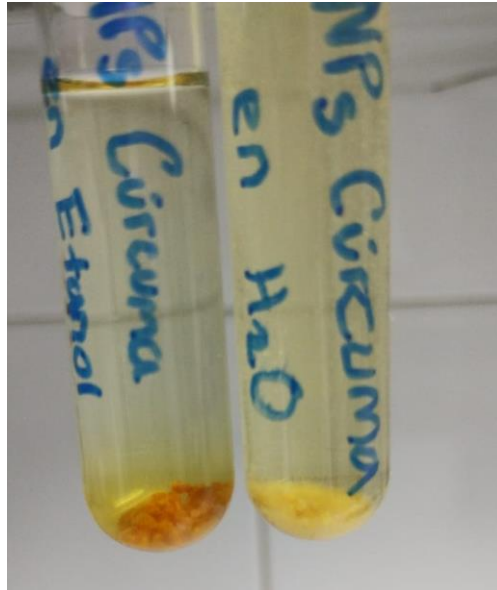


Figure 4

Synthesized turmeric nanoparticles loaded with β -glucan and vitamins C, D3 and zinc

Conclusions

The synthesis of turmeric nanoparticles loaded with β -glucan and vitamins C, D3 and zinc was successfully carried out, as confirmed by the results obtained by FTIR, UV/VIS and SEM analyses. Although further studies, such as cytotoxicity assays, are required to fully analyze their bioavailability. The results presented in this work provide a solid basis to consider turmeric nanoparticles as a promising option in the field of food supplements.

Declarations

Conflict of interest

The authors declare no interest conflict. They have no known competing financial interests or personal relationships that could have appeared to influence in this chapter.

Author contribution

Pinales-Muñiz, Karla Lucía: Contributed to the project idea and methodology research.

Nery-Cepeda, Sebastián: Contributed to the project idea and the writing of the document.

Canales-Pradis, Braulio: Contributed to the project idea and experimental development of the project.

Díaz-Silvestre, Sergio Enrique: Contributed in the methodology research and follow-up of the project.

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Acknowledgements

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Abbreviations

NPs Nanoparticles

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Basics

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Bioremediation through the use of composting

Biorremediación mediante el uso del compostaje

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Key Proceeding

Raise awareness about the importance of saving soil in our country and in the world in order to safeguard the integrity of all living beings, while giving a second use to the waste generated in homes and markets, in search of restoring ecosystems. What is bioremediation, composting and how to use it at home are the bases on which this methodology can be carried out. The methodology is efficient and provides the necessary resources to successfully bioremediate the soil in its biological, chemical, and physical properties.

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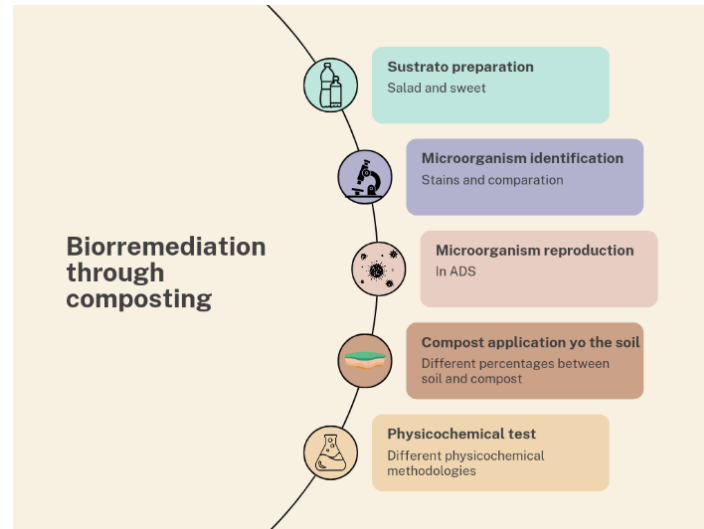
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Abstract

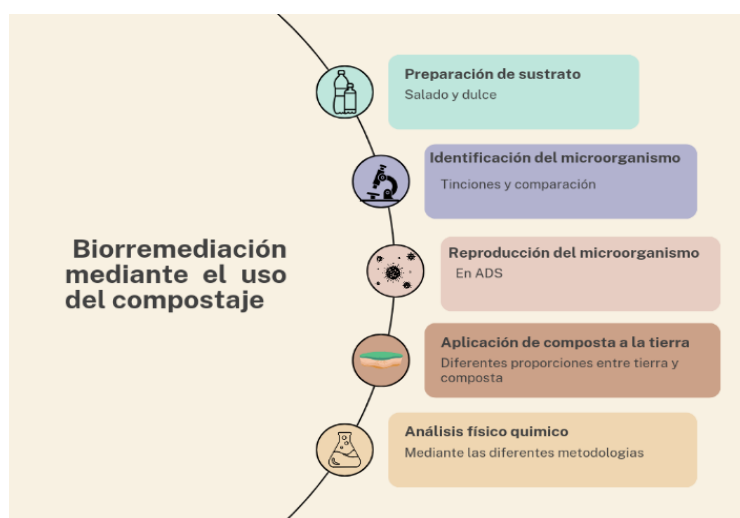
Bioremediation through Takakura composting is a method focused on the rapid and efficient decomposition of organic waste. This method uses a combination of microorganisms and natural materials to accelerate the decomposition process, producing a nutrient-rich compost to eliminate or reduce pollutants in the environment, such as soil or water. This compost can degrade or transform pollutants into less harmful or inert substances. In addition, it provides macro and micronutrients that provide optimal conditions for the development of various types of plants and the restoration of soil fertility. To evaluate the conditions of the soil before and after the use of compost, biological, physical and chemical tests were carried out with the compost in different proportions. The results of these tests were compared with the soil parameters established by FAO, giving guidelines to adjust or maintain the parameters.



Bioremediation, Composting, Testing

Abstract

La biorremediación mediante el compostaje Takakura es un método enfocado en la descomposición rápida y eficiente de residuos orgánicos. Este método utiliza una combinación de microorganismos y materiales naturales para acelerar el proceso de descomposición, produciendo un compost rico en nutrientes para eliminar o reducir contaminantes en el medio ambiente, como suelos o aguas. Este compostaje puede degradar o transformar los contaminantes en sustancias menos dañinas o inertes. Aunado a esto aporta macro y micronutrientes que aportan las condiciones óptimas para el desarrollo de diversos tipos de plantas y la restauración de fertilidad en la tierra. Para evaluar las condiciones de la tierra antes y después del uso de compostaje se realizaron pruebas de carácter biológico, físico y químico con la composta en diferentes proporciones. Los resultados de estas pruebas fueron comparados con los parámetros de suelos establecidos por la FAO dando pauta a realizar ajustes o mantener los parámetros.



Biorremediación, Compostaje, Pruebas

Introduction

Bioremediation is an innovative and sustainable approach to restoring contaminated environments, using the natural ability of living organisms to degrade, transform or stabilize pollutants. This technique, which combines biology and technology, offers an effective and environmentally friendly solution to address soil, water and air pollution.

Through bioremediation, microorganisms such as bacteria, fungi and plants work to break down and remove contaminants such as hydrocarbons, pesticides, heavy metals and other harmful chemicals. This process not only eliminates the source of contamination, but also promotes the recovery of ecosystems and the restoration of environmental well-being.

In a world where pollution is a growing problem, bioremediation emerges as a promising solution, capable of offering benefits to both the environment and society.

There are several types of bioremediation, classified according to the type of organism used, the environment treated and the technique applied. However, the different types of bioremediation are divided into 2 categories; in situ and ex situ. In situ bioremediation is a cleanup process, which is carried out directly at the site where the contaminant is found, without the need to excavate or transport the contaminated materials; its approach uses microorganisms found naturally in the environment or introduced specifically to degrade or transform the contaminants. On the other hand, ex situ bioremediation is a cleanup process that takes place at a location other than the contaminated site. This approach involves excavation and transport of contaminated materials to a controlled treatment site, where bioremediation is applied.

There are four methods of in situ bioremediation: natural attenuation, bioventing, biostimulation and bioaugmentation. There are also four ex situ bioremediation methods: landfarming, composting, biopiles and bioreactors.

In the present work, ex situ bioremediation, specifically composting, is carried out. Composting refers to a process of organic waste degradation based on anaerobic microbial metabolism that is generally carried out at temperatures between 55-65°C. These temperatures are due to the product of the composting process. These temperatures are due to the product of biological activity (Das, 2014).

Within the ex situ composting technique, different methods can be found, for example, the “Takakura”, this is an optimized composting technique based on microorganisms, which consists of preparing a previous substrate called “seed” and a fermentation bed, This provides the optimal conditions for a large number and variety of microorganisms that quickly and efficiently decompose the organic waste, and thanks to the transformation that they carry out, the fungus *Aspergillus Fumigatus* is generated, which has the function of bioremediating the soil low in nutrients.

To decompose organic waste, the Takakura method uses mainly aerobic microorganisms. This transformation is strengthened by the constant movement of the compost, i.e. the movement gives more strength to the aerobes and minimizes the action of anaerobes in the soil, promoting favourable soil conditions.

Soil is the layer of fertile material (earth) that covers the earth's surface and is the natural medium in which plants develop through their roots. It is a complex system composed of minerals, organic matter, water, air and living things that interact with each other to create an environment conducive to plant growth.

Soil has three basic properties to be considered fertile and functional. These properties are chemical, physical and biological. The chemical properties are responsible for providing the non-organic minerals that nourish the soil. The physical properties determine the rigidity and strength of the soil, the ease of root penetration, aeration, soil permeability, plasticity and nutrient retention, among other characteristics. Biological properties refer to those microorganisms that favor soil quality.

Good soil is essential for a good harvest. The soil must have all the nutrients necessary for plant growth, and a structure that keeps plants firm and upright. The soil structure must ensure sufficient air and water for plant roots but must avoid excess water through good drainage.

The importance of bioremediation through the use of compost lies in being a possible solution to improve the quality of life of all living beings, as it can increase biodiversity by creating a habitat conducive to microorganisms and plants, reduce the amount of waste sent to landfills by using it as raw material for bioremediation and help reduce the emission of greenhouse gases by promoting carbon absorption by plants.

The added value of this research is the production of compost within 1-3 months, which is faster than other composting methods, reduces the amount of waste from households and markets, not to mention that it is an economical and sustainable method, as it uses natural materials and does not require expensive equipment.

Its goal is to bioremediate various areas and give them a useful life again.

Methodology

Preparation of the Takakura Compost

The process begins with the preparation of the compost, which consists of two stages: the cultivation of microorganisms and the assembly of the fermentation bed. The cultivation of microorganisms has the function of allowing the development of microorganisms that will work on the waste to generate composting and the production of the fungus *Aspergillus Fumigatus*, for this two substrates must be prepared, one sweet and one salty, which will ferment and facilitate the decomposition of organic waste. They are left to rest under the protection of the sun for 3 to 5 days.

Once both substrates are fermented, the fermentation bed is assembled, which has the function of providing optimal conditions for the fungus and being the basis of the compost. This is left to rest for 3 to 5 days. During this period of time, it should begin to be covered with a white mold (*Aspergillus Fumigatus*), this will be the guideline that indicates that it is ready to be used.

Box 1



Figure 1
Fermentation bed

Source: Own elaboration

Microorganism confirmation (*Aspergillus Fumigatus*)

Once the fungus is available, a sample of the fungus is taken with two objectives: to perform staining tests in order to identify and confirm the species of the fungus (*Aspergillus Fumigatus*) and to perform a culture on ADS agar to reproduce it in a more accelerated manner.

For the first objective, a sample of the fungus is taken and three stains are performed: Gram, Malachite Green and Methylene Blue. Consequently, it is placed under the microscope to observe the result and compare it with different papers to ensure that it is the desired fungus.

Once the identity of the fungus is confirmed, a sample of the fungus is taken and a massive sowing is done in ADS agar and it is put in the incubator until it has a growth.

Box 2



Figure 2

Comparison of the fungus *Aspergillus Fumigatus* obtained with a paper.

Source: Own elaboration

Application to the soil

Areas of soil with low nutrients are selected and measurements are taken of humidity, pH, consistency, temperature and the color of the soil. Samples of the soil are taken and placed on a scale to determine their weight and, according to this, compost is added in different proportions.

Mix the compost with fungus and the soil with low nutrients in different proportions. To do this, the initial weight of the soil must be considered. The proportions must be 50% compost and 50% soil with low nutrients; 40% compost and 60% soil with low nutrients and finally 30% compost and 70% soil with low nutrients. Once the different mixtures are obtained, different types of plants are placed in them and their measurements are taken. In the same way, another section of soil is taken as a target to analyse its development more thoroughly.

Box 3



Figure 3

Low nutrient soil

Source: Own elaboration

Physicochemical tests

Different physicochemical tests are carried out using previously established methodologies and compared with the results of optimal parameters.

The physicochemical tests performed are colour using the Munsell method, humidity determined by a gravimetric method established in the Analytical Methods Manual of the IGA Soil Laboratory, texture by the Bouyoucos Hydrometer-Densimeter method, pH by the potentiometer method described by NTC 5264, salinity determined by the conductivity meter method, total Nitrogen established in the Micro-Kjeldahl method, total carbon by the Mehlich methodology, available phosphorus determined by the Bray method described in NTC 5350 and the quantification of organic matter by the Walkley-Black method.

Box 4

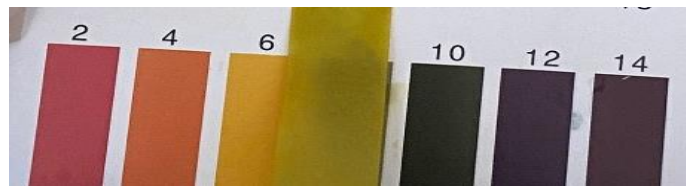


Figure 4
pH test parameter

Source: Own elaboration

Results

Tests with plants and compost

Compost was used in soil with low nutrients and a sandy consistency in different proportions, as well as compost without soil to house the plants. The compost improved the consistency and texture of the soil, which went from having a sandy consistency to a sandy-clayey one, allowing a notable change in color, in addition to improving humidity, pH and nutrient supply.

This generated that the soil had the necessary conditions to keep the plants alive and to help them develop within it, having the appearance of roots, leaves, branches and flowers.

These results are attributed to different factors, soil with a sandy consistency has a poor structure, consistency and fertility, in addition to not being able to retain water, the fungus absorbed the contaminants that it could have and over time this became unified with the soil, allowing the compost to provide the nutrients, returning the soil with a poor structure, but with adequate consistency and good fertility.

Box 5



Figure 5
Color change in the soil

Source: Own elaboration

Physicochemical tests




Samples of soil with low nutrient content were taken to be used as a blank, in addition to analysing the evolution of the conditions and characteristics of the soil once the compost was applied. Analysing the approximate time of its evolution.

The result of the tests was an increase in the fertility and general conditions of the soil as shown in the table below.

Box 6

Table 1

Results of physicochemical tests

Physicochemical test	Soil without compost (white)	Soil with compost (1 month)	Soil with compost (5 months)
Physic Tests			
Color			
Humidity	18.24%	23.57%	44%
Texture	Sandy	Clayey sand	Sandy loam
Chemical Tests			
Total Carbon	19.8 mg/kg	23.48 mg/kg	32.18 mg/kg
Disponibile Phosporus	17.2 mg/kg	20.5 mg/kg	48 mg/kg
Organic Matter	13%	26%	47%
Total Nitrogen	7.67 mg/kg	10.6 mg/kg	27.25 mg/kg
pH	4.6	5.4	6.6
Salinity	3	3	2

Conclusions

Compost provides different macronutrients such as N, P and K and micronutrients that benefit plant growth, as well as improving the physical, chemical and biological properties of the soil, as it increases soil moisture retention and cation exchange capacity, improving its fertility and structure and thus preventing erosion and degradation. Meanwhile, the fungus mobilizes or immobilizes the contaminants found in the soil, mitigating the impact of these contaminants. In addition, the amount of organic waste generated is reduced, returning valuable nutrients to the soil.

