ISSN 2523-6784

Volume 7, Issue 21 — July — December - 2023

Journal of Systematic Innovation

ECORFAN®

Journal of Systematic Innovation, Volume 7, Issue 21, July – December 2023, is a journal edited six monthly by ECORFAN-Taiwan. Taiwan, Taipei. YongHe district, ZhongXin, Street 69. Postcode: 23445. WEB: www.ecorfan.org/taiwan, revista@ecorfan.org. Chief Editor: IGLESIAS-SUAREZ, Fernando. MsC. ISSN-On line: 2523-6784. Responsible for the latest update of this number ECORFAN Computer Unit. ESCAMILLA-BOUCHÁN, Imelda, PhD, LUNA-SOTO, Vladimir. PhD. Taiwan, Taipei. YongHe district, ZhongXin, Street 69, last updated December 31, 2023.

Journal of Systematic Innovation

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Support the international scientific community in its written production Science, Technology and Innovation in the Field of Engineering and Technology, in Subdisciplines of electromagnetism, electrical distribution, sources innovation in electrical, engineering signal, amplification electrical, motor design science, materials in electrical power, plants management and distribution of electrical energies.

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The works must be unpublished and refer to topics of electromagnetism, electrical distribution, sources innovation in electrical, engineering signal, amplification electrical, motor design science, materials in electrical power, plants management and distribution of electrical energies and other topics related to Engineering and Technology.

Presentation of the content

In the first article we present, *Obtaining the parameters of an RC model to know the insulation condition of a distribution transformer* by ROA-ALONSO, Luis Antonio, with adscription in Instituto Politécnico Nacional, CIDETEC, the next article we present, *Smart solar hydroponic system simulation* by PONCE-GONZALEZ, Cristopher, ANTONIO-ANTONIO, Alejandrina, MERINO-TREVIÑO, Marco, Antonio and PEÑA-DELGADO, Adrián Fermín, with adscription in Universidad Tecnológica de Altamira, the next article we present, *Improvement of the maintenance administration system for the official vehicle fleet of the Yaqui River irrigation district* by CONANT-PABLOS, Marco Antonio, FORNÉS-RIVERA - René Daniel, CANO-CARRASCO, Adolfo and LÓPEZ-ENCINAS, Kenia Jaqueline, with adscription in Instituto Tecnológico de Sonora, the last article we present, *Data management system implemented in wristbands with RFID technology (SAYETS)* by GÁMEZ-MARTINEZ, Sandra, YÉPEZ-RODRIGUEZ, Chrismaldy Areli, JUÁREZ-ROMERO, Juan Carlos and RODRÍGUEZ-AGUIRRE, Esmeralda Carolina, with adscription in Universidad Politécnica de Juventino Rosas.

Content

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Obtaining the parameters of an RC model to know the insulation condition of a distribution transformer

Obtención de los parámetros de un modelo RC para conocer la condición del aislamiento de un transformador de distribución

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DOI: 10.35429/JSI.2023.21.7.1.6 Received July 14, 2023; Accepted November 29, 2023

Abstract

Because it is a topic of great interest in the study of the insulation system of oil immersed Transformers, methods have been sought to determine the moisture content and aging of the pressboard, paper and dielectric oil from Transformers, measuring the response of the dielectric materials, which are characterized by known polarization phenomena. One of these techniques is dielectric spectroscopy in the time domain, measuring the polarization-depolarization currents, with this the parameters of an equivalent RC circuit (Debye model) are determined. Using the Debye model (T. K. Saha, P. Purkait y F. Muller, 2005) and obtaining the polarization current through the insulation resistance test, the parameters to establish the condition of the transformer oil-paper insulation system will be determined, using exponential curve fitting of the data obtained from the insulation resistance test with the high vs. Low connection plus tank, the parameters of the time constant τ, the resistance R and the capacitance C of the equivalent circuit are obtained and with this information, the condition of the transformer insulation system is evaluated and decisions are made regarding maintenance actions.

Spectroscopy, Polarization, Depolarization, Resistance, Domain, Dielectric, Parameters

Resumen

Por ser un tema de gran interés en el estudio del sistema de aislamiento de los transformadores inmersos en aceite, se han buscado métodos para determinar el contenido de humedad y envejecimiento del cartón prensado, papel y aceite dieléctrico de los transformadores, midiendo la respuesta de los materiales dieléctricos, que se caracterizan por conocidos fenómenos de polarización. Una de estas técnicas es la espectroscopia dieléctrica en el dominio del tiempo, midiendo las corrientes de polarización y depolarizacion, con las cuales, se determinan los parámetros de un circuito RC equivalente (modelo de Debye). Usando el modelo de Debye (T. K. Saha, P. Purkait y F. Muller, 2005) y obteniendo las corrientes de polarización a traves de la prueba de resistencia de aislamiento, se determinarán los parámetros para establecer la condición del sistema de aislamiento aceite-papel del transformador, realizando ajustes exponenciales de los datos obtenidos de la prueba de resistencia de aislamiento con la conexión alta contra baja más tanque, se obtienen los parámetros de la constante de tiempo τ, la resistencia R y la capacitancia C del circuito equivalente; con esta información se evalúa la condición del sistema de aislamiento del transformador y se pueden tomar decisiones respecto a las acciones de mantenimiento.

Espectroscopia, Polarización, Depolarizacion, Resistencia, Domino, Dieléctrico, Parámetros

Citation: ROA-ALONSO, Luis Antonio. Obtaining the parameters of an RC model to know the insulation condition of a distribution transformer. Journal of Systematic Innovation. 2023. 7-21: 1-6

† Researcher contributing as first author.

Introduction

The transformer insulation system represents one of the most important components of the transformer.

Figure 1 75 kVA pad-mounted transformer insulation system

The dielectric materials of a distribution transformer, i.e. its insulation system, are affected by operating conditions, the environment, physical and chemical conditions, which alter the molecular structure of the dielectric materials of which it is composed; this can accelerate their ageing and the loss of dielectric properties when unfavourable conditions are combined.

In the presence of an electric field, a polarisation current develops due to the tendency of dielectric materials to align dipoles in the direction of the field. When the electric field is removed, the dipoles relax and return to their original state. In the transformer insulation system, each component dielectric material can have a different configuration with its neighbouring molecules. The response time of each group differs from one to another (T. K. Saha, P. Purkait and F. Muller, 2003).

The technical literature (S.M. Gubanski, 2002) considers in the response of insulating media, also called dielectrics, which in general are isotropic and homogeneous, the dielectric displacement vectors (electric flux density), the electric field E and the polarisation P are of equal direction and are interrelated by:

$$D = \varepsilon_0 E + P \quad (1)$$

The physical constant $\varepsilon 0$ = 8.854e-12 As/Vm, is the vacuum permittivity.

The relationship between the dielectric displacement and the applied field is often and in general linear. The relationship can be expressed with a simple factor of proportionality ε_r.

$$D = \varepsilon_r \varepsilon_0 E \quad (2)$$

The factor ε_r is called relative permittivity and describes the dielectric properties of the medium. Therefore, it appears that the polarisation P must be proportional to the electric field E.

$$P = X\, \varepsilon_0 E = \varepsilon_0(\varepsilon_r - 1)E \quad (3)$$

This equation shows the linearity of the system, i.e. it shows the polarisation behaviour directly affected by the dielectric material under study. The quantity X is called the susceptibility of the medium.

If a given electric field E(t) is suddenly applied across a dielectric material, the contained free and bound charges will give rise to a current flow. The movement of the free charges represents the bulk resistivity of the materials, while the bound charges represent the dielectric being a sum of the displacement currents and the bias current. The total current density is given by:

$$j(t) = \sigma E(t) + \frac{\delta D(t)}{\delta t} = \sigma E(t) + \varepsilon_0[\varepsilon_r \delta(t) + f(t)]E(t) \quad (4)$$

The two asymptotic parts of the current j(t), are the instantaneous current density due to the capacitance of the component, $\varepsilon 0 \varepsilon r \delta(t)$ (where $\delta(t)$ means the delta function) and the conduction current density due to the conductivity σ of the material respectively.

The current density due to the polarisation of the material is given by the dielectric response function f(t). It is therefore seen from the above equation that the conductivity σ, the instantaneous (high frequency) component of the relative permittivity $\varepsilon\infty$ and the dielectric response function f(t), characterises the behaviour of the dielectric material in the time domain. It is worth mentioning that current measurements in the time domain can directly lead to the estimation or quantification of σ and f(t).

The step function, which is an exciter, must start at t=0. The function f(t) cannot be assigned instantaneously in application problems, at least one second is necessary which is a dynamic range measurement.

For all homogeneous material, the field strength E(t) is specified as an external voltage applied to the dielectric.

$$i(t) = C_0[\frac{\sigma}{\varepsilon_0}E(t) + \varepsilon_r \frac{dE(t)}{dt} + f(t)E(t)] \quad (5)$$

Co is the capacitance of the test equipment and εr is the relative permittivity of the test material.

The bias current in the dielectric can be obtained by the following equation if a step function is applied in the test with an exciter with Eo amplitude.

$$i_{pol} = C_0E_0[\frac{\sigma}{\varepsilon_0} + f(t)] \quad (6)$$

The Debye model (see figure 1) is used to model the response of the transformer isolation system, through an equivalent circuit of parallel branches containing series resistors and capacitors in each branch. These RC branches represent the dipoles which are randomly distributed and have the associated time constant:

$$\tau_i = R_iC_i \quad (7)$$

Where

Ri and Ci Relaxation parameters (resistance and capacitance).

The different parts of the insulation have unique relaxation parameters that depend on ageing and humidity.

There is also a conduction current due to the insulation resistance Ro; Co represents the geometrical capacitance of the insulation system.

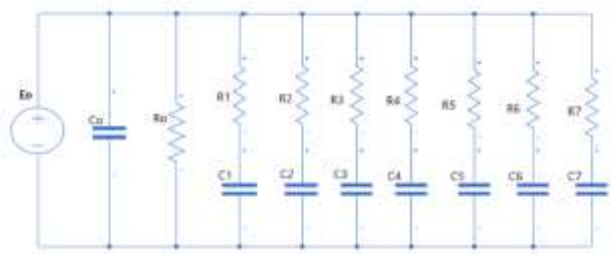

Figure 1 RC circuit, Debye model

The transfer function of the equivalent RC circuit.

$$\frac{I(s)}{E(s)} = \frac{1}{R_0} + sC_0 + \sum_{i=1}^{N} \frac{sC_i}{sR_iC_i+1} \quad (8)$$

Where Ro is the insulation resistance and Co is the geometrical capacitance of the elements; Ri and Ci are the resistance and capacitance of each branch representing the dipoles in the polarisation process and N the number of branches of the RC model.

