

Maintenance management system for a fleet of official vehicles in a higher education institution

Sistema de administración de mantenimiento a flotilla de vehículos oficiales en una institución de educación superior

FORNÉS-RIVERA, René Daniel†*, CANO-CARRASCO, Adolfo, LÓPEZ-FIGUEROA, Julio César and ARMENTA-RAMOS, Juan Israel

Instituto Tecnológico de Sonora, Department of Industrial Engineering, Mexico.

ID 1st Author: *René Daniel, Fornés-Rivera* / ORC ID: 0000-0002-7438-0056, Researcher ID Thomson: G-3906-2018, arXiv Author ID: rene_fornes, CVU CONACYT ID: 280435, SNI CONACYT ID: 280435

ID 1st Co-author: *Adolfo, Cano-Carrasco* / ORC ID: 0000-0002-3392-3667, Researcher ID Thomson: G-5035-2018, arXiv Author ID: adolfo.cano, CVU CONACYT ID: 266064

ID 2nd Co-author: *Julio César, López-Figueroa* / ORC ID: 0000-0002-4068-908X, Researcher ID Thomson: G-3925-2018, arXiv Author ID: julio_lopez_f, CVU CONACYT ID: 355930

ID 3rd Co-author: *Juan Israel, Armenta-Ramos* / ORC ID: 0000-0001-7619-0152, Researcher ID Thomson: AHD-1017-2022, RAMOS, arXiv Author ID: JUAN_ARMENTA

DOI: 10.35429/JIE.2022.16.6.20.27

Received January 20, 2022; Accepted June 30, 2022

Abstract

This investigation is developed in a Higher Education Institution (IES), being the loan process of official vehicles of the fleet of the Technological Institute of Sonora (ITSON), administered by the Headquarters of the Department of General Services and Maintenance (JDSGyM), which presents difficulties as the vehicles are not in optimal operating conditions in the provision of the transfer service between the different campuses, as well as departures to regional and international events of a cultural, sports, academic and research nature; as a result of mechanical and electrical failures, which are detected by the user already in the corresponding commission, putting their integrity and safety at risk; addressing this need through the Reliability Centered Maintenance (RCM) tool. The objective was to formulate a proposal for maintenance activities, through the RCM methodology, to have a relevant preventive maintenance program. The procedure was: Evaluate the object under study; collect data; identify actual and potential failures; proposal of a preventive maintenance program; design training protocol and delivery of results. These were: a pertinent preventive maintenance program (database) and a training program. This achieving the objective of this investigation.

Program, Maintenance, Fleet

Resumen

Esta investigación se desarrolla en una Institución de Educación Superior (IES), siendo el proceso de préstamo de vehículos oficiales de la flotilla del Instituto Tecnológico de Sonora (ITSON), administrada por la Jefatura del Departamento de Servicios Generales y Mantenimiento (JDSGyM), el que presenta dificultades al no encontrarse en condiciones óptimas de funcionamiento los vehículos en la prestación del servicio de traslado entre los diferentes campus, así como salidas a eventos regionales e internacionales de carácter cultural, deportivo, académico e investigación; a consecuencia de fallas mecánicas y eléctricas, las cuales son detectadas por el usuario ya en la comisión correspondiente, poniendo en riesgo su integridad y seguridad; abordando esta necesidad a través de la herramienta Mantenimiento Centrado en Confiabilidad (RCM). El objetivo consistió en realizar una propuesta de actividades de mantenimiento, a través de la metodología RCM, para contar con un programa de mantenimiento preventivo pertinente. El procedimiento fue: Evaluar el objeto bajo estudio; recolectar datos; identificar fallos ocurridos y potenciales; propuesta de un programa de mantenimiento preventivo; diseñar protocolo de capacitación y entrega de resultados. Los mismos fueron: un programa de mantenimiento preventivo pertinente (base de datos) y un programa de capacitación. Logrando así el objetivo de esta investigación.

Programa, Mantenimiento, Flotilla

Citation: FORNÉS-RIVERA, René Daniel, CANO-CARRASCO, Adolfo, LÓPEZ-FIGUEROA, Julio César and ARMENTA-RAMOS, Juan Israel. Maintenance management system for a fleet of official vehicles in a higher education institution. Journal Industrial Engineering. 2022. 6-16:20-27.

* Author's Correspondence (E-mail: rene.fornes@itson.edu.mx)

† Researcher contributing as first author.

Introduction

Nowadays, maintenance operations are focused on carrying out studies on equipment and processes prone to failure, applying statistical techniques, measurement methodologies, economic management of procedures, among others, which allow for planning tasks and resources to prevent failures or production stoppages from occurring (Leyva, 2018). In this way, the aim is to reduce maintenance and prevent halting production in the company as much as possible, which cause substantial losses of resources (Chanta, 2017).