Some chemical nutrients in the soil are stable (phosphorus) while others are lost or consumed very easily (nitrogen). With this method, regular application of these nutrients can be maintained while the crop grows. Poor soil can become productive if it is well managed.

Compost is very easy to prepare and is very useful, which makes it a common factor in bioremediation due to the nutrients it contains and provides to the soil, restoring them with living microorganisms such as bacteria and fungi, while these organisms develop their life and provide a very useful service by helping to maintain the quality of the soil while the fungus *Aspergillus Fumigatus* adapts to the soil helping to eliminate undesirable harmful substances.

This method generates the conditions that plants need to develop, such as water and certain minerals. They absorb them from the soil through their roots thanks to the compost made from organic waste.

Declarations

Conflict of interest

The authors declare no interest conflict. They have no known competing financial interests or personal relationships that could have appeared to influence in this chapter.

Author contribution

Calvillo-Beltrán, Sofía Valentina: Contributed to the project conception, research method and the compost preparation. She performed the analysis of results, as well as the writing of the article.

Hernandez-Rocha, Zaira Michel: Conducted the distribution in different percentages of the compost and collaborated in the development of the comparisons for the evaluation of results. She also contributed to the drafting of the article.

Palacios-Hernández, Gabriela Elizabeth: Conducted the physicochemical tests. She also contributed to the drafting of the article.

Arroyo-Ordoñez, Ivan: Contributed to the development of the research and the process development, he supervised the process and the investigation methodology and the results collection. He also helps with the article.

Availability of data and materials

The materials are domestic waste, and the reagents required for the physicochemical tests are considered for industrial use, the rest of the equipment was used at the university.

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Supports

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Computer device theft detection system




Sistema de detección de robo de dispositivos de computadora

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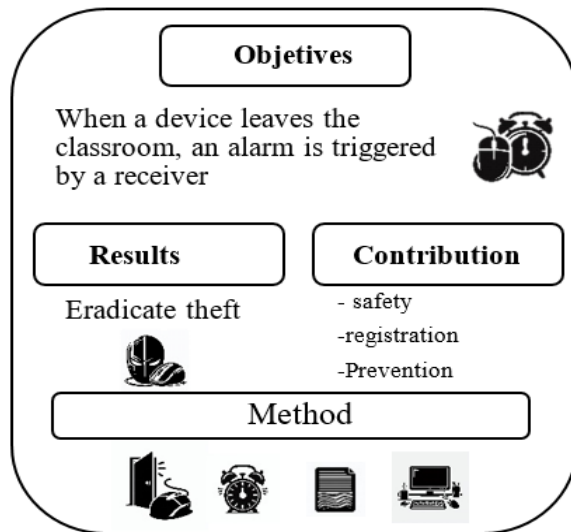
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Abstract

The project aims to protect computers, peripherals, and valuable devices in a laboratory using NFC technology. Each device will be tagged with an NFC identifier, which will trigger an alarm and notify the administration for immediate intervention if the device is removed from the room. Additionally, the system will log the time and location of the incident in a database, facilitating detailed tracking and analysis of events. The project also includes a web platform where students can report theft issues, creating an efficient communication channel for security concerns. This comprehensive approach ensures real-time monitoring, effectively deterring thefts and aiding in the quick recovery of stolen devices. By enhancing the security infrastructure of the laboratory and providing a reliable incident management mechanism, the project aims to create a safer environment for both students and equipment, thereby promoting a secure and efficient academic setting.



Security, Detection, Monitored

Resumen

El proyecto tiene como objetivo proteger equipos de cómputo, equipos periféricos y dispositivos de valor de los laboratorios de la institución mediante el uso de tecnología NFC. Cada dispositivo será etiquetado con un identificador NFC, el cual activará una alarma y notificará a la dirección si el dispositivo es retirado del salón, permitiendo una intervención inmediata. Además, se registrará la hora y lugar del incidente en una base de datos, lo que facilitará el seguimiento y análisis de los eventos ocurridos en ese momento. El sistema también contará con una página web donde los alumnos podrán reportar problemas de robo, proporcionando un canal de comunicación eficiente. Este enfoque también permitirá un monitoreo en tiempo real, disuadiendo robos y facilitando la recuperación de dispositivos de la universidad, mejorando así la seguridad del laboratorio y ofreciendo un mecanismo eficiente para la gestión de incidentes.



Seguridad, Deteccion, Monitoreo

Introduction

In response to the persistent thefts of peripheral equipment at the Fidel Velázquez Technological University, an innovative project is proposed that uses NFC, Arduino and Raspberry Pi technology to strengthen security in laboratories. This system not only seeks to prevent theft by identifying devices with NFC tags, but also activates an alarm and automatically notifies through a database and a website, ensuring the protection of vital resources and the continuity of academic and research operations.

Problem

Computer labs face a constant risk of theft of peripheral equipment, especially computer mice, resulting in significant economic losses and disruptions to educational and research activities. According to a recent survey of 43 students of the network career at the Fidel Velázquez Technological University, 90% of them reported having been affected by these thefts, highlighting the seriousness of the problem. This situation not only generates inconveniences for students, but also compromises the institution's operability and budget.

Box 1

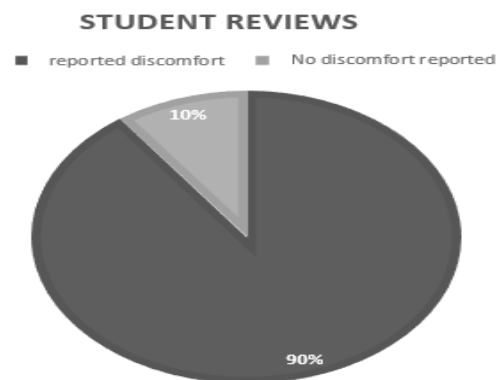


Figure 1
Affected Pupils Graph

Box 2

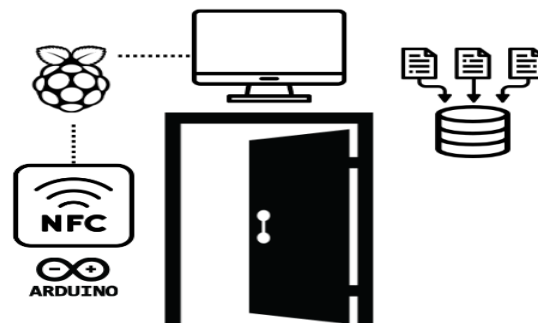


Figure 2
Main idea

To address this challenge, it is proposed to implement an advanced security system based on NFC, Arduino and Raspberry Pi technology. Computer mice will be equipped with NFC tags that will allow their unique identification. A motion detection system, managed by Arduino and NFC sensors, will trigger an alarm for unauthorized movements near the lab gates.

The Raspberry Pi will coordinate communication between devices, sending push notifications through a web page and storing detailed logs in a centralized database. This solution not only protects valuable laboratory resources, but also improves safety, optimizes inventory control, and ensures continuity of educational and research operations.

Benefits and expected results

Improved Security:

- **Theft Prevention:** The NFC technology integrated in the mice and the motion detection system with Arduino will allow you to detect and prevent theft effectively.
- **Quick Response:** Immediate activation of alarms allows for quick intervention by security personnel.

Protection of Valuable Resources:

- **Reduction of Economic Losses:** Avoids the loss of expensive peripheral equipment, thus protecting the institution's budget.
- **Preservation of Academic Activities:** Ensures the continuity of educational activities by minimizing disruptions caused by theft of essential equipment.

Inventory Control Optimization:

- **Accurate Monitoring:** The implementation of NFC tags allows for accurate and automated inventory monitoring.
- **Process Improvement:** Contributes to operational efficiency by providing up-to-date data.

Automated Notification and Registration:

- **Immediate Intervention:** The Raspberry Pi sends automatic notifications to lab management and security personnel in the event of suspicious activity, allowing for a quick and coordinated response.
- **Detailed Incident Logging:** All detected events are systematically logged in a centralized database, making it easy to generate security reports and analysis.

Box 3

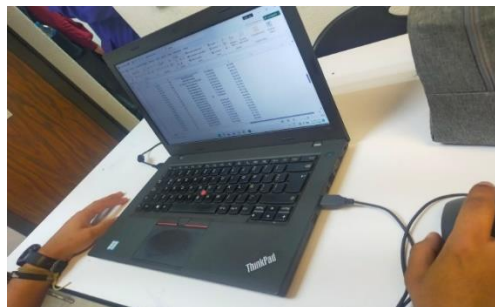


Figure 3

We carry out an inventory count in Excel to know the resources of the university

Central Hypothesis:

The implementation of an integrated security system using NFC technology for device identification, PIR sensors with Arduino for motion detection, and real-time notifications using Raspberry Pi will significantly reduce the risk of theft in laboratories, improving security and inventory management.

Methodology

System Design and Implementation

• Requirements

Objective

The objective of the project is to implement an effective security system that protects peripheral equipment in the laboratories of the Fidel Velázquez Technological University (UTFV), minimizing the risk of theft and guaranteeing the continuity of academic activities

◆ Proposed Methodology

Interviews and Meetings

Interviews will be conducted with professors, administrative staff and the management of the UTFV to identify their needs regarding the safety of the laboratories and the management of peripheral equipment.

Documentation Analysis

Existing safety policies and current procedures related to the handling of peripheral equipment in laboratories will be reviewed.

Functional Requirements

System-specific requirements will be defined, such as the ability to detect unauthorized movements of equipment, generate automatic alarms and notifications, and store detailed records in the database.

Box 4



Figure 4
University property

● System Design

Objective

The goal is to create a detailed design of the security system based on NFC technology, Arduino with sensors and Raspberry Pi for real-time notifications, satisfying the identified requirements.

◆ System Architecture

The system will include:

▪ NFC Devices and Readers:

NFC tags on peripheral devices such as computer mice.
NFC readers at the access doors to the laboratories.

▪ Arduino and Sensors:

Arduino with sensors to detect movements near doors.
Strategically installed sensors for intrusion detection.

▪ Raspberry Pi:

It will function as a control center connected to the internet.
It will coordinate communication between NFC devices, Arduino, and the database.

- **Database Design**

Main Tables:

Peripheral Equipment: Device details and NFC tags.

Security Events: Log of intrusion events with date, time and location.

User Interface Design

- **Real-time monitoring:**

Display of device status and intrusion alerts.

- **System Administration:**

Configuration of NFC readers, PIR sensors, and notifications.

Flowchart

Box 5



Figure 5
Webbside design

- **Implementation**

Objective

Develop and install the security system as per the detailed design, using NFC technology, Arduino with sensors, and Raspberry Pi for real-time notifications.

Software Development

- **Programming of the Monitoring System:**

Develop the software for Arduino that monitors the sensors.

Integrate reading and writing NFC tags to identify and register peripheral devices.

- **Raspberry Pi Setup:**

Program the Raspberry Pi to act as a control center.

Implement real-time notification and event handling logic.

- **Hardware Installation**

Attaching NFC Tags:

Install NFC tags on each peripheral device (computer mice).

Associate each NFC tag with the corresponding device information in the database.

Box 6

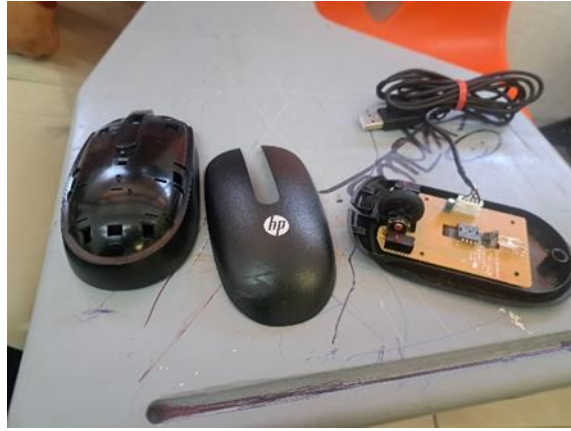


Figure 6
Installing Labels

NFC Reader Configuration:

Place NFC readers on the access doors to the laboratories.
Set up readers so they can read NFC tags on devices when entering or leaving.
Alarm System Configuration

Implementation of the Alarm System:

Configure Arduino with sensors to detect unauthorized movements.
Schedule the activation of an audible alarm when an intrusion is detected.
Setting Up Push Notifications:
Program the Raspberry Pi to send push notifications when the alarm goes off.
Configure notifications to be sent via email, SMS messages, or via an accessible web interface.

Box 7

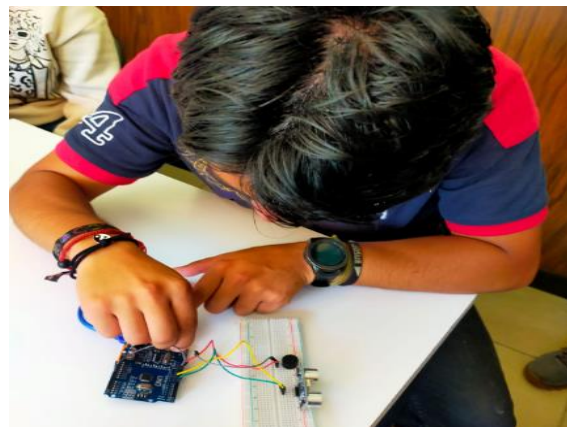


Figure 7
Development of the detection system

• Verification

Objective

To ensure that the system is functioning correctly and meets the specified requirements.

- Individual tests: Verify that each component of the system works individually.
- Integration testing: Ensuring that all components of the system work together properly.
- System testing: Evaluate the entire system in a controlled environment to ensure its correct operation.

- User acceptance testing: Conduct tests with end users to validate that the system meets their needs and expectations.

Box 8

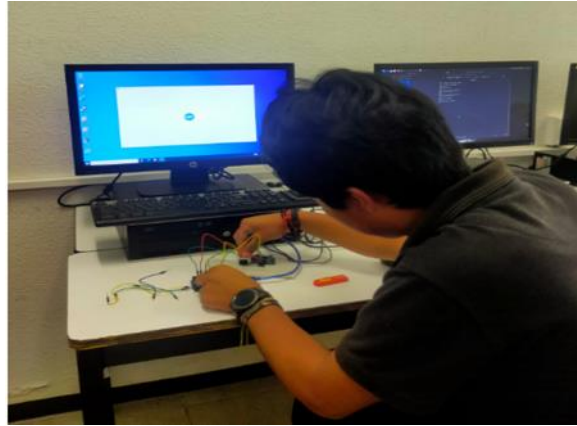


Figure 8
We perform alarm tests

Maintenance

Objective.

To ensure that the system continues to function properly and is kept up to date.

- Technical Support: Provide ongoing technical support to resolve issues that may arise.
- Upgrades and Upgrades: Make regular updates and upgrades to the system as needed.
- Continuous monitoring: Regularly review and evaluate system performance to make proactive adjustments.

Results and Discussion:

It presents the results of the system's tests, the effectiveness in preventing theft, and user feedback.

Conclusions and recommendations:

It summarizes the findings of the project, its impact on laboratory safety, and suggests future improvements and possible extensions to the system.

What we expect from the project

1. Reduced replacement costs

One of the biggest expenses associated with the theft of peripheral equipment is the cost of replacing stolen devices. By implementing NFC technology to prevent these thefts, a considerable reduction in the need to replace lost or stolen mice or other peripheral equipment is expected. This is because NFC technology combined with arduino can help deter theft and make it easier to recover devices if they are misplaced.

2. Less time spent on inventory administration and management

Managing peripheral equipment inventories can be time-consuming and resource-intensive. With NFC, an automated inventory tracking and management system can be implemented. This includes the ability to track the location and status of devices in real-time, simplifying management tasks and reducing the workload of inventory personnel.