The transfer function terms of this model can be identified in the branches containing parameters of the geometrical isolation of the elements. On the other hand, the terms of the transfer function corresponding to the insulation of the oil and paper.

$$\frac{I(s)}{E(s)} = FT_G + FT_{aceite} + FT_{papel} \quad (9)$$

The number of branches of the RC circuit in practical models varies from 6 to 10 (T. K. Saha, P. Purkait and F. Muller, 2003), thus, the time domain current equation is obtained for 7 branches of the RC model.

$$i(t) = \frac{E}{R_0} + \frac{E}{R}e^{\frac{t}{RC_0}} + \frac{E}{R_1}e^{\frac{t}{R_1C_1}} + \frac{E}{R_2}e^{\frac{t}{R_2C_2}} + \cdots + \frac{E}{R_7}e^{\frac{t}{R_7C_7}} \quad (10)$$

Obtaining the parameters and condition of the insulation system

The polarisation current will be obtained from the insulation resistance test, which is a routine test performed on the transformer among others that are carried out during preventive maintenance. Resistance values in Ohms are obtained from this test; the current is calculated for each value of the insulation resistance test.

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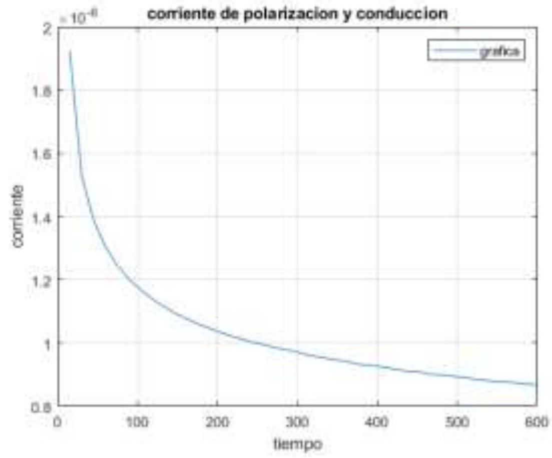
The insulation resistance test of electrical power transformers is one of the routine tests performed during preventive maintenance of electrical distribution transformers. This test consists of applying a direct current voltage to the transformer windings, connected in such a way as to determine the impedance of the oil-paper insulation system of the transformer, applying a direct current voltage, which causes a current to flow through the insulation system; identifying the displacement current due to the geometric capacitance of the insulation system, the dielectric absorption current that occurs due to the polarisation phenomenon of the dielectric materials and the conduction current that flows through the dielectric materials due to the moisture or dirt contained or degradation of their dielectric properties.

From the winding insulation resistance test, it will be possible to obtain the polarisation current and, using the Debye model, we will obtain the equivalent circuit parameters, making the exponential adjustment of the values; which will allow us to know the condition of the insulation system based on the parameters obtained and the characteristics of the graphs obtained.

In the insulation resistance test, with its test connection, a direct current voltage is applied for a certain period of time, and resistance readings are obtained for each time interval. In this way we will analyse and evaluate the response of the dielectric materials, calculating the bias current and the parameters of the Debye model (see Figure 1) which is used to model the response of the transformer insulation system.

Case 1: Insulation resistance test of the transformer as it is at present

With the impedance values obtained over 10 minutes, every 15 seconds, applying a voltage of 5000 V dc, ambient temperature of 21 °C, relative humidity of 40 %, the current is calculated, using Ohm's law.



Graph 1 Polarisation current
Source: Own Elaboration

With the calculated current values, we divide the data in 7 groups that represent the branches of the RC circuit, we make an exponential adjustment to obtain the parameter of the time constant τ. We start by considering that the value of the largest time constant corresponds to the longest time of the test, then we move on to the next group of values until the end. Thus the bias current can be expressed for all points at each part of the insulation with exponential functions of the type:

$$f(x) = A_i e^{\left(\frac{x}{\tau_i}\right)} \quad (11)$$

With the parameters obtained, the equation is parameterised and then we have the mathematical model with which the polarisation current can be determined and condition indicators can be established. As equation 10:

$$i(t) = \frac{E}{R_0} + \frac{E}{R} e^{\frac{t}{RC_0}} + \frac{E}{R_1} e^{\frac{t}{R_1C_1}} + \frac{E}{R_2} e^{\frac{t}{R_2C_2}} + \cdots + \frac{E}{R_7} e^{\frac{t}{R_7C_7}}$$

The second term in the equation corresponds to the instantaneous currents due to the component capacitance decreasing in seconds, so the term is eliminated and not considered for the current calculations for each branch.

For example, to calculate the current in branch 1, the longest set of time values of the 10-minute test is considered; the rest of the branches will have been saturated for these time values and only the conduction current and branch 1 terms are considered.

ISSN 2523-6784

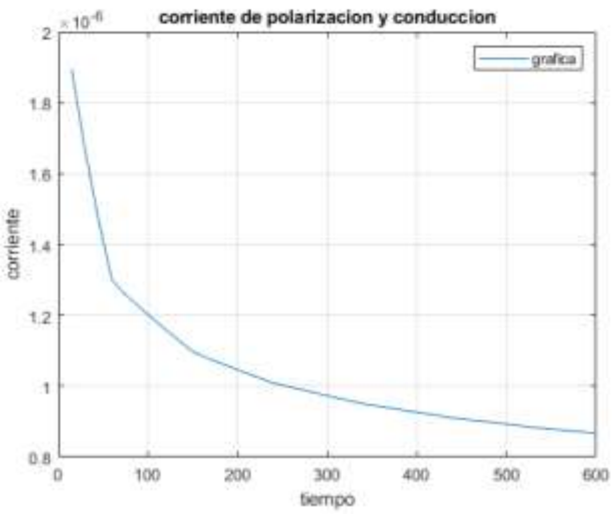
$$i(t) = \frac{E}{R_0} + \frac{E}{R_1} e^{\frac{t}{R_1 C_1}} \quad (12)$$

Obtaining the parameters Ri and Ci.

Branch	Ai [A]	τi [s]	Ri [GΩ]	Ci[nF]
1	1.01751E-06	3747.08	471.5	7.94
2	1.04721E-06	3102.3663	171.85	18.05
3	1.09257E-06	2318.6117	135.2	17.14
4	1.1539E-06	1611.0747	99.027	16.26
5	1.23613E-06	1026.5581	66.5	15.41
6	1.40736E-06	489.1234	33	14.81
7	2.08396E-06	96.4684	9.45	10.207

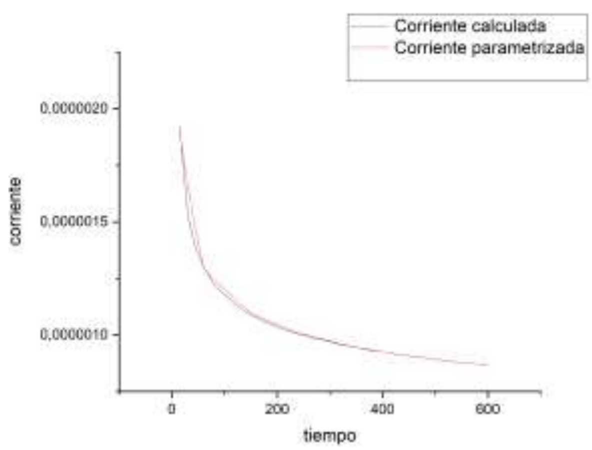
Table 1 Parameters resulting from the exponential adjustment of the initial condition

The values of the current for the rest of the branches are determined, and their values are obtained and plotted (see Figure 2).



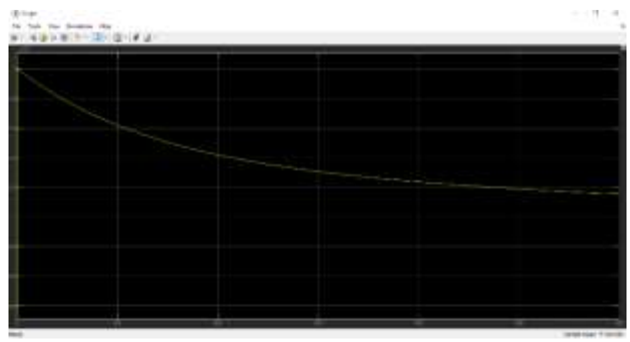
Graph 2 Polarisation currents, with the parameters of the RC equivalent circuit model
Source: Own Elaboration

Comparing the values obtained from the current obtained from the measurement of the insulation resistance and the current obtained from the parameters of the exponential function (see graph 3).



Graph 3 Comparison of the calculated currents and those obtained with the parameters of the RC equivalent circuit model
Source: Own Elaboration

Assigning the values of Ri and Ci of each branch in the equivalent circuit, we obtain the graph of the current (see Graph 4).



Graph 4 Currents obtained by substituting the values of R and C for each branch of the equivalent RC circuit

Analysing the values of the constant **τi** to establish the insulation condition. It is known that, if the constant is less than 100, it represents the oil condition. If one has a constant greater than 100, it represents the solid insulation condition (A. Baral and S. Chakravorti, 2014). As can be seen in Table 2, the branches from 1 to 6 represent the solid materials of the insulation system and with this information, their condición.

Branch	Ai [A]	τi [s]	Ri [GΩ]	Ci[nF]	Isolation
1	1.017E-06	3747.08	471.5	7.94	Solid
2	1.047E-06	3102.3663	171.85	18.05	Solid
3	1.092E-06	2318.6117	135.2	17.14	Solid
4	1.153E-06	1611.0747	99.027	16.26	Solid
5	1.236E-06	1026.5581	66.5	15.41	Solid
6	1.407E-06	489.1234	33	14.81	Solid
7	2.083E-06	96.4684	9.45	10.207	Oil

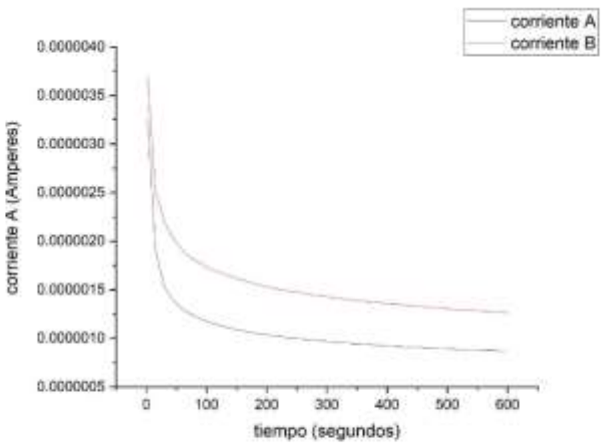
Table 2 Identification of the insulation system

In this way we identify the branches related to solid or liquid insulation and the parameters that define their condition.

Case 2: Transformer insulation resistance test with dielectric oil change

Now we create a condition to the transformer, changing dielectric oil in good condition for oil of low dielectric rigidity. The insulation resistance test is carried out with the high vs. Low tank connection.

By plotting the values of the polarisation currents, the following is obtained:



Graph 5 Comparison of the currents in initial condition and change of dielectric oil with low dielectric strength

The polarisation current describes a descending curve, but with higher values and the tendency is to continue descending, but after 10 minutes it does not approach the value of the initial case, with the dielectric oil with better dielectric rigidity. A table with the old values and the new values is displayed.

	Case 1			Case 2		
Branch	τi [s]	Ri [GΩ]	Ci[nF]	τi [s]	Ri [GΩ]	Ci[nF]
1	3747.08	471.5	7.94	2932.37	254.84	11.5
2	3102.36	171.85	18.05	2588.38	105.88	24.44
3	2318.61	135.2	17.14	2137.707	80.73	26.47
4	1611.07	99.027	16.26	1537.19	62.99	24.4
5	1026.55	66.5	15.41	954.187	41.35	23.07
6	489.12	33	14.81	531.68	22.9	23.11
7	96.46	9.45	10.207	129.15	8.5	15.19

Table 3 Comparison of case 1 and case 2 parameters

The resistance and capacitance values of each branch show the condition of the insulation system and allow actions to be taken to improve conditions. Resistance decreases and capacitance increases, these are the parameters that will be monitored to determine improvements in the insulation system.

Conclusion

Having obtained the parameters of the RC model, it is possible to know the condition of the insulation system and compare the before and after performing preventive maintenance to the transformer, through the parameters of the RC model.

Graph 5 shows the behaviour of the polarisation current for both cases, with parallel curves showing higher current values over time, indicating the condition of the oil-paper insulation system. The condition of the oil has an important influence on the condition of the insulation system, which can be significantly improved if a degassing and filtering process is carried out during corrective maintenance.

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Article

Journal of Systematic Innovation

December 2023 Vol.7 No.21 7-17

Smart solar hydroponic system simulation

Simulación de sistema hidroponico solar e inteligente

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DOI: 10.35429/JSI.2023.21.7.7.17 Received July 14, 2023; Accepted June 29, 2023

Abstract

This project "Simulation of Intelligent Solar Hydroponic System" aims to provide a possible alternative for the generation of food resources that can be consumed in the University community and in the town of Altamira Tamaulipas. The project schedule was divided into three stages, Stage 1: involved research and training, Stage 2: followed by simulations and research formats. stage 3: consisted of refining the details and planning the presentation virtually. In this way, the evaluation and feedback of the project was carried out, it involved the review of the objectives and goals of the project, the simulation test to ensure adequate functionality, the analysis of the project methodology, the review of the contributions of the project team. and the analysis of the costs and benefits of the project. Constructive feedback was provided to the project team, including specific areas for improvement on the job. The development of this project "Smart Solar Hydroponic System Simulation" contributes to society as a promising alternative to generate food resources, using emerging technologies and mechatronic engineering knowledge. The project was developed through effective project planning, management risk management and communication with stakeholders, and the evaluation and feedback process helped ensure the success of the project.

Photovoltaic system, Renewable energy, Hydroponic system, Rainwater capture system, Simulations, Refining, evaluation, Objectives, Analysis, Contributions, Alternative, Virtually, Functionality, Constructive, Development, Promising, Generate, Technologies, Effective

Resumen

El presente proyecto “Simulación de Sistema Hidropónico Solar Inteligente” pretende brindar una posible alternativa de generación de recursos alimentarios que puedan ser consumidos en la comunidad Universitaria y en la localidad de Altamira Tamaulipas. El cronograma del proyecto se dividió en tres etapas, Etapa 1: involucró investigación y capacitación, Etapa 2: seguida de simulaciones y formatos de investigación. etapa 3: consistió en refinar los detalles y planificar la presentación en forma virtual. De esta manera se realizo la evaluación y retroalimentación del proyecto involucró la revisión de los objetivos y metas del proyecto, la prueba de la simulación para asegurar la funcionalidad adecuada, el análisis de la metodología del proyecto, la revisión de las contribuciones del equipo del proyecto y el análisis de los costos y beneficios del proyecto. Se proporcionó retroalimentación constructiva al equipo del proyecto, incluidas áreas específicas de mejora en el trabajo. El desarrollo de este proyecto "Simulación de sistema hidropónico solar inteligente” contribuye a la sociedad como una alternativa prometedora para generar recursos alimentarios, utilizando tecnologías emergentes y conocimientos de ingeniería mecatrónica. El proyecto fue desarrollado a través de la planificación eficaz del proyecto, la gestión de riesgos y la comunicación con las partes interesadas, y el proceso de evaluación y retroalimentación ayudaron a garantizar el éxito del proyecto.

Sistema fotovoltaico, Energía renovable, Sistema hidropónico, Sistema de captación de agua de lluvia, Simulaciones, refinación, Evaluación, Objetivos, Análisis, Aportes, Alternativa, Virtualmente, Funcionalidad, Constructivo, Desarrollo, Promisorio, Generar, Tecnologías, Efectivo

Citation: PONCE-GONZALEZ, Cristopher, ANTONIO-ANTONIO, Alejandrina, MERINO-TREVIÑO, Marco, Antonio and PEÑA-DELGADO, Adrián Fermín. Smart solar hydroponic system simulation. Journal of Systematic Innovation. 2023. 7-21: 7-17

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Introduction

The Smart Solar Hydroponic System Simulation project is an innovative initiative that aims to simulate and evaluate the performance of a solar-powered hydroponic system. Hydroponic systems are becoming increasingly popular as a sustainable alternative to traditional agricultural methods, allowing year-round crop production with minimal water use and space requirements (Small-Scale Aquaponic Food Production. Integrated Fish and Plant Farming, n.d.). In addition, solar energy is a clean and renewable energy source that can significantly reduce operating costs.

The simulation will allow analysis of several factors, including crop growth rates, nutrient supply systems, water use and energy efficiency. The project team plans to use advanced technologies, such as machine learning algorithms, to optimise system performance and predict future crop yields.

The smart solar hydroponic system simulation project has the potential to revolutionise the agricultural industry by providing a sustainable and cost-effective method for producing fresh produce. Furthermore, this project aligns with the global goal of reducing carbon emissions and promoting sustainable development.

Overall, the smart solar hydroponic system simulation project is an exciting venture that has the potential to have a significant impact on the future of agriculture.

Hydroponics is a method of growing plants without soil, using a nutrient-rich water solution. The history of hydroponics dates back to ancient times, when the Hanging Gardens of Babylon were thought to have used a form of hydroponics to grow their plants. However, the modern concept of hydroponics is generally attributed to the work of William Frederick Gericke, a professor at the University of California, Berkeley in the 1920s (From Fertigation *et al.*, n.d.).

Overall objective

Design and automate the process using emerging technologies such as IOT communications or artificial intelligence called "Smart Solar Hydroponic System Simulation" to generate a possible alternative to provide food resources that can be consumed by both the University community and the local community (Li *et al.*, 2014).

Specific objectives

- To design a hydroponic system and generate food resources that can be consumed by both the school community and the local community.
- Automate the process by using emerging technologies such as IOT communications or artificial intelligence.
- It allows to produce more and with less risk under climatic conditions.
- Raise awareness of the use of hydroponics in society in general.
- It does not require more space.

Justification

The proposed research aims to develop a solar and intelligent hydroponic system in order to optimise food production, reduce costs, promote self-sustainability and raise awareness of the importance of avoiding over-processed food. This innovative approach offers direct benefits to the community by providing more accessible and healthy food, while contributing to long-term environmental sustainability through the use of renewable energy and sustainable agricultural practices. This research seeks to address current challenges in producing food efficiently and responsibly.

Issue

Nowadays society leads such a changing life, where the majority of the population consumes canned, frozen products that over time represent a problem for human health, due to the loss of nutrients and the presence of harmful additives, and have negative effects on the environment, due to their intensive production and the generation of non-biodegradable waste.

It is essential to encourage healthier and more sustainable diets, promoting the intake of fresh and local foods, and reducing dependence on processed foods.

Theoretical framework

Hydroponics is a plant cultivation technique based on the use of aqueous solutions instead of soil to provide the nutrients necessary for plant growth. Plants are grown in an inert medium, such as gravel, sand, rock wool or other inert substrates, in which a nutrient solution containing all the nutrients necessary for plant growth and development is supplied (Benizri *et al.*, 1995).

It is also considered a sustainable and efficient cultivation method, as it allows optimal use of water, nutrients and light, and can be used anywhere, even in urban areas with little space for traditional gardens.

General advantages

Water savings: Hydroponics uses a closed water recirculation system, which means that much less water is required than conventional soil cultivation.

Higher yields and production: hydroponic crops can produce more food per unit area than soil crops.

Nutrient control: In hydroponics you can precisely control the amount and type of nutrients your plants receive, resulting in faster and healthier growth.

Less pesticide use: Because hydroponic crops are grown in a controlled environment, it is possible to significantly reduce the use of pesticides and herbicides.

Year-round production: Hydroponics allows for year-round crop production, regardless of external weather conditions.

Space-saving: Hydroponics is a vertical growing technique that allows plants to be grown in small spaces, which is ideal for production in urban areas and areas with space limitations.

Higher quality food: Food grown in hydroponic systems is of high quality, as the growing conditions are carefully controlled.

Types of hydroponic systems

NFT (Nutrient Film Flow) system

This system uses a thin film of nutrient water that flows over the roots of the plants through inclined channels. The water film is continuously recirculated and can be adjusted to maintain a suitable temperature and pH for the crop. This system is ideal for green leafy plants and herbs.

Aeroponic system

In this system, the roots of the plants are suspended in the air and sprayed with a nebulised nutrient solution. The roots are exposed to the air and there is no contact with solid growing media, which allows for greater oxygen uptake and a higher growth rate. This system is ideal for growing high-density, fast-growing plants.

Drip system

This system consists of a system of pipes and a set of drippers that release the nutrient solution to the roots of the plants. Nutrients are supplied at regular intervals and the remaining solution is collected and recirculated. This system is ideal for plants that require more water and nutrients.

Root immersion system

Also known as a flotation system, this system immerses the roots of the plants in a nutrient solution and keeps them in constant contact with it. Oxygen is supplied to the roots through air bubbles, which maintains a suitable environment for plant growth. This system is ideal for plants that require a high level of moisture at the roots.

Drip irrigation system

This system uses a growing medium such as coconut fibre or perlite to support the plants, which are watered through a system of pipes and drippers. The growing medium helps retain moisture and nutrients, and excess nutrient solution is collected and recirculated. This system is ideal for fruit and vegetable plants.

PH

The pH is a measure of the acidity or alkalinity of a solution. It is a scale ranging from 0 to 14, with 7 being neutral. A pH below 7 is acidic, while a pH above 7 is alkaline or basic. pH is an important parameter in many fields, including chemistry, biology, agriculture and environmental sciences, as it can affect the properties and behaviour of living substances and organisms (Domingues *et al*., 2012).

Water is a fundamental resource for life on Earth, and its pH is an important parameter for understanding the chemical and biological processes occurring in aquatic environments. The pH of water is determined by the concentration of hydrogen ions (H+) and hydroxide ions (OH-) present in solution. When water has a pH of 7, it is considered neutral, meaning that the concentration of H+ and OH- ions is equal. When the concentration of H+ ions is greater than the concentration of OH- ions, the water is considered acidic, and when the concentration of OH- ions is greater than the concentration of H+ ions, the water is considered alkaline or basic.