3. Fewer distractions and wasted time for students

Theft of peripheral equipment not only leads to direct costs, but can also cause significant disruptions to academic and administrative activities. Students and staff can waste valuable time searching for or waiting for stolen devices to be replaced. Implementing app technology helps mitigate these disruptions by reducing the incidence of theft and ensuring that the necessary devices are available when needed.

4. Improved User Security and Trust

Implementing NFC technology not only has direct economic benefits, but also improves the overall security of educational environments. Students and staff can feel more secure knowing that peripheral equipment is protected from theft and unauthorized access. This fosters an environment of trust and reduces concerns about the security of technological devices used on campus.

5. Long-term savings in maintenance and safety

In addition to immediate savings in replacement and management costs, implementing the project for peripheral equipment safety can lead to long-term savings in terms of preventative maintenance and improvements to overall campus safety. Fewer thefts mean less need for corrective actions.

Box 9

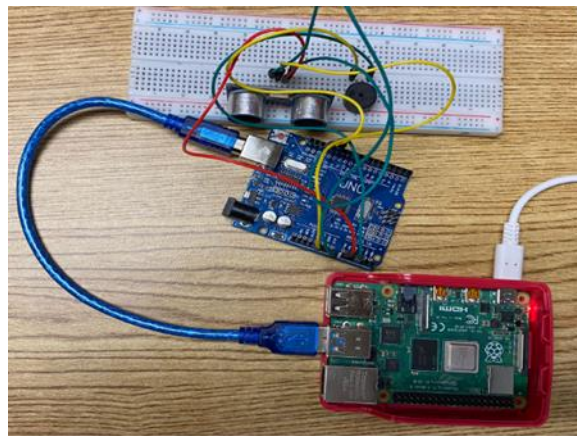


Figure 9
Hardware Test

Required Components:

Arduino: You will use an Arduino (Arduino Uno) as the main platform to control and coordinate the operations of the system.

5V Horn and Buzzer:

The horn and buzzer will be used to generate audible sounds such as alerts or visual notifications to indicate important events, such as an attempted theft or unauthorized access.

NFC module:

You'll need an NFC (Near Field Communication) transmitter and receiver module for communication between peripheral devices (such as mice equipped with NFC tags) and the centralized system that controls access.

Abbreviations

NFC devices:

NFC tags (one for each peripheral equipment such as computer mice).
NFC readers (one for each access door to the laboratories).

Arduino:

Arduino Uno.

Sensors for motion detection.

Raspberry Pi:

Raspberry Pi 4.

MicroSD card for the Raspberry Pi operating system.

Electronic Components:

Buzzer or siren for audible alarm.

Resistors, jumper cables and other components according to the specific design of the circuit with Arduino.

Connections and Accessories:

USB cables for power supply of Arduino and Raspberry Pi.

Connection cables for sensors and other electronic components.

Computer with Development Software:

To program Arduino and Raspberry Pi.

Tools and Equipment:

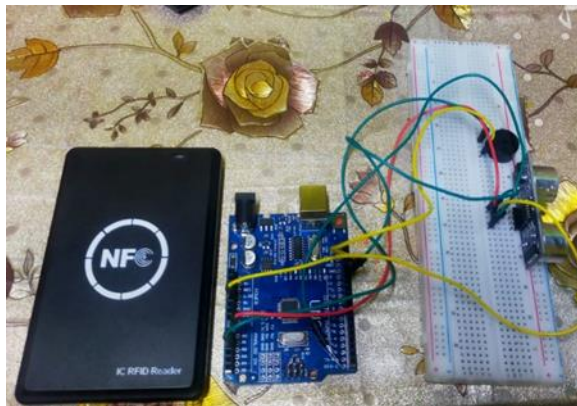
Screwdrivers and basic tools for assembly and configuration.

Internet access to set up and manage the Raspberry Pi.

Software and Platforms:

Arduino IDE for programming Arduino.

Operating System

Box 10**Figure 10**

Part of the hardware

Box 11**Figure 11**

Hardware assembly

Security System Implementation Process

Step 1: Preparation and Planning

Definition of Requirements:

Review and confirm system requirements based on the detailed design.

Set specific implementation goals, including key functionalities such as NFC identification and motion detection.

Selection of Materials and Components:

Acquire all necessary materials, including NFC devices, Arduino, Raspberry Pi, sensors, and additional electronics.

Verify compatibility and ensure components meet design specifications.

Development Environment Configuration:

Prepare a computer with the necessary software to program Arduino and Raspberry Pi.

Install Arduino IDE and the operating system for the Raspberry Pi.

Step 2: Software Development

Arduino Programming:

Develop code for Arduino that includes sensor reading and integration with NFC readers and tags.

Implement logic to trigger an alarm when unauthorized movement is detected.

Raspberry Pi programming:

Set up the Raspberry Pi as a control center.

Schedule communication with Arduino to receive signals from NFC sensors and tags.

Develop the software to send real-time notifications via email, SMS, or web interface.

Step 3: Hardware Installation

Attaching NFC Tags:

Install NFC tags on each peripheral equipment such as computer mice.

Associate each NFC tag with the corresponding device information in the database.

NFC Reader Configuration:

Place NFC readers at classroom exits or critical areas.

Configure the readers to read NFC tags when entering or leaving, recording the movement of the devices.

Step 4: Testing and Adjustments

Functionality Testing:

Perform extensive testing of the entire system to verify motion detection, NFC tag reading, and alarm triggering.

Verify that the Raspberry Pi correctly receives and sends notifications in real time.

Optimization and Adjustments:

Make necessary adjustments to the code and hardware configuration to improve the accuracy and efficiency of the system.

Ensure that all functionalities meet specified requirements and end-user expectations.

Step 5: Implementation and Documentation

Final Implementation:

Deploy the fully operational system in the production environment.
Perform a final check to ensure that all components are working properly and integrating properly.

Documentation and Training:

Prepare detailed system documentation, including user manuals and maintenance procedures.

Train the personnel in charge of the use and maintenance of the system, ensuring that they are familiar with its operation and resolution of basic problems.

Step 6: Monitoring and Maintenance

Continuous Monitoring:

Establish a continuous monitoring system to supervise the operation of the security system.

Implement proactive measures to resolve any issues that may arise and maintain the efficiency of the system in the long run.

Updates and Improvements:

Plan regular software and hardware updates to improve system security and functionality.

Evaluate and implement new technologies or functionalities that may benefit the security system in the future.

Box 12

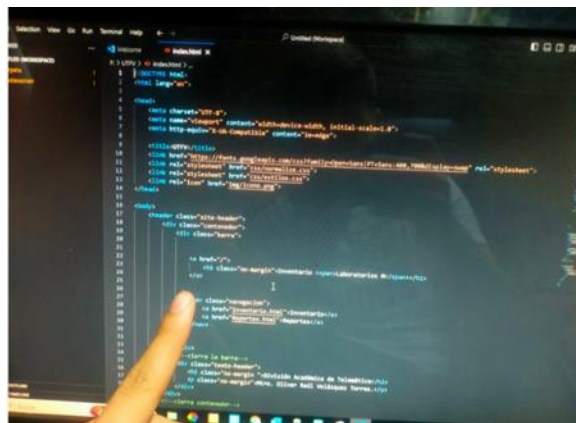


Figure 12

We update the code

Website Development

Creation of a Website for the Project

• Definition of Objectives and Functionalities:

Event Display: Display recorded events such as motion detections or alarm triggers.

System Control: Allow you to activate or deactivate the alarm, view the status of the system, etc.

Interaction with the Database: Use data stored in the database to display relevant information.

• User Interface Design:

The design must be clear, intuitive and adapted to the needs of the laboratory users.

Structure and Organization: A page that facilitates navigation and understanding.

Visual Elements: We use colors, fonts and spaces for the visual identity of the project and that facilitate reading and navigation.

Responsive design: Make sure that the page is responsive, meaning that it looks good and works properly on different devices and screen sizes.

- **Integration with Existing Technologies:**

Use of HTML and CSS: We use HTML for the basic structure of the page and CSS to stylize it and improve its appearance.

PHP and MySQL integration: We interact with the MySQL database, , to query and display logged events.

Security: We implement appropriate security measures, such as data validation and prevention of SQL injection attacks, especially when interacting with the database.

- **Implementation of Key Functionalities:**

Event Display: Design sections or lists to display recent events, with details such as the date, time, and description of the event.

System Control: Includes buttons or forms to activate or deactivate the alarm, depending on the current state of the system.

Notifications: We implemented the ability to display messages or alerts on the web page when important events occur, such as alarm triggering.

- **Testing and Adjustments:**

We carry out extensive tests to ensure that all the functionalities of the website work correctly. Make adjustments as needed to improve usability, security, and page performance.

- **Documentation and Training:**

We document the operation of the website, including user manuals and maintenance procedures. Train the staff in charge of using and maintaining the system on how to use the website effectively.

Box 13

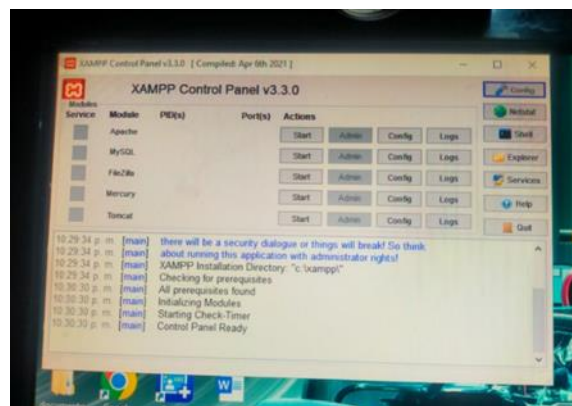


Figure 13

We implement database through Xampp

Box 14

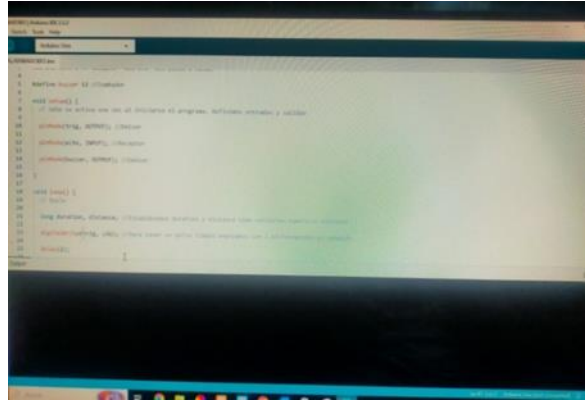


Figure 14
We carry out reviews

Conclusions

In conclusion, the development and implementation of a security system using technologies such as NFC, Arduino, and Raspberry Pi represents a significant advancement in asset protection and management in environments such as educational labs. This integrated approach makes it possible to improve security by providing advanced identification and monitoring methods, such as the use of NFC tags for peripheral devices and PIR sensors for motion detection.

The combination of Arduino for alarm activation and the Raspberry Pi as the control and communication center of the system ensures a quick response to security events, facilitating real-time notifications through a web interface. This not only strengthens the physical security of equipment, but also optimizes inventory monitoring and control, reducing loss risks and improving laboratory operational efficiency.

The implementation of a complementary web page, developed with HTML, PHP and MySQL, provides an intuitive interface to visualize events, monitor the status of the system and receive relevant alerts. This digital component not only improves accessibility to critical information, but also facilitates ongoing security system management and maintenance.

Together, these technologies offer a robust and scalable solution to address security challenges in educational and business environments, promoting a safer work environment, protecting valuable resources, and ensuring continuity of operations without undue interruptions. In addition, they lay the groundwork for future technological improvements and adaptations that can further optimize the security and efficiency of the system in the future.

Main Contributions to Science and Technology

1. Innovation in Perimeter Security: The use of NFC to track and secure peripheral equipment represents an innovation in the way burglary can be prevented in school or office environments
2. Low-Cost and Efficient Technology: The proposed system uses NFC technology, which is relatively inexpensive and easy to integrate into electronic devices, allowing for an approach to security.
3. Security Alert Automation: Implementing an automatic alarm that triggers if a device leaves the designated area improves efficiency in detecting and responding to potential theft.
4. Integration with Existing Technology: The use of NFC tags and alarm systems takes advantage of already established technologies, facilitating the implementation and scalability of the project.

Key Aspects for Applying Universal Knowledge

- Efficiency in Implementation: Understanding how NFC can be used for security applications in different situations will help adapt the technology to various needs and environments.
- Adaptability and Scalability: Evaluate the flexibility of the system to be adapted to other types of equipment and environments, for example, in offices, warehouses, or public areas.

- **Costs and Benefits:** Analyze the cost-benefit ratio of the system to determine its viability in different situations and budgets.
- **Security and Privacy:** Consider how the system can be improved to protect data and prevent unauthorized access.

Main Findings of the Research

1. **System Efficiency:** The NFC-based system is effective in preventing theft of peripheral equipment and is capable of issuing real-time alerts if the equipment is detected to be moving outside the designated area.
2. **Cost-Benefit:** The use of NFC and alarm systems represents a low-cost solution compared to other more complex and expensive security technologies.
3. **Ease of Integration:** NFC technology is easy to integrate with existing devices without requiring significant modifications, simplifying its implementation in educational environments.
4. **Continuous Improvement:** Despite their effectiveness, there is always room for improvement in terms of accuracy, range of alarms and durability of NFC tags.

What institutions do they come from?

State Public Institutions Universidad Tecnológica Fidel Velazquez

Abbreviations

NFC	Near Field Communication
UTFV	Universidad Tecnológica Fidel Velazquez
QR	Quick Response
Av	Avenue
CP	Postal Coding
SQL	Structured Query Language

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Prototype QR code identification system for students and teachers with vehicles




Prototipo de sistema de identificación con código QR para alumnos y maestros con vehículos