The pH of natural water sources, such as rivers, lakes and groundwater, can vary widely depending on a variety of factors, including the geology of the surrounding area, the presence of dissolved minerals and gases, and human activities. Some natural water sources, such as acid rain and volcanic lakes, can have extremely low pH values, which can have harmful effects on aquatic organisms and their habitats. On the other hand, some alkaline lakes and streams can have high pH values, which can also be detrimental to aquatic life.

In addition, changes in the pH of water can affect the solubility and mobility of chemicals, nutrients and metals. For example, some metals become more toxic at lower pH values, and some nutrients such as phosphorus and nitrogen may be more available for plant growth at higher pH values.

Therefore, monitoring and regulating the pH of water is important to maintain the health and productivity of aquatic ecosystems, as well as to ensure the safety and quality of drinking water. (*Ragany, M., Haggag, M., El-Dakhakhni, W. y Zhao, B. (2023). Meta-Investigación de Sistemas Agrícolas de Ciclo Cerrado Utilizando Minería de Texto. Fronteras En Los Sistemas Alimentarios Sostenibles* , n.d.).

Soil nutrients

Some of the main nutrients that plants absorb from the soil are:

Nitrogen: used for the formation of proteins, enzymes and chlorophyll.

Phosphorus: essential for root growth as well as flower and fruit production.

Potassium: necessary for water regulation in plant cells, as well as for fruit and seed development.

Calcium: important for cell health and root growth.

Magnesium: is a key component of chlorophyll, making it an essential nutrient for photosynthesis.

In addition to nutrients, plants also absorb water and oxygen from the soil. Water is used to transport nutrients and maintain plant structure, while oxygen is essential for plant respiration and energy production. They can also absorb other nutrients and elements necessary for their growth, such as sulphur, iron, zinc and manganese, among others.

Substrate type

Loam soil: This is a type of soil with an intermediate texture between clay and sand, which makes it ideal for a wide variety of crops.

Clay soil: This is a heavy, dense soil that holds water and nutrients very well, but can also be difficult to work and may require improvements to improve its structure. Examples of edible crops that can be grown on clay soil are potatoes, tomatoes, cauliflower, carrots, wheat and barley.

Sandy soil: is a light, easy to work soil type, but tends to have a low capacity to retain water and nutrients. Examples of edible crops that can be planted in sandy soil are beets, lettuce, corn, squash, strawberries and watermelon.

Loamy soil: A soil type with a texture intermediate between clay and sandy soil, which retains water and nutrients well, but can also be easily compacted. Examples of edible crops that can be grown in clay soil are garlic, onions, spinach, chard, melon and grapes.

Calcareous soil: This is a type of soil with a high concentration of calcium carbonate, which can affect the availability of some nutrients to plants. Examples of edible crops that can be grown in calcareous soils are broccoli, cabbage, kale, onions, garlic and carrots.

Saline soil: This is a type of soil that contains high levels of salt, which can affect the growth of some plants and may require special measures to correct it. However, some edible crops that can grow in saline soils are asparagus, alfalfa, melons and beets.

Compatible crops

Some of the most common crops used in hydroponics include lettuce, tomatoes, peppers, strawberries, cucumbers, herbs such as basil and cilantro, among others. These crops are well suited to hydroponic systems because of their relatively small root system and their ability to grow in a controlled environment without soil. In addition, many of these crops are in high market demand and can be produced efficiently and cost-effectively using hydroponic techniques (Güohler *et al*., 1989).

Another factor that makes these crops popular in hydroponics is their fast growth cycle. Hydroponic crops can grow up to 50 % faster than soil crops due to the constant availability of nutrients and water, which allows for higher production in a shorter period of time.

It is important to keep in mind that different crops have different nutritional and environmental requirements, so it is necessary to select the right crops for the hydroponic system used and adjust nutrient levels and other environmental factors accordingly to achieve optimal production (Kumar & Cho, 2014).

Aquaponics is a sustainable farming system that combines aquaculture with hydroponics, creating a mutually beneficial relationship between fish and plants. The benefits of aquaponics go beyond the production of fresh and healthy food.

In this article, we will discuss the general benefits of aquaponics in detail.

Sustainable food production: aquaponics is a closed-loop system that recirculates water and nutrients and requires up to 90 % less water than traditional farming methods. This makes it an environmentally friendly alternative to conventional farming.

Efficient use of space: aquaponics allows vertical farming, making it possible to grow more food in less space. This is particularly useful in urban areas where land is scarce.

No pesticides or chemicals: aquaponics relies on natural processes to control pests and diseases, eliminating the need for harmful chemicals and pesticides. This means that the food produced is free of harmful residues and safe for consumption.

Year-round harvesting: With the right setup, aquaponics allows fresh produce to be harvested all year round, regardless of the season. This provides a constant supply of fresh and healthy food, even during the winter months.

Reduced energy consumption: Compared to traditional cultivation methods, aquaponics requires less energy. This is because the system relies on natural processes such as gravity and does not require heavy machinery or equipment. Diverse range of crops: aquaponics allows the cultivation of a wide range of crops, including fruits, vegetables, herbs and flowers. This provides a varied diet and helps promote biodiversity.

Economic benefits: Aquaponics has the potential to provide economic benefits to farmers, especially in areas where land is expensive. It is also a viable option for small farmers and urban gardeners, who can sell their produce locally.

Educational and therapeutic benefits: Aquaponics is an excellent educational tool that provides hands-on learning opportunities for children and adults alike. It can also have therapeutic benefits, as it is a calming and relaxing activity.

The nitrogen cycle

The nitrogen cycle is a natural process that occurs in nature, is essential for the life of plants and animals, and is of utmost importance in aquaponics. This process takes place in four main stages: nitrification, denitrification, nitrogen fixation and mineralisation.

Nitrification is the first stage of the nitrogen cycle, in which bacteria convert ammonium (NH_4^+) into nitrite (NO_2^-) and then into nitrate (NO_3^-). In aquaponics, this stage occurs thanks to the nitrifying bacteria found in the filters and in the growing medium of the plants.

Denitrification is the second stage of the nitrogen cycle, in which bacteria convert nitrates (NO_3^-) into nitrogen gas (N_2) and nitrous oxide (N_2O). In aquaponics, this stage occurs in the root zone of the plants, where anaerobic bacteria reduce the nitrates present in the water.

Nitrogen fixation is the third stage of the nitrogen cycle, where bacteria convert gaseous nitrogen (N_2) into ammonium (NH_4^+). In aquaponics, this stage can occur thanks to the presence of nitrogen-fixing bacteria in the roots of the plants.

Mineralisation is the fourth stage of the nitrogen cycle, in which bacteria break down organic debris and release ammonium (NH_4^+) into the environment. In aquaponics, this stage occurs through the decomposition of fish and plant waste.

In aquaponics, the nitrogen cycle is essential to maintain a healthy environment for fish and plants. The presence of nitrifying and nitrogen-fixing bacteria is essential for maintaining water quality and supplying nutrients to plants. In addition, the removal of ammonium and nitrite is essential to prevent the build-up of toxic substances in the water and to maintain a healthy environment for the fish.

Types of fish suitable for aquaponics

The selection of appropriate fish species is crucial for a successful aquaponic system (Grozea, 2011). In this article, we will discuss in detail the types of fish that are suitable for aquaponics.

Tilapia: Tilapia is one of the most widely used fish in aquaponics due to its resilience, rapid growth and high tolerance to poor water quality. Tilapia can tolerate a wide range of temperatures, making it suitable for both warm and cold climates.

Catfish: Catfish are another popular choice for aquaponics. They are known for their rapid growth rate and can thrive in a wide range of water temperatures. Catfish are also resistant to many diseases and can tolerate low levels of dissolved oxygen.

Trout: Trout are a cold-water fish that thrive in temperatures between 10°C and 20°C. They require high levels of dissolved oxygen and a stable pH to thrive. Trout can grow rapidly and reach maturity in as little as 12 to 18 months.

Koi: Koi is an ornamental fish species that can add aesthetic value to an aquaponic system. They are hardy and can tolerate a wide range of water temperatures. Koi also produce a significant amount of waste, making them an excellent choice for larger systems.

Barramundi: Barramundi are tropical fish that grow well in warm water. They are known for their sweet and delicate taste, making them a popular choice for aquaponics looking to sell their fish as a premium product. Barramundi require high quality water with a stable pH and high levels of dissolved oxygen.

Bluegill: Bluegill are a popular choice for smaller aquaponic systems. They are hardy and easy to care for, which makes them an excellent choice for beginners also have a high reproductive rate, which means they can quickly establish a breeding population in a small system.

Maintenance and care of the aquaponic system

Maintenance and care are essential for the proper functioning and sustainability of an aquaponic system. Proper maintenance and care can lead to increased production of both fish and plants. Here are some important aspects of maintenance and care of an aquaponic system:

Water quality: The quality of the water in the system should be monitored regularly. Test kits are available to test the water quality for pH, ammonia, nitrate, nitrite and dissolved oxygen. If any of these parameters are outside the acceptable range, steps should be taken to correct them.

Fish health: Fish are an integral part of an aquaponic system and their health should be monitored regularly. Proper nutrition, water quality and temperature must be maintained to keep the fish healthy.

Plant health: Plants depend on nutrient-rich water from fish waste. It is important to check for nutrient deficiencies or toxicity in plants. Any unhealthy plants should be removed immediately to prevent the spread of disease.

System components: All system components, such as pumps, filters and culture beds, should be checked regularly to ensure that they are functioning properly. Any defective components should be replaced or repaired immediately.

Harvesting: Proper harvesting techniques should be used to avoid damage to plants or fish. Fish should be harvested in a humane manner and plants should be harvested at the correct time to obtain the maximum yield.

Cleaning: The system should be cleaned periodically to remove any debris or algae build-up. It is also important to remove any dead plant material or uneaten fish feed from the system.

Pest and disease control: Any signs of pests or disease should be addressed immediately to prevent the spread of infection. Natural remedies or biological controls can be used to address these problems.

Solar panels

Solar energy is a renewable and sustainable energy source that has become an attractive alternative for electricity generation worldwide. Solar panels are an essential component of solar energy systems, as they are responsible for converting sunlight into usable electrical energy.

Solar panels are made up of solar cells, which contain semiconductor materials that absorb sunlight and convert it into electrical energy. Solar panels can be used to power a wide variety of devices, from small solar lights to large-scale solar energy systems to power homes and buildings (Wang *et al*., 2023).

There are different types of solar panels, each with its own advantages and disadvantages. The most common solar panels are photovoltaic (PV) solar panels, which use solar cells to convert sunlight into electrical energy. Solar thermal panels, on the other hand, use solar energy to heat water or air, which can be used to heat buildings or provide hot water.

In addition, there are also hybrid solar panels, which combine photovoltaic and thermal solar panel technologies to maximise energy efficiency and reduce production costs. Hybrid solar panels are particularly useful in areas where sunlight is limited, as they can provide both electricity and heat.