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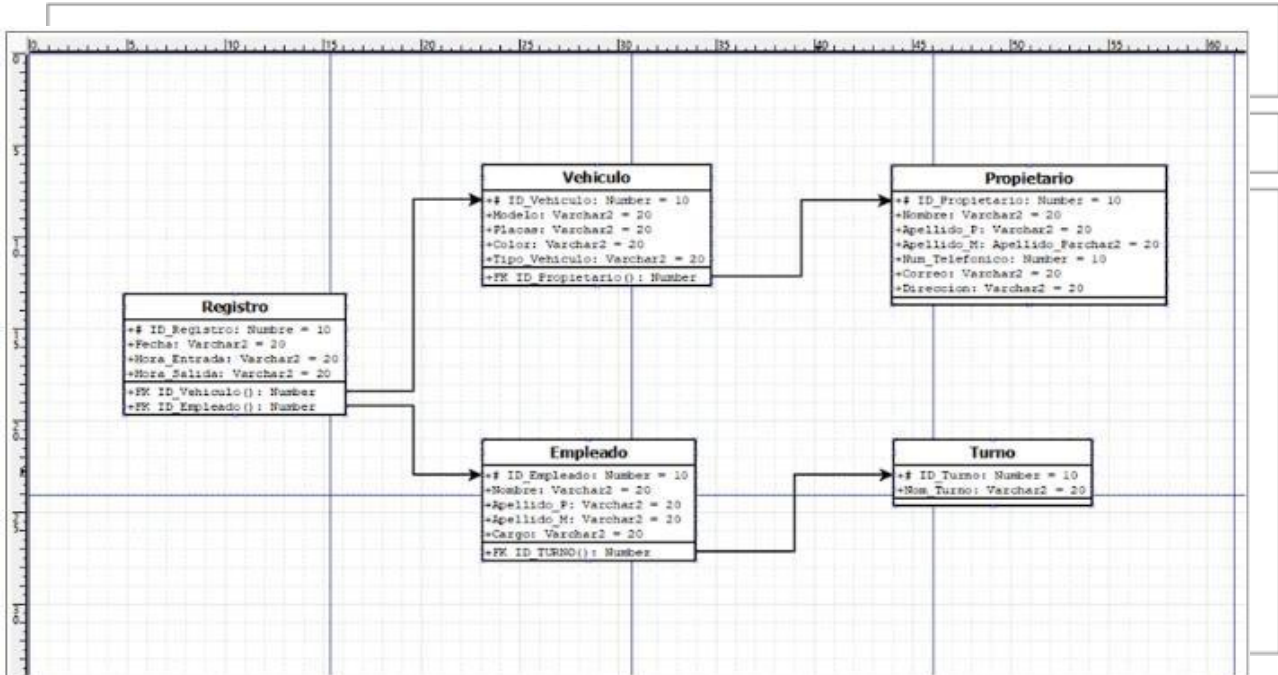
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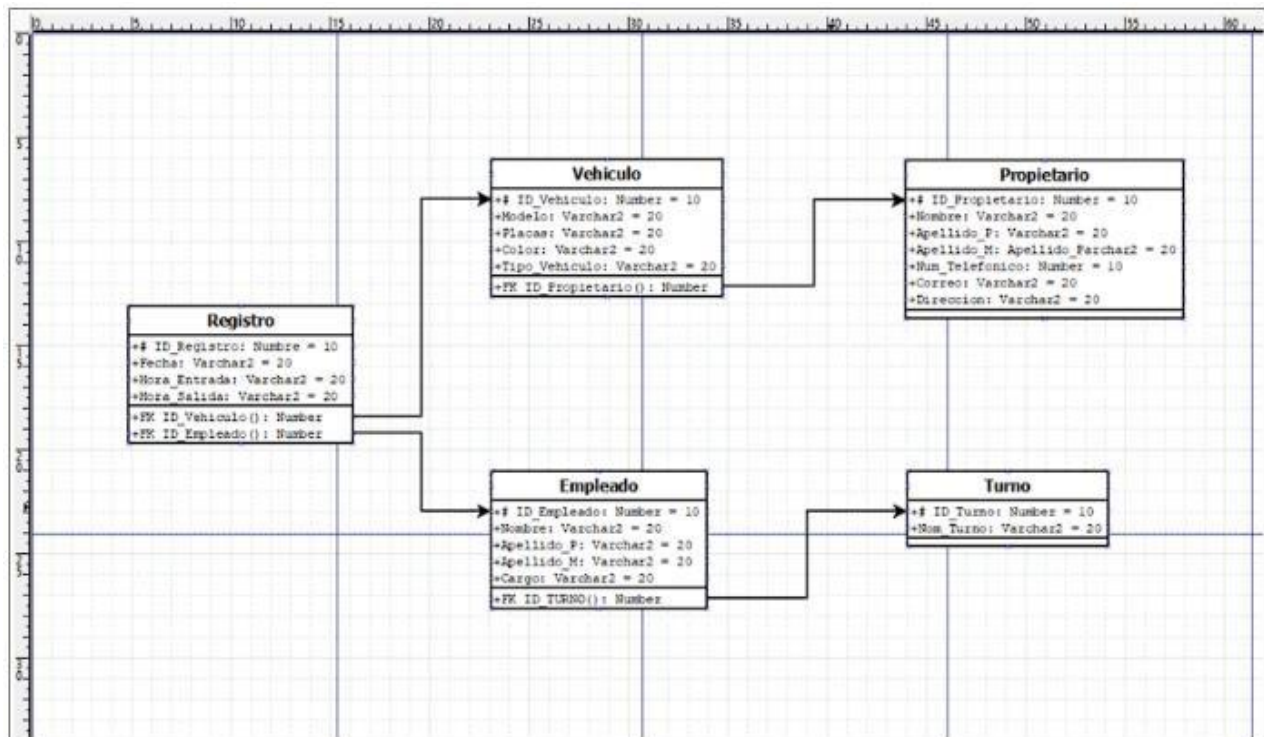
Abstract

This project aims to develop an automated system based on QR codes and an SQLite database to manage the vehicle data of students and teachers at an educational institution. The system includes a user-friendly interface for data entry and QR code generation, enhancing the efficiency and security of data management. The project follows the Agile (Scrum) methodology for incremental development and uses Python for implementation.



Resumen

Este proyecto tiene como objetivo desarrollar un sistema automatizado basado en códigos QR y una base de datos SQLite para gestionar los datos vehiculares de alumnos y maestros en una institución educativa. El sistema incluye una interfaz de usuario intuitiva para la entrada de datos y la generación de códigos QR, mejorando la eficiencia y seguridad en la gestión de datos. El proyecto sigue la metodología Ágil (Scrum) para un desarrollo incremental y utiliza Python para la implementación.



Introduction

A QR Code (Quick Response code) is a type of two-dimensional barcode which can store alphanumeric data. That can store information Encoded. QR codes are easily scannable using smartphones and are useful for sharing information quickly. It was developed in 1994 by Denso Wave, a subsidiary of Toyota, to track parts in automobile manufacturing. Unlike barcodes that can only be read in one direction (from top to bottom), the codes.

QR codes can be read in two directions (horizontal and vertical), allowing them to store a larger amount of information in a small space. QR codes are widely used today in various applications due to its ability to store information such as URLs, texts, contact details, among others. These codes can be easily scanned with a mobile phone, making them very accessible and convenient.

A database manager (DBMS) is software that allows you to create, manage, and manipulate databases. It is a software that allows you to create, manipulate and manage databases. Makes it easy to organize, store, and Data recovery. Its primary function is to provide an efficient and efficient environment. to store and retrieve large amounts of data in a secure manner. Organized.

DBMS facilitate interaction between end users, applications and the database, ensuring the integrity, consistency, and security of data.

Types of Database Managers

1. Relational (RDBMS): They use a table-based data model. Every Table is made up of rows and columns. Data can be related to each other through primary and foreign keys. Examples: MySQL, PostgreSQL, SQLite, Oracle Database.
2. NoSQL: Designed to handle large volumes of unstructured data or semi-structured. They do not use tables, but other data models such as documents, graphs, key-value, and columns. Examples: MongoDB, Cassandra, Redis.
3. NewSQL: Combines the advantages of traditional SQL and NoSQL systems, offering horizontal scalability while maintaining the use of SQL. Examples: Google Spanner, CockroachDB.
4. Object-oriented: They allow you to store data in the form of objects, such as in object-oriented programming. Examples: ObjectDB, db4o.

MySQL

MySQL is a relational database management system (RDBMS) of code which uses structured query language (SQL) to access and manage data. It was developed by MySQL AB and is currently owned by Oracle Corporation. MySQL is known for its reliability, performance, and ease of use, which means that it is not possible to use the which makes it a popular choice for web applications, including blogs, forums, and e-commerce platforms. Python is a high-level, interpreted, and purposeful programming language general, with a clear and simple syntax. It is widely used for web development, analytics and automation. Created by Guido van Rossum and first released in 1991. Python is known for its simple and readable syntax, which makes it easy to learn and use.

Box 1

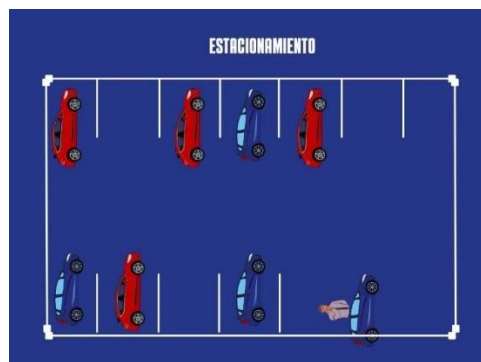


Figure 1

Estacionamiento

This project aims to develop an automated system based on QR codes and an SQLite database to manage the vehicle data of students and teachers at an educational institution. The system includes a user-friendly interface for data entry and QR code generation, enhancing the efficiency and security of data management. The project follows the Agile (Scrum) methodology for incremental development and uses Python for implementation.

Background

The manual management of vehicle data for students and teachers in an educational institution is inefficient and prone to errors. An automated solution is required to allow more efficient and secure management of this information. This project proposes the development of a system based on QR codes and an SQLite database to address this problem. The integration of these components will provide a modern and effective solution for vehicle data management.

General Objective:

Develop an automated system based on QR codes and an SQLite database to manage the vehicle data of students and teachers at the educational institution.

Specific Objectives:

- Design and implement an SQLite database to store vehicle information.
- Develop a module to generate QR codes with relevant information.
- Create a user-friendly interface for data entry and QR code generation.
- Integrate the QR code system with the database.
- Test and validate the system in a real environment.

Justification:

This system will provide an efficient, secure, and modern solution for vehicle data management, improving the accuracy and speed of handling this information and facilitating administration within the campus.

Methodology:

The Agile (Scrum) methodology will be used with 2-4 week sprints for the incremental development of the system. The project will be divided into several phases, including planning, design, development, integration, testing, and deployment.

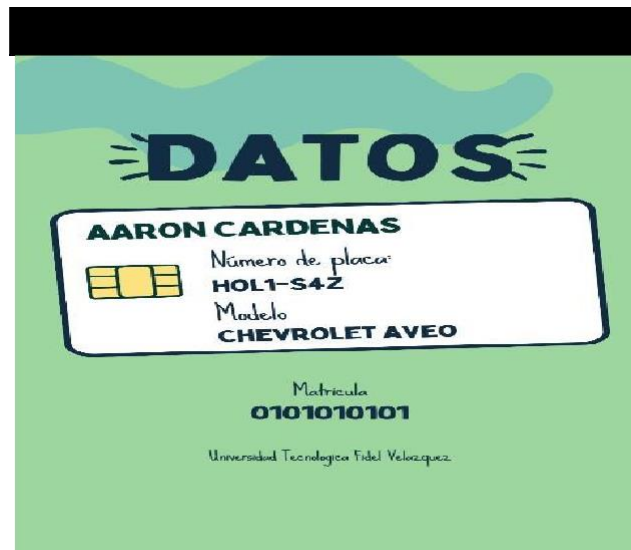
Project Development:

1. Design: 1.1. Functional Requirements:

- QR Code Generation: The application must generate QR codes that contain specific information about students and teachers.
- Database: Use SQLite to store the data of students and teachers, including vehicle information.
- User Interface: Create a graphical interface (optional) to facilitate data entry and QR code generation.

1.2. Non-Functional Requirements:

- Portability: The application must be executable on different operating systems (Windows, macOS, Linux).
- Usability: The interface must be intuitive and easy to use.
- Security: The data stored in the database must be secure and accessible only to authorized users.

Box 2**Figure 2**

- **1.3. Diagrams:**

Use Case Diagram:

- Primary Actor: User (students and teachers).
- Use Cases: Enter student/teacher data, Generate QR code, Save QR code, Query database.

Class Diagram:

- Main Classes: User, Database, QRCodeGenerator.

- **Development: 2.1. Development Environment:**

- Programming Language: Python
- Required Libraries: sqlite3, qrcode, tkinter (optional) 5

2.2. Project Structure:

- main.py: Main file containing the application logic.
- database.py: Module to manage the SQLite database.
- qr_generator.py: Module to generate QR codes.
- ui.py (optional): Module for the user graphical interface.

Results

The results will be presented by chapter section, highlighting the progress and achievements in each phase of the project.

Conclusions

The obtained results will be clearly explained along with possibilities for improvement for future implementations.

Appendices

Tables and appropriate sources will be included to support the information presented in the project.

Declarations:

Conflict of Interest

The authors declare no conflict of interest. They have no financial or personal interests that could have influenced this chapter.

Acknowledgements

Professor CasasGómez Víctor Manuel and Professor Hidalgo Baeza María del Carmen

Abreviattions

- Date of highest NVDI peak of the season(POS).
- End of Season (EOS)
- Maximum NDVI value POS
- Average sum of NDVI values

Problem

The manual management of student and teacher vehicle data in educational institutions presents multiple challenges. The lack of an efficient automated system can lead to problems such as:

1. **Administrative Inefficiency:** Manual collection and verification of vehicle data consumes significant time and resources. This can result in long waits for users and an additional burden on administrative staff.
2. **Human Error:** Manual data entry and handling is subject to error, which can lead to incorrect or outdated information. These errors can cause confusion and problems in vehicle identification and access.
3. **Lack of Security:** The absence of a robust vehicle data management system can put the security of the institution at risk. Improper verification of the identity of vehicle owners can allow unauthorized access.
4. **Difficulty in Data Management:** Maintaining and updating manual records is an arduous and error-prone task. In addition, searching for specific information in manual records can be slow and inefficient.

Advantages

1. **Increased Efficiency:** The automated system reduces the time and effort required for managing vehicle data, streamlining administrative processes and allowing staff to focus on more critical tasks.
2. **Reduced Human Error:** Automation minimizes the risk of human errors in data entry and verification, ensuring more accurate and reliable information.
3. **Enhanced Security:** The system provides a secure method for verifying the identity of vehicle owners, preventing unauthorized access and enhancing the overall security of the institution.
4. **Improved Data Management:** A centralized SQLite database allows for easy storage, retrieval, and updating of vehicle information, facilitating better data organization and access.
5. **Faster Verification Process:** QR codes enable quick and easy scanning, significantly speeding up the process of verifying vehicle and owner information compared to manual methods.

6. **Better Traceability:** The system offers comprehensive digital records of vehicle access, allowing for easy tracking and monitoring of vehicle history and patterns, aiding in decision-making and incident investigation.
7. **User-Friendly Interface:** The Python-based interface is designed to be intuitive and easy to use, making it accessible even for users with limited technical knowledge.
8. **Cost-Effective Solution:** Utilizing open-source technologies like Python and SQLite helps in keeping the development and maintenance costs low while providing a robust solution.
9. **Scalability:** The system can be easily scaled to accommodate more users and additional features as needed, ensuring it can grow with the institution's requirements.
10. **Environmental Benefits:** By reducing the need for paper-based records and manual processes, the system contributes to environmental sustainability efforts.

Results

1. **Improved Efficiency:** The implementation of the QR code-based system has significantly reduced the time required for vehicle data management. Administrative tasks that previously took hours are now completed in minutes, leading to increased productivity.
2. **Accurate Data Management:** The automated data entry and verification processes have minimized errors. The SQLite database ensures that all vehicle and owner information is accurate and up-to-date, enhancing the reliability of the system.
3. **Enhanced Security:** The system has strengthened the security measures within the institution by providing a reliable method for verifying vehicle ownership. Unauthorized access has been effectively prevented, ensuring a safer campus environment.
4. **User Satisfaction:** Feedback from users indicates a high level of satisfaction with the new system. The user-friendly interface and quick QR code scanning process have been well-received, making the system accessible to all users, regardless of their technical proficiency.
5. **Efficient Data Retrieval:** The centralized database has made it easier to store, access, and update vehicle information. This has facilitated quicker data retrieval and better data management practices.
6. **Successful Integration:** The integration of the QR code generation and scanning with the SQLite database has been seamless. The Python-based implementation has proven to be robust and reliable, supporting the system's core functionalities effectively.
7. **Positive Environmental Impact:** By reducing the dependency on paper-based records, the system has contributed to environmental sustainability. The digitization of records has decreased paper usage, aligning with the institution's green initiatives.
8. **Scalability and Flexibility:** The system has demonstrated its capability to scale up as needed. Additional users and features have been integrated without any significant issues, showcasing the system's flexibility and adaptability to future requirements.
9. **Cost Efficiency:** The use of open-source technologies like Python and SQLite has kept the development and maintenance costs low. The project has delivered a cost-effective solution without compromising on quality or functionality.
10. **Positive Feedback from Stakeholders:** Stakeholders, including administrative staff and users, have provided positive feedback on the system's impact. The improvements in efficiency, accuracy, and security have been acknowledged and appreciated.