Solar panels are an essential technology for solar power generation and are used in a wide variety of applications, from small devices to large-scale solar power systems. There are different types of solar panels, each with its own advantages and disadvantages, and choosing the right solar panel depends on the specific application.

Methodology

Define project goals and objectives

The project aims to provide an alternative solution to food resources that can be consumed by both the school community and the local community. Specific objectives include making the project economically profitable, automating the process through emerging technologies such as IoT or AI, generating food resources and applying the knowledge acquired during the mechatronics engineering degree (Hinojosa *et al*., n.d.).

Determine the scope of the project

The project will focus on providing a simulation guide for a smart solar hydroponic system that could be of interest to investors, government departments and students studying the topic.

Establish a project team and determine the necessary resources

A laptop with a Core i7 processor and an Nvidia 3070 graphics card will be required for the simulation, and other resources will be provided by the team members' own computers.

Figure 1 Computer equipment for project development

Develop a timetable

The project will be completed in three stages. February-March will be devoted to research and training, March-April will focus on completing simulations and research formats, and April-Final will refine details and plan the presentation.

Identify risks and contingencies

Risks and contingencies, such as technical risks, cost overruns, delays, stakeholder expectations and regulatory compliance, will be addressed through effective project planning, risk management and communication with stakeholders.

Evaluate and provide feedback

The project will be evaluated based on objectives, deliverables, methodology, schedule, project team, costs and benefits. Comments will be constructive and include specific areas for improvement and praise for the team's work. By following this methodology, the project "Simulation of smart solar hydroponic system" can be completed effectively and efficiently, ensuring a successful outcome.

The 5 steps

Planning phase (early February 2023): in this phase, the project team would define the objectives, scope, required resources and timeline of the project. They would also identify potential risks and contingencies and develop a risk management plan. During this phase, the team would determine the specific tasks, activities and deliverables needed to successfully complete the project.

Figure 2 Side view of project simulation

Design phase (mid-February to early March 2023): in this phase, the project team would create the initial design of the simulation, including the system architecture, simulation models and simulation parameters. They would also develop a test plan to ensure that the simulation works as intended. The team would collaborate to ensure that the simulation design meets the project objectives and requirements.

Figure 3 Top view of project simulation

Development phase (mid-March to early April 2023): in this phase, the project team would implement the design, develop and integrate the simulation models, and test the simulation to ensure that it meets the requirements. They would also address any technical issues that arise during development and testing.

Testing phase (mid to late April 2023): in this phase, the team would conduct extensive testing of the simulation to ensure that it works correctly and generates accurate results. The team would use the test plan developed in the design phase to identify and address any defects or problems.

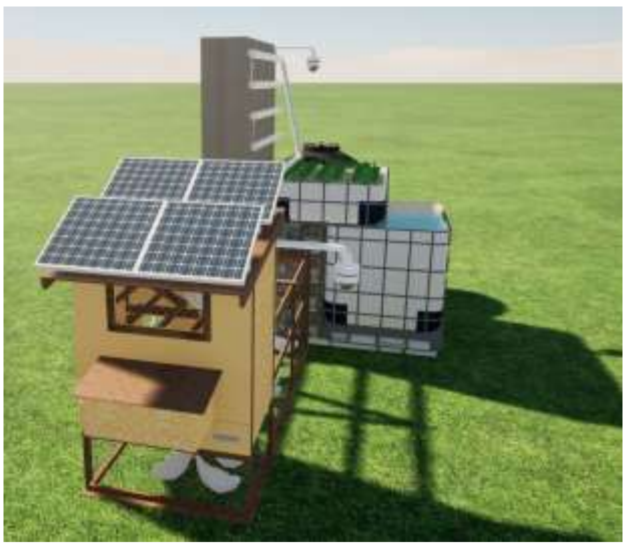

Figure 4 Front view of project simulation

Implementation phase (end of April 2023): in this phase, the project team would implement the simulation for its intended audience. They would also provide training and documentation to users to ensure that they understand how to use the simulation effectively. The team would conduct a final review to ensure that the simulation meets the goals and objectives of the project.

Results

As a result, the design and simulation of a solar and intelligent hydroponic system that allows the self-sustainable production of healthy food for the population of Tamaulipas is shown, thus guaranteeing greater reliability and profitability for the proper functioning of the project, the estimated cost for the development of the project will be $14,865.00.

Finally, illustration 5 shows the completed project.

Technological University of Altamira Project cost table ***Hydroponic system simulation Solar and intelligent***			
Quantity	Description	Price	Amount
1	Tinaco Rotoplas	$3,733.00	$3,733.00
1	450 lts	$6,290.00	$6,290.00
1	IBC 1000 L container	$1,953.00	$1,953.00
1	Kit of 18W solar panels and 4000 w power inverter	$498.00	$498.00
1	Submersible water pump of 12v ½ inch 24w	$988.00	$988.00
1	Dry Clay Stones for hydroponics	$312.00	$312.00
1	Durable hydroponic pots	$237.00	$237.00
7	Biochemical plastic filter units for hydroponics aquaculture	$122	$854.00
Total			$14,865.00

Table 1 Project Cost Table

Figure 5 Project Simulation

Acknowledgements

We would like to thank Mr. Cristóbal Ponce Alvarado for the facilities of the land for the development of the project and the student Gabriel Antonio Martínez Duque for his donation of poultry for the development of the experimental phase of the project.

Conclusions

In conclusion, a project to simulate an intelligent solar hydroponic system has great potential to revolutionise agriculture and make it more sustainable. By using a combination of solar energy, hydroponic technology and intelligent control systems, this system can optimise plant growth and resource utilisation while reducing environmental impact and operating costs.

The simulation model developed in this project can help identify optimal configurations for different crop types and growing conditions, as well as predict their performance under various scenarios. This can help farmers and investors make informed decisions about which crops to grow, where to grow them and how to manage resources effectively.

In addition, the integration of smart technologies such as sensors, IoT and machine learning algorithms can enable real-time monitoring and data analysis of key parameters such as temperature, humidity, pH and nutrient levels. This can enable precise control of the growing environment, ensuring optimal conditions for plant growth and avoiding waste of resources.

In addition to the economic benefits, the implementation of this system can have positive environmental impacts, such as reducing water use and reducing the carbon footprint associated with traditional agriculture. This is particularly relevant in regions with limited water resources and where traditional agricultural practices have led to soil degradation and other environmental problems.

Overall, a smart solar hydroponic system simulation project can contribute to the transition towards a more sustainable and resilient agricultural sector. However, further research and development is needed to fully exploit its potential and overcome technical and economic barriers.

Funding

This work has been funded by the Technological University of Altamira.

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Article **Journal of Systematic Innovation**
December 2023 Vol.7 No.21 18-24

Improvement of the maintenance administration system for the official vehicle fleet of the Yaqui River irrigation district

Mejora del sistema de administración de mantenimiento a flotilla de vehículos oficiales del Distrito de Riego del Río Yaqui.

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DOI: 10.35429/JSI.2023.21.7.18.24 Received July 14, 2023; Accepted November 29, 2023

Abstract

This project was carried out in an organization in charge of operating, conserving and managing the canal network, drainage network, roads and hydro-agricultural infrastructure of the Yaqui Valley, in which various problems and delays in the service have been occurring because of failures in the personnel transport vehicles, due to a deficient maintenance process of the fleet, for which the objective was to make proposals for improvement through a procedure based on Reliability Centered Maintenance (RCM), by analyzing the current situation of the area under study, identifying occurred and potential failures, proposing a preventive maintenance program, designing a training protocol and delivering results to the client. Following the procedure described above, resulted in the design of a critical data collection format for the object under study, a list of recurring failures, a maintenance program proposal, and a user training protocol. Thus, the objective established by delivering to the interested parties improvement proposals to the preventive maintenance process of the personnel transport units of the Yaqui River Irrigation District was met.

Vehicle fleet, Maintenance, Reliability

Resumen

El presente proyecto se llevo a cabo en un organismo encargado de operar, conservar y administrar la red de canales y drenaje, caminos e infraestructura hidroagrícola del valle del Yaqui, en el cual se han estado presentando diversos problemas y retrasos en el servicio que presta, debido a fallas en los vehículos de transporte de personal, a causa de un deficiente proceso de mantenimimeto de la flotilla, por lo que el objetivo fue hacer propuestas de mejora por medio de un procedimiento basado en el mantenimineto centrado en la confiabilidad (RCM), a través de analizar la situación actual del área bajo estudio, identificar fallos ocurridos y potenciales, proponer un programa de mantenimiento preventivo, diseñar protocolo de capacitación y entregar resultados al cliente. El seguimiento al procedimiento anteriormente descrito, generó como resultado el diseño de un formato de recolección de datos críticos del objeto bajo estudio, lista de fallas recurrentes, propuesta de programa de mantenimiento y protocolo de capacitación a usuarios. Con lo que se cumplio el objetivo planteado al entregar a los interesados propuestas de mejora al proceso de mantenimineto preventivo de las unidades de transporte de personal del Distrito de Riego del Rio Yaqui.

Flotilla de vehículos, Mantenimiento, Confiabilidad

Citation: CONANT-PABLOS, Marco Antonio, FORNÉS-RIVERA - René Daniel, CANO-CARRASCO, Adolfo and LÓPEZ-ENCINAS, Kenia Jaqueline. Improvement of the maintenance administration system for the official vehicle fleet of the Yaqui River irrigation district. Journal of Systematic Innovation. 2023. 7-21: 18-24

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1. Introduction

Although it can be said that maintenance has existed since the human being has consciousness (Montilla 2016), its appearance as a systematically organized activity is considered to have taken place in the United States in office and in the military sector during the First World War (Carcel, 2016).

The history of maintenance can be divided into four generations: the first from the beginning of the 20th century, until 1950, characterized by purely corrective maintenance actions, the second generation between the years of 1950 and 80 where preventive maintenance appears, the third from 1980 to 2000, marked by the application of predictive maintenance and condition monitoring; and from the 21st century, the fourth generation with comprehensive maintenance techniques such as total productive maintenance, focused on risks, focused on reliability, management focused on results and clients, knowledge management and energy efficiency (Pérez, 2021).

Maintenance is considered a series of management activities and techniques that aims to increase the availability, reliability and useful life of the equipment (Pérez, 2021; Contreras, 2016; Bermúdez-Puente, 2019; and Fernández, 2018); achieving in this way, maximizing the benefits obtained by the investment of both material and human resources, so that maintenance is a key part to make the processes more effective (Rendón, 2021).

For Gutiérrez and Valencia (2020) and Pérez (2021), the types of maintenance can be classified as: Corrective maintenance or breakage, which consists of repairing or replacing what has failed (must be repaired immediately) does not generate fixed expenses, because you only invest in it when it is clear that it is necessary, but in this system production becomes unpredictable and unreliable, the useful life of the equipment is shortened and it is difficult to diagnose the causes that cause the failure, which means assuming economic risks that can sometimes be significant.

Preventive or time-based maintenance, which consists of reconditioning or replacing the components of a piece of equipment or the equipment in its entirety, regardless of its state at that time, is scheduled based on the estimated life of the component or equipment, offers greater reliability, reduced downtime and longer useful life of equipment and facilities; On the other hand, this can suppose an unnecessary cost if it is applied to equipment in which the preventive maintenance has no effect.

Predictive or condition-based maintenance, which consists of using equipment or sensors to monitor and detect the condition by monitoring indicators at regular intervals of time and taking actions to prevent failures. This type of maintenance allows to increase the useful life and availability of the equipment, allows corrective actions in a preventive way, decreases the downtime of the asset and reduces labor costs; but on the other hand, it requires greater investment for the acquisition of sensors or diagnostic devices and greater investment in the training of personnel for its correct follow-up.

These classifications coincide with those suggested by Gallará and Pontelli (2020), only that they comment that the first major division of the classification has to do with the way in which the failure occurs, if the failure occurs unexpectedly it is classified as break maintenance, and if it occurs as expected as scheduled or planned maintenance.

Breakdown maintenance is equivalent to the corrective maintenance classification and scheduled maintenance includes preventive (based on time) and predictive (based on condition) of the Gutiérrez and Valencia (2020) and Pérez (2021) classification. In addition, Gallará and Pontelli (2020), add two more classifications to planned maintenance, maintenance due to breakdowns and corrective maintenance.

The breakdown is when an unexpected failure occurs, but due to its impact or severity its fix can be planned for later and the corrective consists of making improvements to its design to facilitate its preventive maintenance.

ISSN 2523-6784

Given so many options and advances in relation to maintenance, Reliability Centered Maintenance or RCM (Reliability Centered Maintenance), which is defined as a "Process to determine what must be done to ensure that any team continues to do what that its users want it to do, in its current operational context", offers decision makers a coherent model that allows them to apply those elements that provide the greatest value for them and their companies (Moubray, 2021).

In any organization, maintenance is a key element in making processes more effective, and the administration and efficient use of water for agriculture is no exception.

Climate change, inappropriate uses and practices, and inconsistencies in the allocation of this resource pose serious challenges to water management systems for agricultural use, considering that on average, 70% of the water extracted in the world is used for this activity and that irrigated agriculture currently represents 20% of the total cultivated area, contributing 40% of the total food production worldwide; In addition, by the year 2050 the projections ONU (2023) predict that the world population will increase from the current 8 billion to close to 10 billion inhabitants and, to satisfy basic food needs, the predictions regarding agricultural production is estimated at an increase of 70% for said year (Rendón, 2021).

The state of Sonora is one of the main agricultural producers in the country, with a production of 1.8 million tons of wheat grain, among other products (Government of Mexico, 2021), as well as in Mexico and throughout the world, for agriculture to be carried out, actions are necessary at the socio-organizational level in water management and consider improvements in water supply systems to provide services on demand, (Centro Internacional del Mejoramiento del Maíz y Trigo [CIMMYT], 2021). ; Therefore, the Federal Government since 1926, the year the National Irrigation Commission was created, has developed irrigation projects such as Irrigation Districts, which include various works, such as storage vessels, direct derivations, pumping plants, wells, channels and roads, among others (CONAGUA, 2023).

The state of Sonora covers a total area of 492,991 hectares, which is made up of the Yaquis, Altar, Mayo river, Yaqui river, Hermosillo coast, Papigochic, Guaymas colonies and dependents of district 038 (CONAGUA, 2023).

The body in charge of regulating water in the Yaqui River is the Yaqui River Irrigation District (for its acronym in Spanish, DRRY), whose purpose is to operate, conserve, and manage the network of canals, drainage network, roads, and hydro-agricultural infrastructure of the Yaqui Valley, this is located in the south of Sonora, partially covering the municipalities of Cajeme, Bacum, San Ignacio Rio Muerto, Navojoa, Etchojoa and Benito Juárez, becoming an essential part of the economy of the south of the state of Sonora (DRRY, 2023).

On June 27, 1951, the Yaqui River Irrigation District was established by presidential decree, but it was not until 1992 that the administration and operation of the irrigation districts were transferred to the users and the Yaqui River Irrigation District was created. , S. de R.L. from I.P. and C.V. with the objective of providing users with the service of operation of the canal network, measurement, irrigation plans, hydrometry and statistics; Canal network conservation works are carried out, such as clearing, formation of banks, formation of roads, application of herbicides, extraction of silt and aquatic plants, among others; as well as acquisition of machinery and specialized equipment, for the benefit of users and irrigation modules (DRRY, 2023).

For the above and to provide a good service, it has offices to the west of Cd. Obregón and the Carlos Conant Maldonado unit, where the warehouse, laboratory, electromechanical, vehicle control and machine shop departments are located.

In the vehicle control department the loan of trucks and vehicles is offered to the various areas that make up the Institution, however, the present study was limited to the personnel transfer units, which have 155 pick-ups used for the transport of personnel and use of managers, department heads, among others, due to the fact that through a personal communication on February 6, 2023.

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The head of the department commented that mechanical failures and accidents due to them frequently occur in this type of vehicle, causing delay in service, which can bring serious consequences to users such as flooding, lack of water for irrigation, among others; Therefore, the need to carry out actions to improve the maintenance program of the DRRY transport units was raised, so that their vehicles remain in optimal conditions of use and increase their availability and useful life.

2. Methodology to develop

The object under study is the preventive maintenance process of the fleet of vehicles for personnel transport, made up of 155 pick-ups, managed by the DRRY vehicle control department at the Carlos Conant Maldonado unit. The procedure was based on reliability centered maintenance (RCM), exposed by Moubray (2021).

3. Results

The results that are presented below include figures that, due to their size, will only be presented in part.

Analysis of the current situation of the area under study

In this first step, it was found that currently the official vehicle fleet administration system follows a manual documentary process (paper and pencil) and that it also omits a series of important data, such as: Vehicle model, type of engine, fuel use, maintenance history, description of activities carried out, criteria for scheduling maintenance, maintenance projections, among others; for which they were added in the improvement proposal to the maintenance management system; as well as it was possible to observe that the operators register the failures and send them to the vehicle control offices to issue the order. One of the reports is used to issue service orders for the units and the following is implemented for material requirements (see Figure 1).

Figure 1 Service order format and materials and service requisition format
Source: Yaqui River Irrigation District (DRRY, 2023)

Identification of occurred and potential failures

After collecting the pertinent data and supported by the interview with the inspector, as shown in figure 2, a list of recurring failures that the fleet has presented during its operation was created; This also includes a series of possible causes that would have originated these recurring failures, which helps to diagnose the breakdowns or breakdowns that each of the vehicles could present to be taken into account in periodic reviews and maintenance planning.

Figure 2 List of recurring failures
Source: Self-Made

Note. In the left column of figure 2 are the recurring failures of the fleet and in the right column the possible causes that cause them and/or recommendations are shown.

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Preventive maintenance program proposal

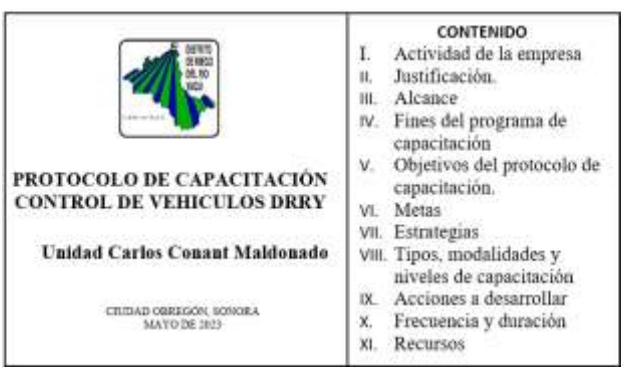
The maintenance program was prepared with Microsoft Excel software. As an example, in the format shown in figure 3 you can see the economic number of the vehicles, management to which it belongs, as well as the department, the most recent maintenance date, description of the service that was performed, key type (service performed), and odometer (see Figure 3).

Figure 3 Service program
Source: Self-Made

In figure 3, in addition to the service log, you can see the tabs of the other sheets that contain the maintenance program databases, which consists of four sheets, which include: Services, one report per unit, catalogs (keys, description and contacts), and the units that are active. The maintenance program is designed with a filter that allows you to easily identify the maintenance status of each of the vehicles.

Training protocol design

The scope of the training protocol shown in figure 4 reaches all members belonging to the offices in the vehicle control area and fleet users and includes: I. Activity of the company, II. Justification, III. Scope, IV. Purposes of the training program, V. Objectives of the training protocol, VI. Goals, VII. Strategies, VIII. Types, modalities and levels of training, IX. Actions to develop, X. Frequency and duration and XI. Resources (see Figure 4).


PROTOCOLO DE CAPACITACIÓN CONTROL DE VEHICULOS DRRY

Unidad Carlos Conant Maldonado

CIUDAD OBREGÓN, SONORA
MAYO DE 2023

CONTENIDO

I. Actividad de la empresa
II. Justificación.
III. Alcance
IV. Fines del programa de capacitación
V. Objetivos del protocolo de capacitación.
VI. Metas
VII. Estrategias
VIII. Tipos, modalidades y niveles de capacitación
IX. Acciones a desarrollar
X. Frecuencia y duración
XI. Recursos

Figure 4 DRRY vehicle control training protocol
Source: Self-Made

Delivery-Reception of results to the client

For the delivery-reception of results to the client, a completion letter was prepared for the closure of the project, it was signed, validating the delivery and fulfillment of the proposed objectives as shown in figure 5. The Delivered products were: Critical data collection format of the object under study, list of recurring failures, maintenance program and user training protocol. See letter in Figure 5.


Cd. Obregón, Sonora a 10 de mayo de 2023

LIC. LUIS ERNESTO VILLEGAS BARCELO
GERENTE ADMINISTRATIVO

PRESENTE.

Por medio de la presente, me dirijo a usted para realizar la entrega final de los resultados obtenidos del proyecto de prácticas profesionales que llevó por nombre:

"MEJORA DEL SISTEMA DE ADMINISTRACIÓN DE MANTENIMIENTO A FLOTILLA DE VEHÍCULOS OFICIALES DEL DISTRITO DE RIEGO DEL RIO YAQUI."

Realizado por la alumna Kenia Jaqueline López Encinas, el cual tenía por objetivo: "Realizar acciones de mejora, a través de una metodología de mantenimiento para contar con un programa de mantenimiento preventivo". De este se presentan las propuestas de mejora que se enlistan a continuación para el departamento del área de control de vehículos:

• Instrumento de recolección de datos técnicos de la flotilla.
• Plan de mantenimiento preventivo de la flotilla
• Protocolo de capacitación al usuario de uso/revisión previo y posterior a la concesión del préstamo de una unidad.