Access door: Pedestrian access control system




Puerta de acceso: Sistema de control de acceso de peatones

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CONAHCYT classification:

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Area: Engineering

Field: Systems Engineering

Discipline: Systems Engineering

Subdiscipline: Systems Engineering

Key Proceeding

The application of new development methods that help the effectiveness of automation, with the uses of different areas of knowledge help to integrate the tools that allow the operation of this project. By integrating key aspects such as curiosity, interdisciplinarity, critical thinking, creativity, collaboration, continuous learning, and tolerance with basic principles of observation, experimentation, analysis, synthesis and communication, as well as effective tools and techniques, The foundations are laid for truly meaningful universal knowledge. These components, based on values and ethics, not only promote the development of knowledge, but also facilitate the construction of a more sustainable and equitable future for humanity. The search for knowledge, therefore, is not only an intellectual task, but a social commitment towards the common good. This project would help improve security since, due to their operation through the use of credentials, the turnstiles will provide more effective access control, preventing entry to unauthorized people, allowing for a safer environment for the student community. In addition to streamlining the flow of students, allowing faster entry for students, avoiding crowds at access points.

Citation: Sánchez-Ocaña, Luis Fernando, Torrealba-Mariño, Angelys Gabriela, Cisneros-Blas, Ashley Vanessa and Martínez-Román, Alejandro. 2024. Access door: Pedestrian access control system. 56-66. ECORFAN.

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Peer Review under the responsibility of the Scientific Committee **MARVID**[®] in contribution to the scientific, technological and innovation Peer Review Process by training Human Resources for the continuity in the Critical Analysis of International Research.



Abstract

At the Fidel Velázquez Technological University (UTFV), the congestion of students at door 4 pedestrian access has caused delays and inconveniences. This project proposes the installation of a pedestrian access control system that consists of the installation of 3 turnstiles at the three doors of the university integrated with a barcode scanner for the student community's credentials. The main objective is to expedite the entry of students to improve efficiency in the institution. En la Universidad Tecnológica Fidel Velázquez, la aglomeración de estudiantes en la única puerta de entrada con dos accesos ha generado retrasos y molestias. Este proyecto propone la instalación de torniquetes en tres accesos específicos para distribuir mejor el flujo de estudiantes. Se implementará un sistema de código de barras en las credenciales de los estudiantes, con escáneres en los torniquetes para habilitar el acceso. El objetivo principal es agilizar el ingreso de alumnos para mejorar la eficiencia en la institución.

Access, Automation, Barcode**Resumen**

Velázquez, la aglomeración de estudiantes en la única puerta de entrada con dos accesos ha generado retrasos y molestias. Este proyecto propone la instalación de torniquetes en tres accesos específicos para distribuir mejor el flujo de estudiantes. Se implementará un sistema de código de barras en las credenciales de los estudiantes, con escáneres en los torniquetes para habilitar el acceso. El objetivo principal es agilizar el ingreso de alumnos para mejorar la eficiencia en la institución.

Acceso, Automacion, Código de barras

Introduction

During an observation of the environment, specifically at the Fidel Velázquez Technological University, a problem was identified that can cause several inconveniences to students, because it can cause certain delays when entering the institution. This project proposes a possible solution, which will be developed throughout the document.

Development of chapter titles and subtitles with later numbers

Problem Statement

Every day hundreds of students arrive at their educational institution, the UTFV, however, as it only has one entrance door with 2 entrances, there is an agglomeration of people since there are only 154 students studying digital network infrastructure, causing delays in getting to classes, inconvenience and discomfort for students.

Theoretical framework database

A database is a systematic, electronically stored collection of data. It can contain any type of data, including words, numbers, images, videos, and files. You can use software called a database management system (DBMS) to store, retrieve, and edit data. Breadboard.

USB Input / SD Input / Connection 1 XLR-3 (External Return Line-3) female / Connection 2 XLR-3 (External Return Line-3) female / Auxiliary Input Jack 6.5 mm / RCA Connection / Auxiliary Input 3.5 mm. The LINEAR SOUND structure with its nine 3” speakers creates a quasi-linear sound source. The distance between the drivers are close enough so that they constructively interfere with each other and thus send sound waves of better quality than traditional speakers, and with an output pattern, offering a more uniform distribution of sound.

scanner

When referring to hardware, a scanner or optical scanner is a hardware input device that optically "reads" a physical image and converts it into a digital signal. For example, a scanner can be used to convert a printed image, drawing, or document (hard copy) into a digital file that can be manipulated or edited on a computer.

A scanner can connect to a computer using many different interfaces, although today it is most commonly connected to a computer using a USB cable.

Firewire
Parallel
SCSI
USB

The first forms of scanners appeared in the 1860s. However, the scanner as we know it today was created in 1957 by a man named Russell Kirsch of the United States National Bureau of Standards. The first image scanned by this device was a picture of Kirsch's son. This black and white image measures just 5x5 cm and has a resolution of 176 pixels on each side

Motor for a turnstile

WEJOIN MTRTOR – Replacement Half Body Turnstile Motor, No Controller Card Included / Compatible with TVB451006 / TVB451005

The motor for the half-length turnstile is an accessory for the tripod that is powered by electric current and its electronic control: it only requires a small push from the user to start the movement and from there its motor provides the smooth and precise rotation of the arms. Once installed with its electronic card, different configurations can be made with respect to the needs that the client requests to be able to give access in different ways, it can be manual, visually or through the built-in electronic circuit, it denies or allows the passage of only one person at a time, to access a certain place.

Applications

They are mainly used in sports facilities (stadiums, gyms, sporting events), transportation (public transportation) and access to public and private buildings (companies, nightclubs, pubs, etc.), as a tool for controlling people's access and as a means of payment.

Specifications

Voltage $\pm 10\%$ 110V
 Frequency 60HZ
 12VDC control circuit
 Consumption 30W
 Passing speed ≤ 50 People/min
 Working temperature -20 ~ +55
 Communication Socket Standard RS232 Plug

Arduino board

Arduino can be used to develop autonomous elements, or connect to other devices or interact with other programs, to interact with both hardware and software. It serves both to control an element, for example a motor that raises or lowers a blind based on the light there is thanks to a sensor connected to the Arduino, or to transform information from a source, such as a keyboard, and convert the information into something that a computer understands, for example.

Currently, the use of Arduino can be classified into two large groups:

1. Arduino is used as a microcontroller, when it has a program downloaded from a computer and works independently of it, and controls and powers certain devices and makes decisions according to the downloaded program and interacts with the physical world thanks to sensors and actuators.
2. Arduino acts as an interface between a computer or other device, which executes a certain task, to translate said task in the physical world into an action. And vice versa, thanks to sensors that are connected to the Arduino board we can make the computer execute a certain action.

Justification

Carrying out an analysis, the implementation of the use of turnstiles is proposed, which through a barcode scanner where it will be placed on the back of the credential, these will be assigned to doors 2 and door 4, distributed 3 in each one of them. This will allow student access to be distributed, facilitating their arrival to their classrooms since they could enter through the door closest to their building.

Box 1

Material Costs	
Material	Cost
Protoboard	50
Arduino	90
WEJOIN WJTSBRD	4500
Cable USB	100
Jumpers	2.5
WEJOIN MTRTOR	10000
PARKTRON PRKTRNBR	8000
	22742.5

Figure 1
Material Costs

Technology

A barcode is a fundamental part of this project, since it will allow the identification of the student and enable their access.

To do this, a scanner will be implemented at the turnstiles to scan the code, which will contain stored student information. With this, the use of a database must be applied, which will safeguard the student's information, such as names, surnames, career and enrollment.

The barcode would be found on the back of the credential, making it practical to activate the turnstiles, since the code would only need to be passed through the scanner for the turnstile to be activated.

Box 2



Figure 2

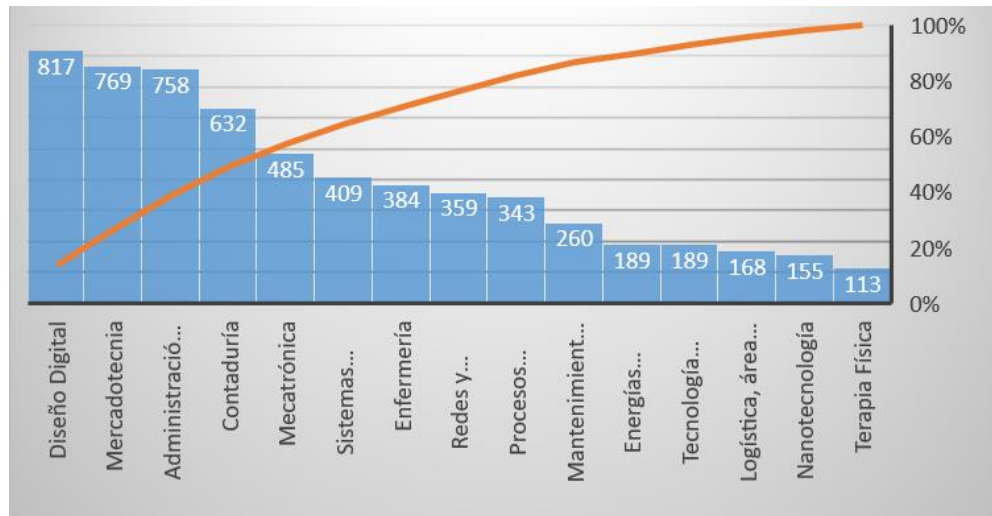
Entry of students to the UTFV facilities

Box 3

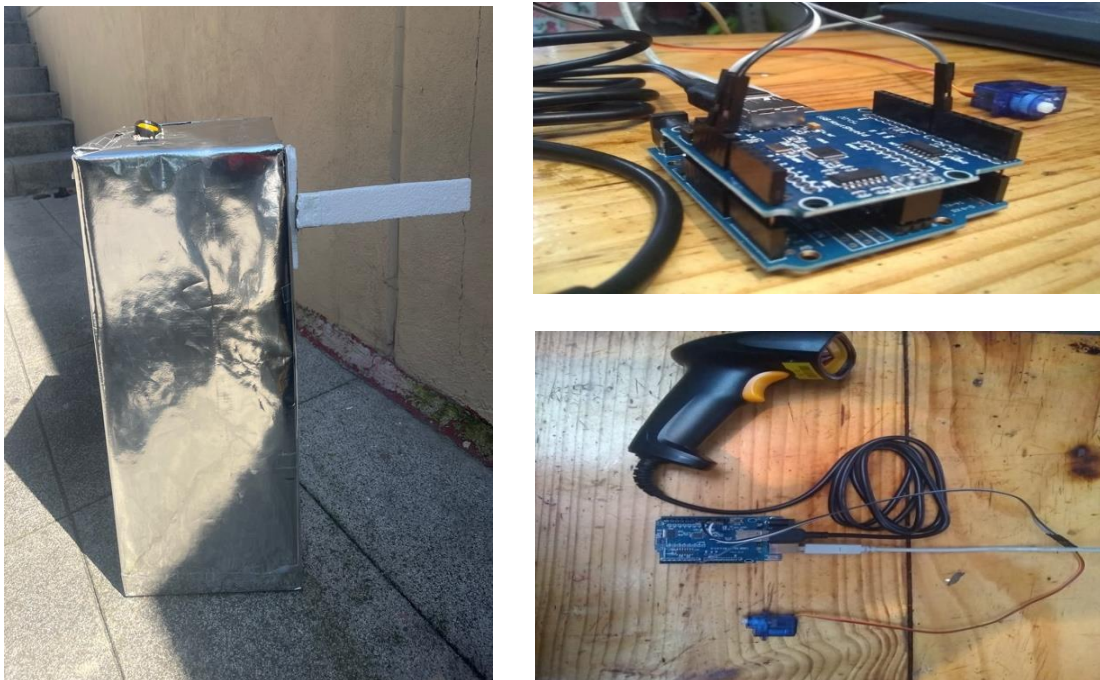
Table 1

Total Students

Study area	Enrolled students
Total	6030
Digital design	817
Marketing	769
Human Capital Management	758
Accountancy	632
Mechatronic	485
Information systems	409
Nursing	384
Networks and telecommunications	359
Industrial processes	343
Industrial maintenance	260
Renewable energy	189
Environmental technology	189
Logistics, Land Transport area	168
Nanotechnology	155
Physical therapy	113

Box 4**Figure 3**

Graphic of total students

Box 5**Figure 4**

Idea of tourniquets to apply

Methodology

To carry out the structure and analysis of the system, information was collected to create the appropriate environment for the needs, which over time occur in the university community, in this sense, it is necessary to create a conceptual design and functional analysis, which requires systematizing and guiding the management areas, so that the service is provided for a greater number of university studies.

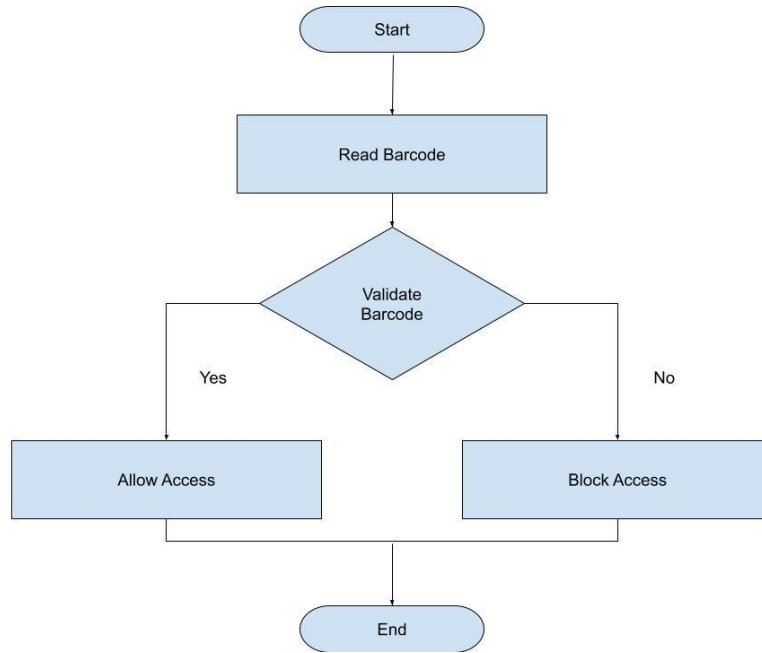
Box 6

Figure 5
Structure

For the execution of this project, the XP (Extreme Programming) methodology will be implemented.

Results

- The expected results are to improve and speed up the step in student entry
- Taking control of them and helping in the security of the institution

Conclusions

I provide you with several tests with the access turnstile we could expect good results at the time of entry and exit, obtaining good results.

After a fairly long analysis we concluded that with the access turnstiles, they are more effective at the time of entry and exit, it is not difficult to be with the security constantly showing and it is not so long, we see that some students arrive quickly and on time to their buildings with the solution so that they do not arrive late to their classes.

Box 7

Figure 6
Attachment

Declarations

Conflict of interests

The analysis carried out identified that in reality we do not have that much risk in case of extreme situations, in case of a fire or some problem the closest and easiest exit route will be enabled.

Author contribution

Torrealba Mariño Gabriela Angelys: contributed with the research of the tools we will need with the prototype, and the type of program that will facilitate coding.

Sánchez Ocaña Luis Fernando: contributed to the problem analysis, obtained evidence of where the turnstiles will be installed on different doors.

Martínez Cruz Ingrid Anahí: contributed the project idea for the turnstiles and developed the analysis.
Cisneros Blas Ashley vanessa: Contributed to the program that performed the encoding and created the barcode encoding.

Availability of data and materials.

Breadboard, generator (when the bars rotate), scanner, bars, some cables to connect the materials.

Money

We carry out tests to find out if it gives access with the school card and if it is lost, I do not know about access with that card.

Thanks

We carried out several tests with the coding of a database, with some materials to make the prototype of turnstiles with the analysis we did on the main doors of the university.

Abbreviations

UTFV Fidel Velazquez Technological University

References

National Autonomous University of Mexico (UNAM): UNAM, one of the largest and most prestigious institutions in Mexico, has implemented turnstiles at some of its entrances to regulate the flow of people and improve security on campus¹.

CES University: Although not located in Mexico, CES University in Colombia also uses turnstiles. To access, students must register their ID or, if they do not have it, use their citizenship card or passport as a visitor².

Remember that the implementation of turnstiles may vary depending on the university and its security policy.

Ancestors. The background of a project is all the work previously carried out on the topic to be investigated and that provides relevant information for our work. This background, also known as research background or background of a problem, allows us to know the points of view of different authors, their methodologies and results. In addition, they help us define the direction of the project and know which aspects have been addressed and which remain to be explored.

To prepare a project background, follow these steps:

Documentation: Collect information related to the problem you are going to treat. Look for reliable sources in university libraries or research centers.

Literature review: Select publications relevant to your thesis and link them to your project.

Organization of information: Order the works chronologically to know the progression of the study.

Writing: Presents an introduction, identifies the authors, explains the procedures used and summarizes the results.

The essential. The essential elements of a project are fundamental components that guarantee its success. Here are some of them:

- **Objective:** It is the specific goal of the project, clear and measurable.
- **Scope:** Defines the limits and boundaries of the project, including expected results and activities.
- **Planning:** Details activities, resources, deadlines and dependencies between tasks.
- **Organization:** Assign roles and responsibilities to the team.
- **Resources:** Elements necessary for the project (capital, personnel, technology).
- **Time:** Deadline management and activity monitoring.
- **Budget:** Allocation of financial resources.
- **Communication:** Interaction between the team and stakeholders.
- These elements ensure efficient execution and successful results.

Support. The importance of this is with the help of the barcode or through the QR code on the credential. It is where it will be based so that the student can enter since it will be linked to a database in order to minimize the entry of external people, since it will also have an ID in case of loss where the credential is deleted for external use.

Differences. Our intention is for our institution to have a more comfortable access system for its students.

Discussions. The discussions section in a project article is where the results obtained are interpreted and validated, beyond statistics. Here the findings are analyzed, compared with previous studies, and implications discussed¹. Must be:

- **Summary of Findings:** Begin with a brief summary of the results.
- **Comparison and Contrast:** Compare the results with other studies and discuss differences.
- **Limitations and Future Research:** State the limitations of the study and suggest future research².
- **Explicit Conclusions:** Write clear conclusions to leave a final message to the reader³.

It is important to avoid repeating information from the results section and not include cost data unless it is relevant to the study.

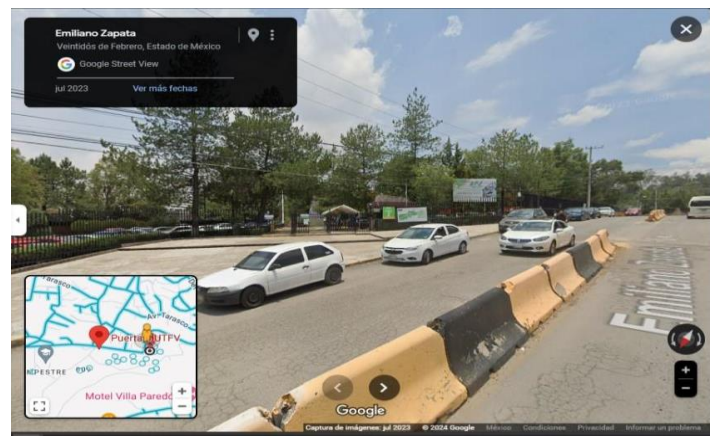
In general, a work can enjoy intellectual protection from its creation, without the need to register in the Intellectual Property Registry. However, originality is a crucial requirement to obtain that protection.

Annexs

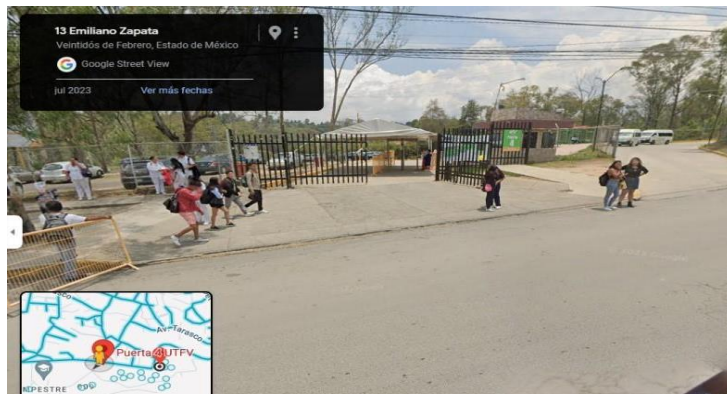
Annex 1



Annex 2



Annex 3



Annex 5: UT Fidel Velázquez Official




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Comparative analysis of the advantages and disadvantages of teleworking vs. face-to-face work of teachers attached to the TESVG

Análisis comparativo de las ventajas y desventajas del teletrabajo vs trabajo presencial de los docentes adscritos al TESVG

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Area: Social Sciences

Field: Economic Sciences

Discipline: Sectorial Economic

Subdiscipline: Investigation and development

Key Proceeding

To initiate students to the part of applied research promotes their curiosity and their ability to want to innovate, improve or create a new process for the benefit of society and a clear example, was this research as it analyzed a phenomenon occurred a few years ago during the pandemic of COVID_19, which was the type of work used during the contingency, although it was done in a microeconomic way in the educational institution where students study, they could carry out in a practical way everything they learned in the classroom. Knowing the most relevant characteristics, advantages or disadvantages of the models of on-site work and telework in the Tecnológico de Estudios Superiores de Villa Guerrero, helped them to visualize the challenges faced by the world of work in terms of new models of organizational planning, in order to design new strategies both in the business and legal area.

Citation: Figuroa-Pérez, Yadira, Valladares-Carbajal, Mari Carmen and García Castillo, Karla Yazmín. 2024. Comparative analysis of the advantages and disadvantages of teleworking vs. face-to-face work of teachers attached to the TESVG. 67-82. ECORFAN.

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Abstract

A rather complicated situation was in store for us once the first case of coronavirus in the world became known. With the arrival of the COVID-19 pandemic, many companies in Mexico were forced to modify their way of working, such as teleworking, which was used in practically all operations, in order to continue with activities in the face of the health emergency. It has been a real challenge to convert the face-to-face work that was previously carried out in an organisation to a fully virtual one, although it brings great benefits for all those involved, it is also a challenge for both the organisation and the worker. In the last three years, the world of work in Mexico, as in other countries, has undergone a major change in the way work activities are carried out in each company. According to the information gathered by the National Institute of Statistics and Geography (INEGI) to measure the impact of covid-19 in companies, in the first months of the health emergency, 12% of the organisations in the country implemented telework as a measure to continue with their operations. Therefore, the objective of the present research was to find out the most relevant characteristics, advantages or disadvantages of the models of on-site work and teleworking among the teachers of the Tecnológico de Estudios Superiores de Villa Guerrero, as well as to identify the most relevant characteristics, advantages or disadvantages of the models of teleworking and face-to-face work among the teachers of the Tecnológico de Estudios Superiores de Villa Guerrero.

Teleworking, COVID-19, Traditional Labour

Abstract

Una situación bastante complicada nos deparaba el destino una vez que se conoció el primer caso de coronavirus en el mundo. Con la llegada de la pandemia por COVID-19, muchas empresas en México se vieron obligadas a modificar su forma de trabajo, tal es el caso del teletrabajo, que prácticamente fue utilizado en la totalidad de las operaciones, para continuar con las actividades ante la emergencia sanitaria. Donde se ha observado que ha sido todo un verdadero reto convertir el trabajo presencial que antes se realizaba en una organización, a uno virtual en su totalidad, si bien si aporta grandes beneficios para todos los involucrados, también es un reto tanto para la organización, como para el trabajador.

En los últimos tres años el mundo laboral en México al igual que en otros países, ha tenido un gran cambio en el modo de llevar a cabo las actividades laborales correspondientes de cada empresa. De acuerdo con la información levantada por el Instituto Nacional de Estadística y Geografía (INEGI) para medir el impacto de la covid-19 en las empresas, en los primeros meses de la emergencia sanitaria el 12% de las organizaciones en el país implementó el teletrabajo como medida para seguir con sus operaciones. Por lo anterior en la presente investigación se estableció como objetivo el Conocer las características, ventajas o desventajas más relevantes de los modelos de trabajo presencial y teletrabajo en los docentes del Tecnológico de Estudios Superiores de Villa Guerrero, además de establecer como hipótesis que durante la pandemia por COVID-19 surgió un nuevo modelo de trabajo (teletrabajo) para impartir clases el cuál fue utilizado por los docentes del TESVG, lo que ocasiono que en la actualidad prefieren el trabajo presencial por su forma tradicional.

Teletrabajo, COVID-19, Trabajo Tradicional

Introduction

In the last three years, the world of work in Mexico, as in other countries, has undergone a major change in the way companies carry out their work activities. According to information gathered by the National Institute of Statistics and Geography (INEGI) to measure the impact of covid-19 in companies, in the first months of the health emergency, 12% of organisations in the country implemented telework as a measure to continue their operations.

But when projecting it as a permanent action, only 5.7% of companies contemplate this modality. This is due to the confinement by COVID-19 that caused people to be unable to leave home, so they changed from face-to-face work to remote work.

This new model of working brought with it good things, but at the same time was somewhat complex for those who were not familiar with the technology. Telecommuting involves the use of ICTs, which for some people was a drastic change and made it difficult to adapt to, but at the same time gave them the opportunity to learn new things, get out of the routine and of course spend more time with their families.

Therefore, this research aims to find out the most relevant characteristics, advantages and disadvantages of both work models at the Tecnológico e Estudios Superiores de Villa Guerrero, in order to generate a comparison between the two and analyse which is the best model for the organisations, and what impact it has on the world of work for both the worker and the employer.

Development

1.1 Working Model

There are different ways of working within a company depending on the needs of each company, as defined by the author Schellhas (2016), who mentions that ‘Working models describe how a company functions on a day-to-day basis and details the working arrangements for the workforce. It is not uncommon for companies to have different working models for various departments’.

Through the emergence of COVID 19 many companies had to start having flexibility in the way they worked as the author Iglesias (2017) says, ‘So we arrived in December with 3 working modalities, on the one hand the companies that have decided to keep the traditional on-site model in which employees must work from the company's premises; on the other hand, those that have opted for a 100% online model in which each employee can work from wherever he or she wants; and finally, a hybrid work model that combines on-site work under certain circumstances with an online model adapted to each employee’.

There are 2 different work models that have emerged over time through uncontrolled situations, as we already know that the traditional form is the one that has normally been used since the beginning of time, which, according to the author Rodríguez (2015), ‘is the model that has been present in all companies throughout history. That is to say, it involves the development of the work activity in a physical space that is the same for all colleagues and during the working days of the week. You always go to the office and have face-to-face meetings, you never work remotely from home.

As time went by, different situations started to arise in the world that made them change the traditional way of working to telework as Sabadell (2020) says ‘Although until the end of 2019, telework has had a slow and uneven expansionary path, the COVID-19 pandemic has forced many organisations to implement telework in an adaptive way, in an attempt to contribute to slowing down the transmission of the virus.

Thus, the year 2020 has presented an inflection in the progression of telework numbers and, in parallel to the widespread and sustained spread of the virus, ICT-mediated remote working has made its presence felt in a disruptive way. For this observation, we will abandon the approach we have been taking from the perspective of companies, in order to collect the results from available surveys, based on the perception of individuals’.

1.2 Telework

The pandemic originated by COVID-19 has provoked many changes in living and working habits, as mentioned by CETYS (2021),

The origin and evolution of telework are key aspects of an era in which telework is here to stay. The future is full of questions, but opportunities are also opening up thanks to the irruption of new technologies. This health and economic crisis has shown us that many employees can work from home if they are equipped with the necessary IT tools. Although remote working is not new, it is true that many companies have implemented it to improve their productivity. However, questions still arise as to how best to implement telework in a company“.

Teleworking is a new model for carrying out work activities that is supported by technologies, as mentioned by Cristina Civit, who tells us that, “It is a way of organising work in such a way that it is carried out with the help of information and communication technologies, in a different place and away from the central offices or production facilities“.

1.2.1 Telework model

Teleworking models, increasingly present in companies and employment contracts, provide for the company to have the possibility of having physical facilities, either because its employees work from different locations around the world or simply because they prefer to do so.

For this model, it is essential to have digital tools and management software that guarantee workflows, promote communication and the achievement of objectives.

Their meetings are generally via video calls, however, it is likely that there are occasions when employees choose to meet face-to-face, for team bonding, in which case they will make use of coworking or temporary rented workspaces, without the need to invest in a permanent physical workspace.

According to the teleworking law in force since July 2021 in Spain, this model of teleworking is correctly called remote work and occurs when the work development of an employee is continuous and not occasional, always away from the company headquarters. Although attendance at the office is not prohibited, such attendance must be less than 30% of the time corresponding to the working day stipulated in the contract.

1.2.2. Advantages of the telework model

According to various research studies, some advantages of the telework model were identified, which are mentioned below:

- Promotes work autonomy: Greater autonomy for the professional to better organise his or her working day and tasks thanks to the savings and better distribution of time. Adequate software for task and project management is an indispensable tool for remote workers to optimise their work and enjoy the sought-after flexibility that the labour system is tending towards.
- Ensures work-life balance: It improves the integration of work and personal life, which is increasingly a priority for families.
- Boosts concentration: It increases the ability to concentrate at work and thus productivity, which is impaired in the face-to-face model by continuous interruptions and external stimuli.
- Improves connectivity and teamwork: It allows and improves work between multidisciplinary and global teams. No matter where they are and when they connect. Digital tools make it possible to work remotely and manage people, time and projects.
- Optimises talent management and retention: Adopting and offering teleworking models represents a great attraction for talent retention, especially in highly competitive sectors. It also improves the motivation of professionals and their relationship and loyalty to the company.

- It represents an economic saving for the company: Companies save costs by eliminating or optimising space, travel, meetings and physical meetings.
- Promotes self-management of working time: It provides employees with extra training in self-management, with which they learn to optimise the time they devote to each task and project, which also serves them in their personal lives.

1.2.3 Elements

In order to be able to carry out teleworking, a series of elements are occupied, which are as follows:

- Mobile computing
- Internet connection
- Ergonomics and health
- Data security

Theories of Telework

2.1 Agency theory

Agency theory emphasises the need to measure outcomes and the outcome criteria that employees can influence (Eisenhardt, 1988). Outcome-based contracts can be useful for telework as the physical supervision of the principal over the agent disappears and therefore the teleworker (agent) has full autonomy to schedule and control his or her tasks. Not being able to control the teleworker's behaviour, the employer may prefer a performance-based contract to avoid agency costs.

2.2 Institutional theory

Institutional theory primarily analyses the impact of institutional factors (norms, values, culture, policies) on organisations (Oliver, 1997) and on the diffusion of organisational practices within this framework of factors. Institutional theory has been used to study the impact of human resource practices (Gooderham et al., 1999), and more specifically in the field of flexible work-family management (Wood, 1999), which is one of the potential inherent advantages of telework. According to institutional theory, the firm would opt for telework or a greater degree of telework depending on the level of external pressures on the firm (Daniels et al., 2001): number of firms that have adopted it, favourable taxation, etc. Although most of the work adopting the institutional perspective analyses how external institutional factors affect the forms of organisation of the firm (DiMaggio and Powell, 1983; Oliver, 1991), there are others that also include internal factors (Daniels et al., 2001).

Thus, the institutional perspective is useful in explaining the influence of managers on the adoption of telework because telework is an innovation that is subject to the same normative and cultural influences as other human resource practices (Tregaskis, 2000). Huws et al. (1990) suggest that telework may be atypical in organisations due to management resistance and the strength of the organisational culture'. A further barrier to telework relates to the rewards perceived by employees. The desirability of evaluating and rewarding teleworkers on the basis of performance is contrary to the tenets of institutional theory because of the lack of legitimacy it represents and because, in general, organisations that behave in this way are less effective and less likely to survive (Meyer and Rowan, 1977).