Así mismo, se presentan una serie de recomendaciones como; la propuesta de segmentación por afinidad de la base de datos, es decir, agrupar por separado de los datos de resguardo y técnicos de cada vehículo, un formato de reporte de incidencias con el propósito de crear futuro, un historial de fallas o quejas del proceso de mantenimiento de la flotilla y, por último, se integró una lista de fallas recurrentes y potenciales para tomar referencia en las revisiones periódicas de la flotilla

Sin más por el momento, aprovecho para enviarle un cordial saludo y para agradecer al departamento por sus atenciones y recibimiento.

Kenia Jaqueline López Encinas
Luis Ernesto Villegas Barcelo

Figure 5 Project completion letter
Source: Self-Made

Note: The completion letter shows the general data of the project, the products to be delivered and the release signatures.

4. Conclusions

The development of this project through the methodology used, made it possible to achieve the proposed objective of making improvements to the maintenance program of the DRRY personnel transport units, since the analysis of the current situation, as well as the mode and effect of the failures that occur, allowed the identification of critical points where improvements could be made to the current maintenance process, according to the needs, to optimize it and, thus, provide a better service to the users of the fleet of official DRRY vehicles.

As well as the design of the database in Excel will facilitate the follow-up and correct documentation of the services provided.

5. Recommendations

To achieve the desired success, it is recommended to implement the preventive maintenance plan proposed to the fleet and, when replacing components, ensure that they meet and/or exceed the specifications of the original parts, follow the training protocol, make use of and keep updated the data collection instrument (Excel); as well as create awareness among users about periodic reviews, preventive care, defensive driving and recurring failures.

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ISSN 2523-6784

Article **Journal of Systematic Innovation**
December 2023 Vol.7 No.21 25-32

Data management system implemented in wristbands with RFID technology (SAYETS)

Sistema de administración de datos implementado en pulseras con tecnología RFID (SAYETS)

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DOI: 10.35429/JSI.2023.21.7.25.32 Received July 14, 2023; Accepted December 10, 2023

Abstract

In the last decade, the loss of elderly family members has been a major problem, as well as in traffic accidents, therefore, it is important to know personal information such as medical issues for the proper care of those affected. SAYETS, is a project that aims to design an administration and data management system implemented in a wristband with RFID technology, so that the information is transmitted to different users. The project contributes to the health sector, since there are emergency cases in which it is not possible to disclose the necessary information about the health of the affected elderly, such their medical history with personal information (name, age, address) so as emergency contacts (names, telephone numbers, addresses, relationship). SAYETS can also be applied in several areas, such as work and personal usage.

System, Data management, Health

Resumen

En la última década, la perdida de familiares mayores de edad ha sido un gran problema, así como en accidentes de tránsito, por lo tanto, es importante conocer información personal como cuestiones medicas para la correcta atención de las personas afectadas. SAYETS, es un proyecto que tiene como objetivo desarrollar un sistema de administración de datos implementado en una pulsera con tecnología RFID, programada para que la información sea transmitida a diferentes usuarios. El proyecto contribuye en el sector de salud, dado que, existen casos de emergencia en los cuales no es posible dar a conocer la información necesaria sobre la salud de las personas mayores afectadas, como su historial médico con información personal (nombre, edad, domicilio) así como los contactos de emergencia (nombres, números teléfonos, domicilios, parentesco). Así mismo, SAYETS puede ser implementado en varias áreas, como laborales y personales.

Sistema, Gestión de datos, Salud

Citation: GÁMEZ-MARTINEZ, Sandra, YÉPEZ-RODRIGUEZ, Chrismaldy Areli, JUÁREZ-ROMERO, Juan Carlos and RODRÍGUEZ-AGUIRRE, Esmeralda Carolina. Data management system implemented in wristbands with RFID technology (SAYETS). Journal of Systematic Innovation. 2023. 7-21: 25-32

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Introduction

The reason for the implementation of the SAYETS project comes down to the search for new ways to prevent the disappearance of elderly people, as a consequence of the lack of information necessary for their identification. Also, the loss and death of the adult population due to the lack of medical data, as well as the delay in obtaining these parameters. [1]

The project will be implemented to provide a safe life, as each wristband will be technologically programmed to ensure the safety and well-being of the wearer.

In addition, the focus of the project is to use each device as a reliable source of information, and to fulfil the function of a locator, in situations of loss or accidents on the part of the wearer.

This project aims to design and promote an innovative product with the development of RFID-coded bracelets, in which the personal data of the owners of the device will be included, in order to fulfil the purpose of reducing the disappearance of older adults, because, by wearing the bracelet, it will be easier to find their whereabouts.

In recent years, multiple projects have been developed, mainly focused on the health care of children and the elderly, including the use of electronic and radiofrequency systems (RFID), which aim to provide greater care to the population, as in the case of the project carried out by Arce Valdez et al. (2021), which focuses on the care of the elderly, as well as in the article Barillaro et al. (2017) which develops a project to monitor and send an alarm in case of problems of an elderly person. [1][3]

In addition, there are other projects such as the ones developed by Dolatabadi et al. (2019) and Elsa (2017) that seek to improve the care of adults and children, but all the aforementioned projects do not have the necessary features for the storage and visualisation of an adult's data, so the project developed and shown in this article generates a product that can replace those mentioned above. [6][7]

Motivation

The reasons that encourage the realization and implementation of the project, are reduced in the search for new ways to prevent the disappearance of older people, as a result of the lack of information necessary for the identification of the same.

Also, the loss and death of the adult population due to the lack of medical data, as well as the delay in obtaining these parameters. There are currently more people over the age of 60 than under the age of 4. By 2050, women aged 60 and over will represent 23.3 per cent of the total female population and men will constitute 19.5 per cent of the total male population.

The increase in the number of older adults will have an impact on the health care system and challenges to family organisation, as well as additional care workloads, especially for women, who do most of the care work (Figure 1).

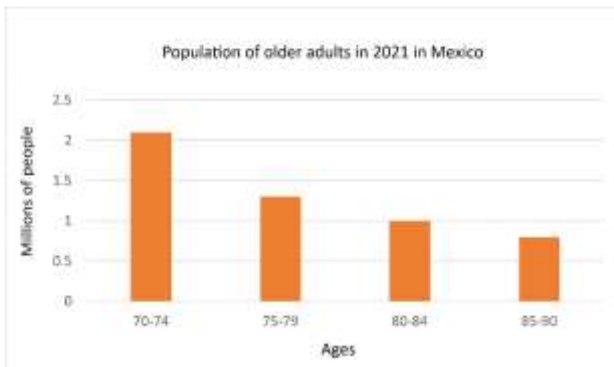

Figure 1 Older adult population
Source: INEGI, General Population and Housing Census, 1970 Inmujeres based on CONAPO. Population Projections 1990-2009 and 2010-2050.

At first hand, it was noted that: "The World Health Organisation (WHO) estimates that approximately 60 million people globally are living with Alzheimer's, of which 8.1 percent are women and 5.4 percent are men over the age of 65". And according to figures obtained from the health ministry: "It is estimated that in Mexico approximately 1.3 million people in Mexico suffer from Alzheimer's disease, a figure that represents between 60 and 70 percent of dementia diagnoses and most often affects people over 65 years of age.

Materials and methods

Oracle Cloud was implemented to create a virtual machine, which allowed the development of a database in the cloud as shown in Figure 2.

Figure 2 Virtual Machine in Oracle Cloud
Source: Own Elaboration

One of the necessary configurations of the virtual machine created through Oracle is the installation of the Vesta interface (Figure 3). Because, it allows to enable the necessary ports for the execution of the database through phpmyadmin. [2]

Figure 3 Installation of vesta
Source: Own Elaboration

.

The entity-relationship (ER) model was developed to facilitate the design of the DB as shown in Figure 4, as it allowed the creation of a schema that represents the overall logical structure of the database.

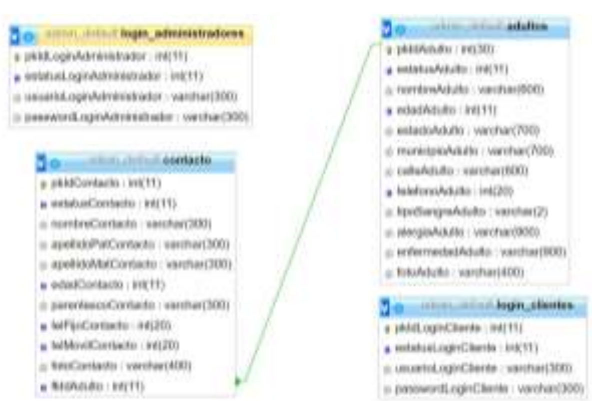

Figure 4 ER Diagram
Source: Own Elaboration

Methodology

The project is being carried out through the following stages depicted in Figure 5.

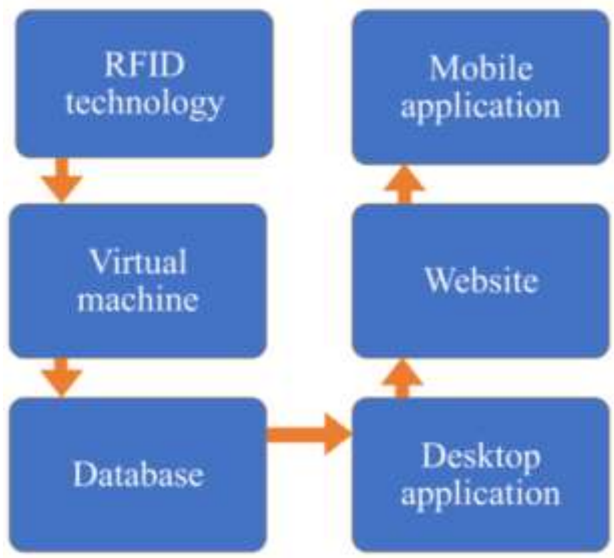

Figure 5 Diagram of stages
Source: Own Elaboration

RFID technology

ESP32 connection with Wiegand 26 reader [4].
Detection of the RFID identification number. [5]

Virtual machine

Configuration of phpMyAdmin in Vesta.
Entity-relationship diagram.
Creation of tables in phpMyadmin**.**

Database

Oracle cloud.
Vesta.

Desktop application

Java programming.
Connection with the database.
Creation of the database**.**

Web page

Requirements analysis.
Design of digital screens.
HTML programming.
PHP and JavaScript programming. [9] [10**]**

Mobile application

Design of digital windows.
Database connection.
Programming in Android Studio and creation of the interface. [8]

Results

Development of the desktop application for administrators to control information.

Figure 6 shows the main screen of the application, where the administrators will have to log in with their username and password to access.

Figure 6 Login screen
Source: Own Elaboration

When registering a new senior citizen, administrators can carry out this process by entering the person's data in the fields, as shown in Figure 7.

Figure 7 Registration of older adults
Source: Own Elaboration

The registered seniors will be displayed in a table as shown in Figure 8.

Figure 8 Table of registered older adults
Source: Own Elaboration

Website aimed at the general public and RFID technology owners, for the consultation of their own data. Figure 9 shows the home screen of the site, where you can log in and also consult some sections.