2.3 Resource theory

This is a theoretical perspective developed around internal firm competencies (Wernerfelt, 1984; Prahalad and Hamel, 1990; Peteraf, 1993). According to this approach, competitive advantage is based on the firm's internal resources and capabilities (Pfeffer, 1994, 1996). The resource theory or approach is one of the most widely used in human resource management, both theoretically and empirically (Wright et al., 2001). With its emphasis on the internal resources of the firm as a source of competitive advantage, the resource approach seems appropriate for studying telework, as telework focuses on organisational and human resource issues. Managers can use telework as a flexible organisational form to recruit and retain those employees/most valuable employees who require temporal and spatial flexibility in their work. In this way, valuable company resources such as the knowledge of its human resources, or ICTs leveraged with its human resources (Powell and Dent-Micallef, 1997) can be a source of competitive advantage for companies through telework.

3. Legal framework

The importance of the Federal Labour Law has been a topic of constant discussion and relevance in the labour framework of any country. This law establishes the rights, duties and obligations for both employees and employers, providing a legal and fair framework for labour relations.

According to (Ley Federal del Trabajo., n. d.), the Federal Labour Law (LFT),

'governs the labour relations included in Article 123, Section "A" of the Constitution' (State workers are excluded), Individual labour relations, Working conditions, Rights and obligations of workers and employers, Women's work, Minors' work, Special work (trust workers, transport workers, rural workers, trade agents, professional sportsmen, actors and musicians, home-based work, domestic workers, hotel workers, family industries, etc.), Collective labour relations, Strikes, Occupational hazards, Statute of limitations, Labour and social services authorities, Legal staff of the Conciliation and Arbitration Boards, Workers' and employers' representatives, Labour procedural law, Enforcement procedures, Responsibilities and sanctions.

The Federal Labour Law plays a crucial role in establishing a legal and fair framework for labour relations. It guarantees the protection of workers' labour rights, promotes occupational safety and health, contributes to the economic and social development of a country and facilitates the resolution of labour disputes. It is a vital tool for creating an equitable and fair working environment for all parties involved.

3.1 Federal Labour Law Decree

"THE GENERAL CONGRESS OF THE UNITED MEXICAN STATES, DECREES: ARTICLE 311 IS REFORMED AND CHAPTER XII BIS OF THE FEDERAL LABOUR LAW IS ADDED, IN MATTERS OF TELEWORKING.

Sole Article. - Article 311 is amended; and a Chapter XII Bis is added with articles 330-A; 330-B; 330-C; 330-D; 330-E; 330-F; 330-G; 330-H; 330-I; 330-J and 330-K of the Federal Labour Law, to read as follows:

Article 311.- Home work is that which is habitually performed for an employer, in the worker's home or in premises freely chosen by the worker, without the immediate supervision or direction of the person providing the work.

If the work is performed under conditions other than those indicated in this Article, it shall be governed by the general provisions of this Law.

CHAPTER XII BIS

Telework

Article 330-A.- Teleworking is a form of subordinate work organisation that consists of the performance of remunerated activities, in places other than the establishment or establishments of the employer, so that the physical presence of the worker under the modality of teleworking is not required, in the workplace, using primarily information and communication technologies, for the contact and command between the worker under the modality of teleworking and the employer.

The teleworker is the person who provides personal, paid and subordinate services in a place other than the company's premises or the employer's workplace and uses information and communication technologies.

For the purposes of the telework modality, information and communication technologies shall be understood as the set of services, infrastructure, networks, software, computer applications and devices whose purpose is to facilitate the tasks and functions in the workplaces, as well as those required for the management and transformation of information, in particular the technological components that allow the creation, modification, storage, protection and retrieval of such information.

The provisions of this Chapter shall apply to employment relationships which are carried out more than 40 per cent of the time at the worker's home under the teleworking modality, or at the home of the worker's choice.

Telework shall not be considered to be that which is carried out on an occasional or sporadic basis.

Article 330-B.- The working conditions shall be set down in writing by means of a contract and each of the parties shall keep a copy. In addition to the provisions of article 25 of this Law, the contract will contain:

- I. Name, nationality, age, sex and domicile of the parties;
- II. Nature and characteristics of the work;
- III. Amount of the salary, date and place or form of payment;
- IV. The work equipment and supplies, including those related to health and safety obligations that are provided to the worker under the telework modality;
- V. The description and amount to be paid by the employer to the teleworker for payment of home-based services related to teleworking;
- VI. The mechanisms of contact and supervision between the parties, as well as the duration and distribution of schedules, provided that they do not exceed the legal maximums, and
- VII. Any other stipulations agreed by the parties.

Article 330-C.- The modality of teleworking shall be part of the collective labour contract, if any, existing between trade unions and companies, and a copy of these contracts shall be delivered free of charge to each of the workers who perform their work under this modality.

Likewise, they shall facilitate the mechanisms of remote communication and dissemination that the workplace has, including electronic mail or others, in order to ensure that workers under the telework modality are aware of the procedures of freedom of association and collective bargaining, as established in the obligations set forth in sections XXXII and XXXIII of Article 132 of this Law.

Article 330-D.- Employers who do not have a collective labour contract must include telework in their internal work regulations, and establish mechanisms to ensure the linkage and contact between workers who perform their work under this modality.

Article 330-E.- In teleworking modality, employers shall have the following special obligations:

- I. Provide, install and take care of the maintenance of the necessary equipment for teleworking, such as computer equipment, ergonomic chairs, printers, among others;
- II. Receive work in a timely manner and pay wages in the form and on the dates stipulated;
- III. To assume the costs derived from the work through the telework modality, including, if applicable, the payment of telecommunication services and the proportional part of electricity;
- IV. To keep a record of the inputs delivered to the workers under the telework modality, in compliance with the provisions on safety and health at work established by the Ministry of Labour and Social Welfare;
- V. Implement mechanisms that preserve the security of the information and data used by workers in the telework modality;
- VI. Respect the right to disconnection of workers in the telework modality at the end of the working day; VII;
- VII. enrol teleworkers in the compulsory social security system; and
- VIII. Establish the necessary training and advisory mechanisms to guarantee the adaptation, learning and adequate use of information technologies of the workers in the teleworking modality, with special emphasis on those who change from face-to-face to teleworking.

Article 330-F.- Teleworking workers have the following special obligations:

- I. To take the greatest care in the safekeeping and conservation of the equipment, materials and tools they receive from the employer;
- II. Inform in a timely manner about the agreed costs for the use of telecommunications services and electricity consumption, derived from teleworking;

- III. Obey and conduct themselves in accordance with the provisions on safety and health at work established by the employer;
- IV. Attend to and use the operational mechanisms and systems for the supervision of their activities; and
- V. Comply with the policies and mechanisms for the protection of data used in the performance of their activities, as well as the restrictions on their use and storage.

Article 330-G.- The change from on-site to teleworking shall be voluntary and established in writing in accordance with the present Chapter, except in cases of duly accredited force majeure. In any case, when there is a change to the teleworking modality, the parties shall have the right of reversibility to the face-to-face modality, for which they may agree on the mechanisms, processes and times necessary to validate their will to return to such modality.

Article 330-H.- The employer must promote the balance of the labour relationship of workers in the telework modality, so that they enjoy decent work and equal treatment in terms of remuneration, training, education, social security, access to better job opportunities and other conditions covered by Article 2 of this Law to face-to-face workers who provide their services at the headquarters of the company. Likewise, it shall observe a gender perspective that makes it possible to reconcile personal life and the availability of workers under the teleworking modality during the working day.

Article 330-I.- The mechanisms, operating systems and any technology used to supervise teleworking must be proportional to its objective, guaranteeing the right to privacy of teleworking workers, and respecting the applicable legal framework on the protection of personal data. Video cameras and microphones may only be used to supervise telework on an extraordinary basis, or when the nature of the duties performed by the teleworker so requires.

Article 330-J.- The special safety and health conditions for the work carried out under this Chapter shall be established by the Ministry of Labour and Social Security in an Official Mexican Standard, which shall consider ergonomic and psychosocial factors, and other risks that could cause adverse effects on the life, physical integrity or health of the workers who work in the telework modality.

Article 330-K.- Labour Inspectors have the following special powers and duties:

- I. To verify that the employers keep records of the inputs delivered to the workers in the telework modality, in compliance with the obligations of safety and health at work;
- II. To ensure that salaries are not lower than those paid in the company to the on-site worker with the same or similar functions;
- III. To verify due compliance with the special obligations established in this Chapter.

4. Telework in Mexico

In Mexico, as in other countries, telework brought with it great challenges for organisations, due to the Covid-19 pandemic, as mentioned by the author Olivia Segura, who tells us that,

Telework represents benefits for companies and collaborators, such as improvements in productivity, but it also brings challenges in its implementation. The main point to note is that there is alignment on certain issues between companies and the workforce, such as the willingness to maintain the work scheme, productivity and culture changes that both parties recognise to some extent. 63% of companies plan to maintain a teleworking scheme after the pandemic, and 40% believe that between 26% and 50% of their workforce will remain teleworking after the pandemic ends. Of the latter, 91% believe that employees will continue to telecommute two or more days a week''.

These percentages show us very important data to take into account when making decisions and carrying out work activities.

According to the Survey on the Impact Generated by Covid-19 in Companies (ECOVID-IE), carried out by the National Institute of Statistics and Geography (INEGI) and derived from the COVID-19 health crisis, in Mexico only 12.2% of companies have adopted the telework or home office modality.

In terms of the size of the organisations, 44.8% of large companies have used this modality of work, 19% of small and medium-sized enterprises (SMEs) and 11.2% of micro-enterprises.

4.1 Experience of Telework Linked to the Covid-19 pandemic

The employees who had to face the transformation from traditional work to telework immediately, many of them had too many communication problems because nobody had prepared them for such an issue, they had great experiences and had to adapt immediately, there were some who adapted immediately because it was more comfortable based on some aspects, but also conflicts arose because at the same time of doing the work they had to deal with other issues such as children as it says in one article

‘In Mexico, the declaration of phase three of the COVID-19 pandemic reduced people's mobility and implied the suspension of face-to-face activities of companies, government and social organisations considered non-essential. This put several companies to the test and they had to migrate their way of working to the so-called home-office, i.e. they suspended face-to-face activities, but it was essential to continue to operate and be productive online. Migration to telework or home-office in Mexico seemed distant for some companies and their workers. However, at that time, employees were faced with the need to use technological platforms as a means of contact and coordination with their work teams. The time for multitasking had come, employees had to follow up with their children during online classes, carry out routine household chores, adapt a home-office workspace and strengthen the competencies needed to deliver fast results in the face of the escalation of layoffs that occurred as a result of the global economic crisis resulting from COVID-19.

Methodology

The method that will be used in this research is the mixed method, because it will be using quantitative and qualitative methodology, due to the fact that surveys will be applied to be able to collect data, through traditional statistics that are quantifiable as the author Perez (2017), tells us that ‘the quantitative method is a procedure that is based on the use of numbers to analyze, investigate and verify both information and data.

Quantitative research or methodology is produced by the cause and effect of things, and is one of the most known and used methods in sciences, such as mathematics, computer science and statistics’. Similarly, the qualitative method will be used as we will also be collecting information regarding the most salient characteristics of the subject, so that at the end we can make a correlation on the data obtained and a comparison, as mentioned by the author Narváez (2023), ‘is a method or research process that seeks a deep understanding of a phenomenon within the natural environment, focuses on the “why” instead of the “what” and basically focuses on collecting data that are not numerical’.

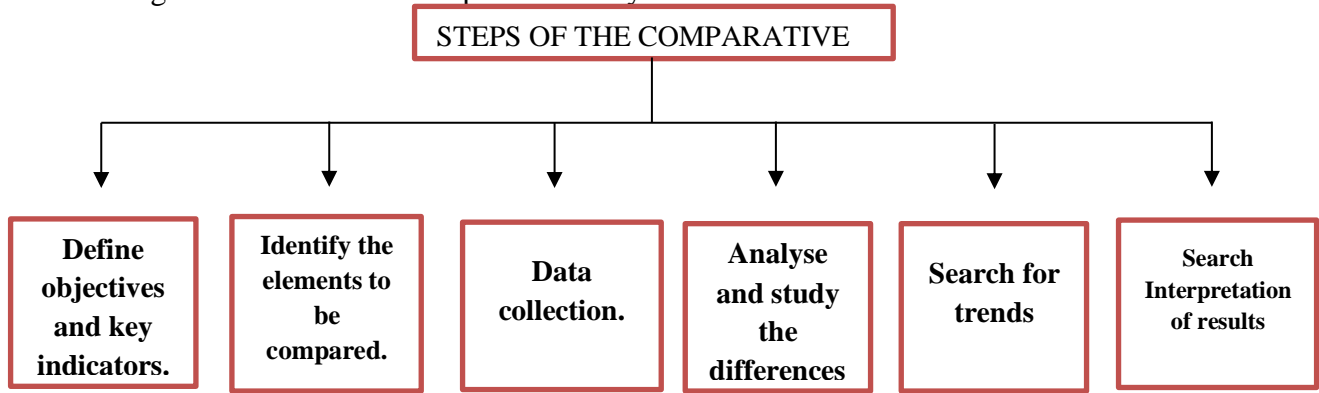
The quasi-experimental research design will be used because it will focus on the context of the two types of models to visualise the advantages and disadvantages of both types of work, in order to evaluate and observe the behaviour of the workers through surveys that will be carried out on the teachers of the Tecnológico de Estudios Superiores de Villa Guerrero who, through the pandemic, had to adapt and experience both models, as the author Parra (2023) tells us; that ‘the quasi-experimental design is a type of study that is characterised by the fact that the study subject is not selected randomly, but is found or established previously. It is characterised by being descriptive, which consists of observing the behaviour of individuals and different social variables and recording qualitative and quantitative data’.

Once the data were obtained, use was made of the comparative analysis methodology, where peculiarities that arise through experimentation with the types of work were analysed, as conceptualised by the author Charles (2023), who mentions that, ‘it consists of contrasting a small number of cases to capture the peculiarities of each one’.

Box 1

Table 1

Methodological scheme of the comparative analysis



In order to obtain, process and analyse the information, a questionnaire was applied to evaluate the job satisfaction of the workers of the Tecnológico de Estudios Superiores de Villa Guerrero and thus determine which work model is the one to which they are best adapted.

The survey applied to the TESVG teachers included questions to find out the value of different aspects of both face-to-face work and telework, for example: stress, physical working conditions, motivation, whether or not they liked their work and also the benefits of both models. Instructions for answering the survey were given and anonymity was preserved throughout.

Convenience sampling was used to determine the sample, as some of the teachers who teach classes cannot answer the survey because they started working after the pandemic, which means that they have only worked in person in the institution, Convenience sampling is defined by the author Cristina Ortega (2023) as ‘a non-probabilistic, non-random sampling technique used to create samples according to the ease of access, the availability of people to be part of the sample, in a given time interval or any other practical specification of a particular element’.

Results

The following are the results obtained from the survey of the teachers of the Tecnológico de Estudios Superiores de Villa Guerrero in order to make a comparison with the results obtained. It should be noted that the same questions were asked for both the face-to-face and teleworking models, so much so that the graphs that were made give a clear view of the model with which they feel more comfortable.

The survey was applied to 59 teachers out of 92 teachers who are currently working in the institution. All 59 teachers reported teaching during the COVID-19 pandemic, so the remaining 33 teachers who were not yet working at that stage were discarded.