Figure 9 Website homepage
Source: Own Elaboration
.

It has a validation, in case the parameters entered for the login are incorrect (Figure 10).

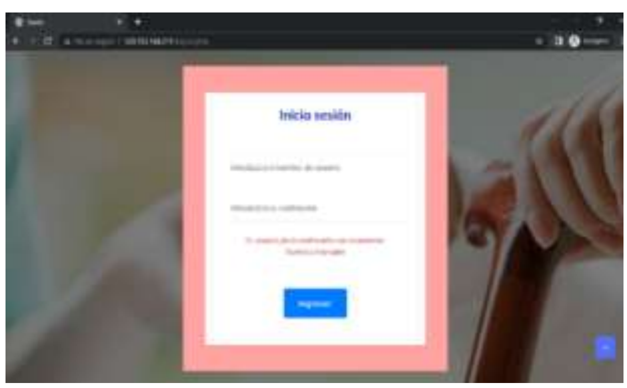

Figure 10 Login error
Source: Own Elaboration

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Emergency contacts can be viewed, added and even deleted as shown in Figure 11.

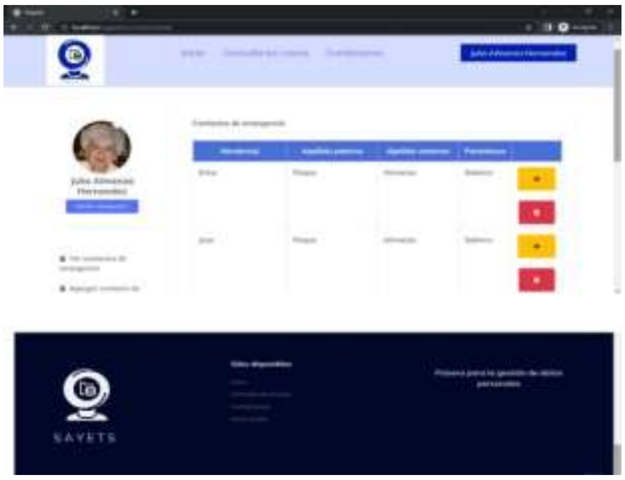

Figure 11 Consultation of emergency contacts
Source: Own Elaboration

The site also has a personalisation section for users, where they can change their photograph (Figure 12).

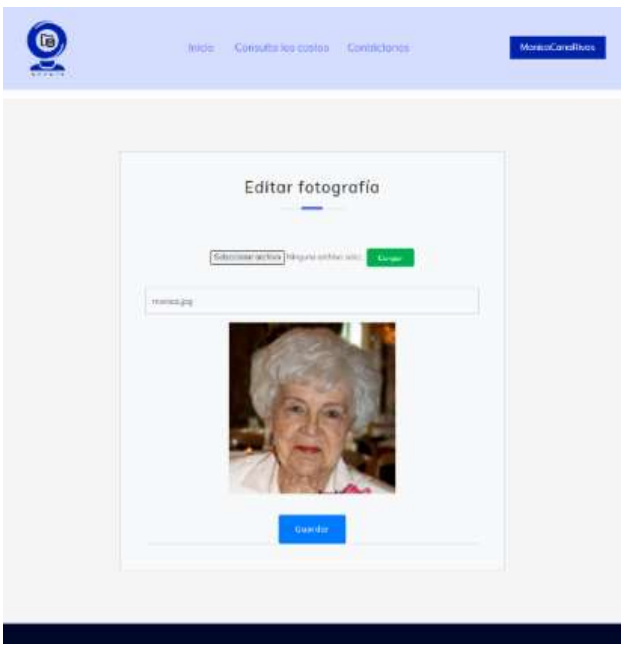

Figure 12 Edit photo
Source: Own Elaboration

Mobile application aimed at users to control their information.

Like the website, the main screen is the login screen for users (Figure 13).

Figure 13 Main login screen
Source: Own Elaboration

The user will have three main options to view their data, review emergency contacts and add new contacts, as shown in Figure 14.

Figure 14 Main menu for the user
Source: Own Elaboration

Emergency contacts can be viewed by the user as shown in Figure 15.

Figure 15 List of registered contacts
Source: Own Elaboration

Emergency contact information can be viewed and updated (Figure 16).

Figure 16 Detailed contact information
Source: Own Elaboration

The user will still be able to edit his or her photo as shown in Figure 17.

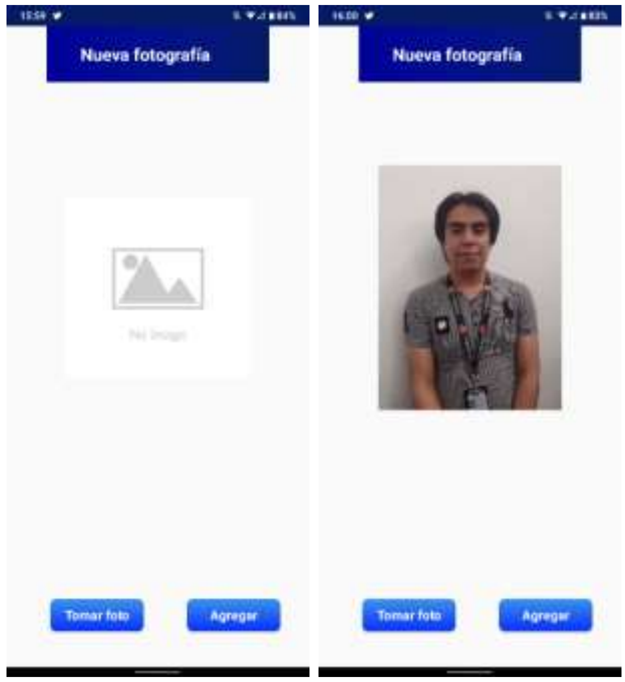

Figure 17 Screen to add photo
Source: Own Elaboration

Figure 18 shows the main screen, where the elderly person's personal information and emergency contact details will be displayed.

Figure 18 Health and safety sector page
Source: Own Elaboration

The following diagram shown in Figure 19 was used for the connections of the RFID reader to the ESP32.

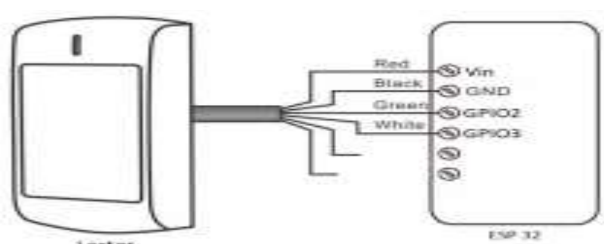

Figure 19 Connections
Source: Own Elaboration

The connections made are for the detection of cards with RFID tags through the Wiegand 26 reader. The coupled circuit can be seen in Figure 20.

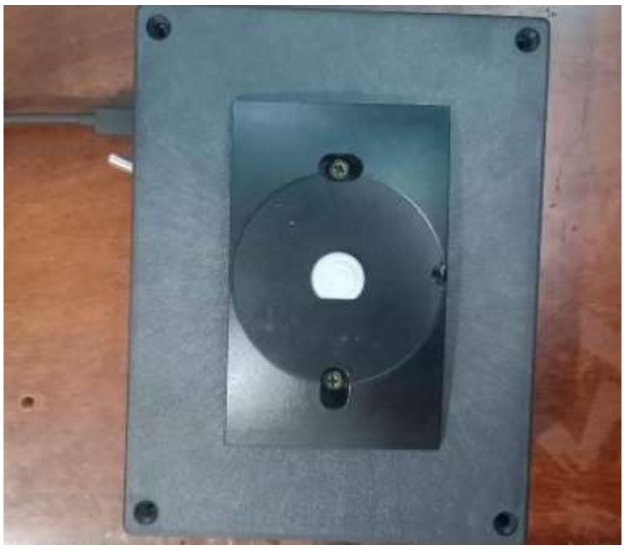

Figure 20 RFID circuit coupling
Source: Own Elaboration

Figure 21 shows the implementation of the connections in the diagram shown above.

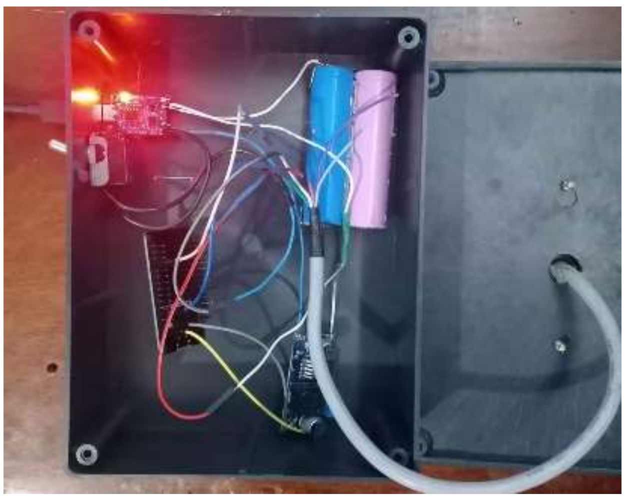

Figure 21 Internal view of the RFID circuit
Source: Own Elaboration

Acknowledgement

We would like to thank our advisors, Israel Yáñez and Luis Rey Lara, who with their knowledge are guiding us in the realisation of this project.

Conclusions

SAYETS is an applied project for the management of data from the elderly, through the development of a system consisting of a web page, desktop application and mobile application; it will also allow access to the information of the emergency contacts designated to each registered elderly person.

The health and security sectors will have access to the information stored by users through RFID technology applied to the registered wristbands.

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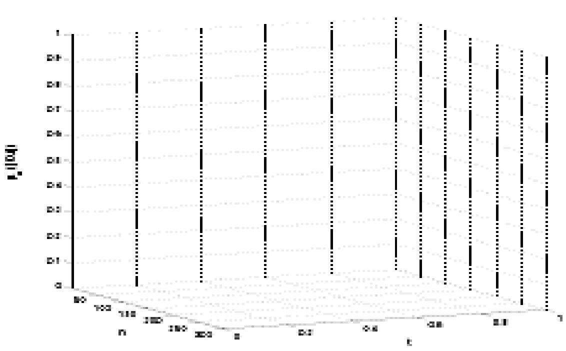

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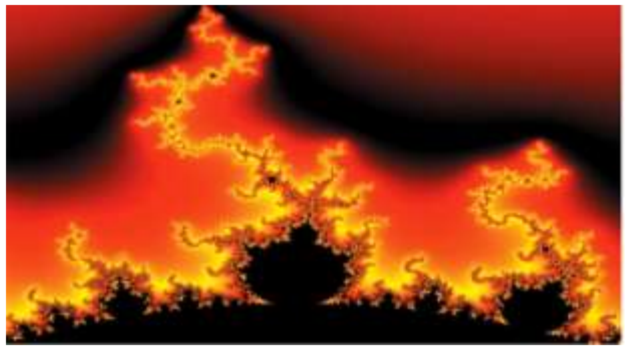

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