Results graphs

Box 2

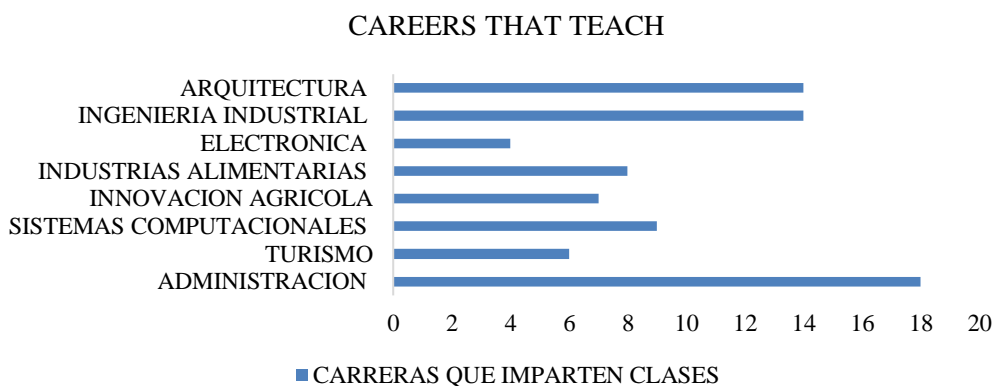


Figure 1

Careers where classes are held

The graph shows the number of teachers per degree course, from which we can see that the majority of teachers are in administration (30.5%), followed by industrial engineering and architecture (23.7%), computer systems (15.3%), food industries (13.6%), agricultural innovation (11.9%), tourism (10.2%) and electronics (6.8%).

Box 3

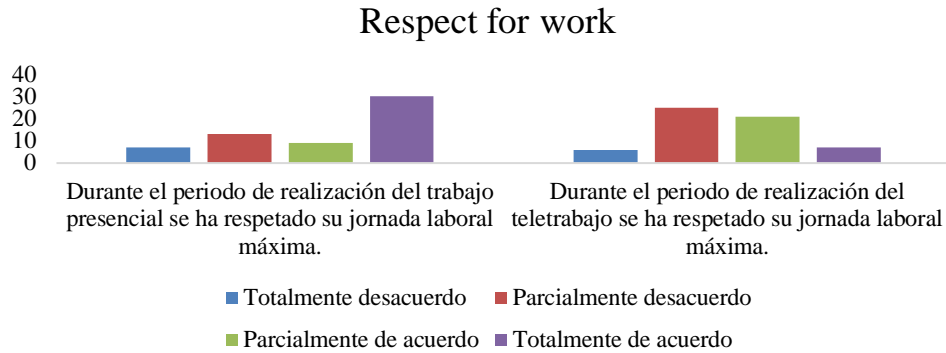


Figure 2

Respect for maximum working hours

When comparing the work models, a distinction is made as to which one has respected its maximum working day. In face-to-face work, they totally agree that their maximum working day has been respected, while in teleworking they partially disagree.

Box 4

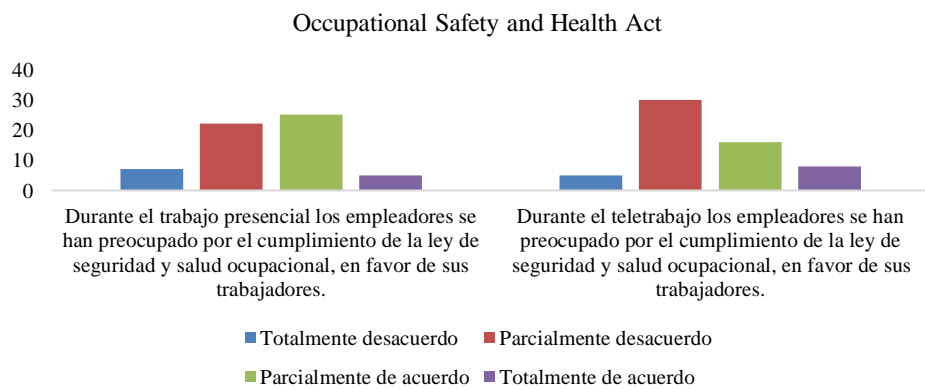


Figure 3

Compliance with the health and safety law

In both work models there was a differentiation in how health and safety was handled and they consider that in face-to-face work they partially agree that they have been concerned about compliance with the health and safety law, while in telework they partially disagree that they have been concerned about compliance with the health and safety law.

Box 5

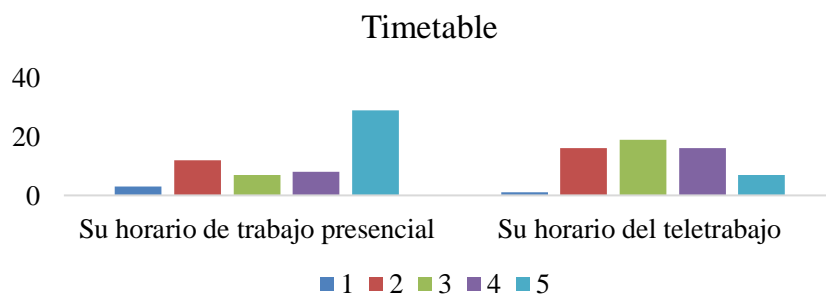


Figure 4

Timetable

In order to visualise the level of satisfaction between the two working models, the people surveyed consider that the working hours for face-to-face work are rated with a 5 and for teleworking with a 3.

Box 6

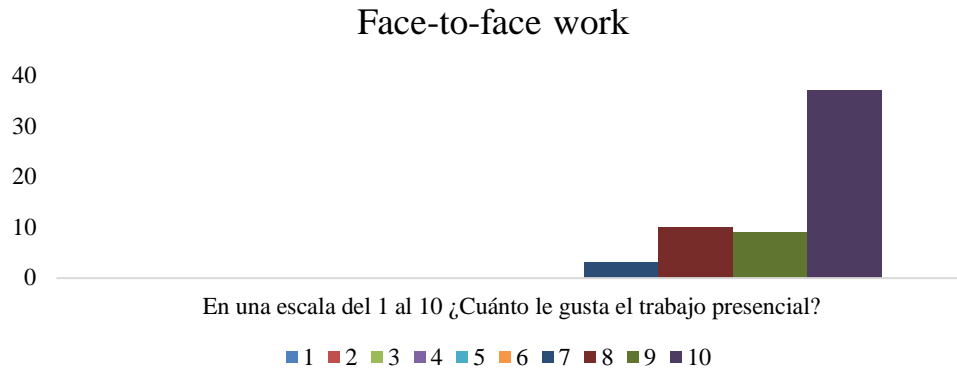


Figure 5
How much do they like face-to-face work?

Box 7

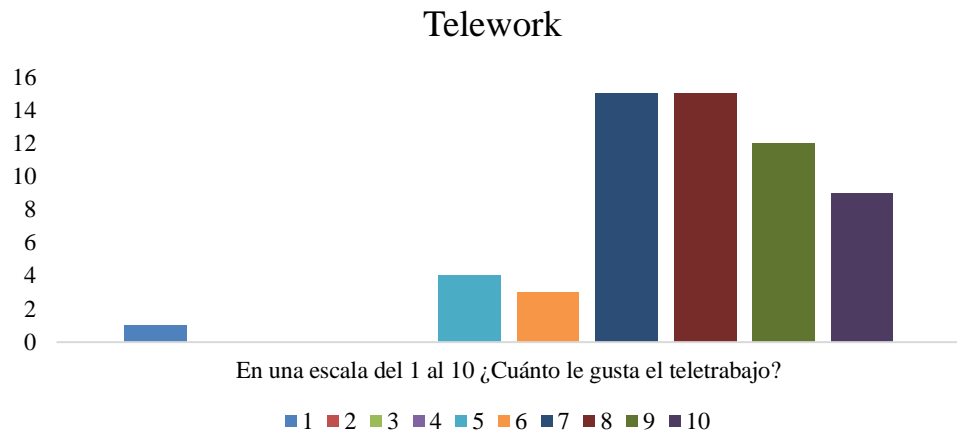


Figure 6
How much they like teleworking

According to the scale from 1 to 10, 62.7% of the workers say that they like face-to-face work at a level of 10, 16.9% at 8, 15.3% at 9 and 5.1% at 7.

According to the scale from 1 to 10, 25.4% of the workers say that they like teleworking at 7 and 8, 20.3% at 9, 15.3% at 10, 6.8% at level 5, 5.1% at 6 and 1.7% at level 1.

Table of variable table results

Once the questions were analysed by means of a descriptive statistical analysis with bar graphs, we proceeded to make the comparative tables, classifying the first in the variables of the object of study in the first table and in the second by the two types of work that were taken into consideration, face-to-face and teleworking.

Box 7**Table 2**

Results table of variables

Variables	Telework	Face-to-face work
Job satisfaction	27.11% of respondents were very satisfied with their work being done in a timely manner. Note: There is a clear difference between the satisfaction between these two variables here it is concluded that the best job satisfaction is in face-to-face work.	54.23% of respondents feel very satisfied with the timely and proper performance of their work. Note: There is a clear difference between the satisfaction between these two variables here it is concluded that the best job satisfaction is in face-to-face work.
Productivity	This variable reflects a lack of productivity, as it is open to us that workers use all their capacities, here only 13.55% say that they use their capacities to perfection.	Productivity is more reflected in this variable of face-to-face work as it tells us that 50.84% have a great possibility of using their skills when carrying out their work
Working conditions	10.16% of the respondents tell us that working conditions are very good. Note: it is concluded that working conditions are better in face-to-face work for different reasons.	10.16% of the respondents tell us that working conditions are very good. Note: it is concluded that working conditions are better in face-to-face work for different reasons.
Adaptability	The adaptability of this variable is 15.3%, which shows that it is more difficult to adapt in a telework scenario because you do not have the necessary resources	The adaptability of this variable is 62.7%, where it is reflected that more than half of those surveyed quickly adapted to their face-to-face work because they have the resources to do so.
Stress level	The stress level in normal is not so high as a rating of 1(low) -5 (highest) tells us that most of it is at 2 and here it is 40.67%. Note: there is a tie with the stress level.	The stress level in normal is not so high as a rating of 1(low) - 5 (highest) tells us that most of it is at 2 and here it is 40.67%. Note: there is a tie with the stress level
Freedom of expression	In this variable it is not easy to have freedom of expression since everything is virtual and here I show that only 20.33% have good freedom of expression	There is better freedom of expression in this variable as it tells us that 38.98% are free to express themselves as they want and can
Communication Boss - Worker	In this variable, communication between boss and worker is more complicated, as there is no direct and physical contact, and the survey tells us that 11.86% totally agree that there is good communication.	There is very good communication in this variable, as it is direct and physical, and the survey showed that 28.81% agree that there is better communication in face-to-face work.

Box 7**Table 2**

Results advantages and disadvantages

Variable	Advantages	Disadvantages
Telework	<ul style="list-style-type: none"> - Less stress - Availability of working hours - Carrying out more activities while working. - Cost reduction - Greater autonomy and responsibility 	<ul style="list-style-type: none"> - Lack of socialisation - Less physical activity - Lack of communication - Isolation - Decreased security - Not everyone is ready to telework
Face-to-face work	<ul style="list-style-type: none"> - Facilitates communication - Facilitates learning and practice - Socialisation - You get more physical activity - Your responsibilities are commensurate. 	<ul style="list-style-type: none"> - No such work-life balance - Increased stress episodes - High costs - Increased distractions

Conclusions

Once the data collected has been analysed, we have the necessary and sufficient information to achieve the objective of knowing the most relevant characteristics, advantages or disadvantages of the models of on-site work and teleworking of the teachers of the Tecnológico de Estudios Superiores de Villa Guerrero, which allows us to reach the following conclusion; Teleworking is a method that was used in times of pandemic for 2 years, in the same way it is used by some institutions or companies which require virtual work as it is also used with certain productivity. On the other hand, according to the research this type of work is not so feasible as many people have a very low job satisfaction compared to face-to-face work.

Face-to-face work is the favourite of the majority of the respondents as it was highly favoured in all the elements to be evaluated. One of the elements to be taken into consideration is productivity, as 50.84% are more productive in face-to-face work because they feel useful and they themselves can act in time and form, whereas in telework they can only act in time, but there are many factors which can affect their productivity. Another element which is analysed in this research is the working conditions, because it is essential to analyse and keep in mind that the integrity of each of the workers or employees who are working at the Tecnológico de Estudios Superiores de Villa Guerrero depends on this.

Talking about the integrity of the employees or in this case of the teachers who work in this institution, the level of stress that they present was analysed and in this evaluated element it tells us that the people do not get very stressed in the on-site work due to the fact that their working day is respected and they do not spend time on their established work.

With the analysed elements it was possible to answer the research question and we realised that most of the teachers of Tecnológico are satisfied and motivated with their current job, which is the face-to-face work, but they are also willing to adapt to teleworking, since the pandemic brought them experience, If another similar situation were to arise, it would only be necessary to train new teachers, but it would also be a good idea to update teachers who have been working for a longer period of time, because teleworking is becoming more and more common in this world and in the future it will no longer be necessary to go to work in a physical space, everything will be done from a screen or with the help of other technologies.

With all of the above, the hypothesis was proven; the COVID-19 pandemic caused confinement for 2 years, and as a result a new work model (teleworking) emerged, which is why the teachers at the Tecnológico de Estudios Superiores de Villa Guerrero did not adapt and currently prefer to work in person because of its traditional form.

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The authors declare that they have no conflict of interest. They have no known competing financial interests or personal relationships that could have influenced this chapter.

Author contribution

Figuroa-Pérez, Itzel Yadira: Contributed to the research technique, as well as to the design of the future recommendations to the company, object of study.

Valladares-Carbajal, Mari Carmen: Contributed to carrying out the research method within the company, object of study.

García-Castillo, Karla Yazmín: Contributed to the design of the research techniques, as well as field work and advice on data processing.

Abbreviations

TESVG Technological College of Superior S

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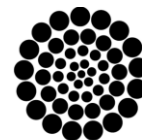
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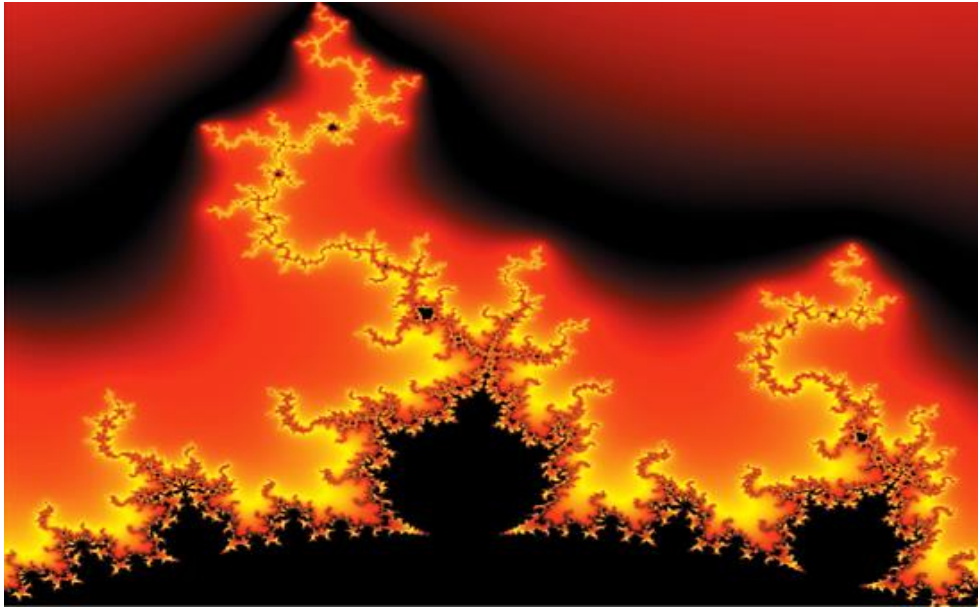


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