Maintenance is the set of operations and required upkeeps to ensure that facilities, buildings, industries, among others, can continue to function properly (Real Academia Española, [RAE], 2021). Bermúdez-Puente (2019); and Fernández (2018) consider that the common factor in the maintenance objective is to ensure the longest possible service life of production plants and machinery, aiming for maximum availability, profitability, productivity and operational safety. According to Bermúdez-Puente (2019) and Gutiérrez y Valencia (2020); maintenance is classified into: Corrective Maintenance: repair or replacement of equipment after it has already failed; Preventive Maintenance: consisting of refurbishing or replacing components of a piece of equipment or the equipment as a whole; Predictive Maintenance: consisting of carrying out inspections at regular time intervals and taking action to prevent failures and their consequences, including inspections with instruments or with human senses; Detective Maintenance: the regular inspection of the internal functions of the equipment to check if they are failing and repair them if necessary; Upgrade Maintenance: is the modification or redesign of the original condition of the equipment or its installation method; Total Productive Maintenance (TPM) is defined as the removal of production losses due to the condition of equipment, or, in other words, keeping equipment ready to produce products of the expected quality at its maximum capacity, without unscheduled downtime.

Reliability Centered Maintenance (RCM), is a methodology to elaborate maintenance plans that include all types of strategies (preventive, predictive, fault finding, etc.) expressed by Tambra-Sanchez (2021). In the same order of ideas it is a process for determining what needs to be done to ensure that any equipment continues to do what its users want it to do, in its current operational context (Moubray, 2021 and Melendres-Quispe, 2019).

In any industry it is essential to know the performance for which indicators are variables that attempt to measure, quantitatively or qualitatively, events occurring within the company in order to support actions. Some of the main attributes of a good indicator are availability, simplicity, specificity and reliability (Silva-Astudillo, 2019). According to Quintana (2020), they are a quantitative, observable and verifiable expression that allows describing characteristics, behaviors or phenomena of reality. In the words of López and Valdiviezo (2017), indicators empower to optimally evaluate the performance of the maintenance management system and plan activities in line with the goals and objectives outlined by the department, which are; Reliability: ability of an asset to perform a required function; Maintainability: which will allow for prediction, evaluation and improvement of decisions; and Availability: ability of the equipment to operate under stable conditions. In the opinion of López (2019), costs are the set of resources sacrificed or lost to achieve a specific good, being for Suárez (2019), a consideration that is provided in order to receive a product or service. In turn, for IMG (2020), maintenance costs represent a high proportion of total production costs.

For Muyulema et al. (2020) and Aguirre (2018), they are the unavoidable expenses to maintain a production line; whereas Torres (2017) argues that the decrease in the budget limits the amount of investments programmed to maintain the company at its optimal level; affecting its productivity; which is defined by López (2018) and Vásquez (2018) as the relationship between the amount of goods and services produced and the amount of resources used in manufacturing, which serves to evaluate the performance of workshops, machines, work equipment and employees.

The above is supported by the efficient use of the fleet defined by Nissan Business & Fleet (2022) as a group of vehicles operated under a single business; in turn, according to Todo Seguros (2022), a fleet is a set of specific vehicles or of different types, from cars, trailers, pick-ups, motorcycles and trucks, which are part of the assets of a company in order to carry out an activity according to its line of business. For the efficient use of a fleet, it is necessary that it be managed through databases, which are very useful tools for managing large files and facilitating information retrieval (IONOS Digital Guide, 2019). They are an essential part of information systems: they enable to store, modify, process and interconnect the information necessary for the proper functioning of software, applications and programs designed to run on computers, servers or mobile applications (Arcidiacono, 2021 and OMS, 2021). The aforementioned is associated with continuous improvement being for ISO 9001 (2015), a process that seeks to improve the products, services and processes of an organization through a general attitude, which forms the basis for ensuring stabilization and continuous detection of errors or areas of opportunity. As stated by Leyva (2018), it is to carry out activities and constant changes that are applied to improve products or processes in order to seek total quality and customer satisfaction or stakeholders. Taking into account Evans and Lindsay (2020), process improvement is an important business strategy in the markets because customer loyalty is based on the value delivered, this is created through business processes. These changes should be a proactive management task which should be considered as an opportunity and not simply as a reaction to problems and threats from competitors.

The object of the study is the institutional vehicle fleet as part of the general services offered by the JDSGyM, which is the lease of these vehicles. The fleet consists of 150 units: 61 pick-ups, 51 sedans, 19 vans and 1 motorcycle, 13 trucks, 3 minibuses, 1 wagon and 1 bus. These vehicles are assigned to different areas of the six ITSON campuses with different locations, two in Ciudad Obregón, two in Navojoa, one in Guaymas and one in Empalme, in the state of Sonora, Mexico.

The use of the vehicles is for institutional purposes such as regular transportation services between the different campuses, as well as trips to regional and international cultural, sports, academic and research events. The units have mechanical and electrical failures detected by the user during commissions which affects arrival and departure times and endangering the safety and integrity of the personnel occupying such vehicles because of not being in optimal operating conditions and not having adequate control of the different preventive maintenance services that each unit should have (ITSON, 2021). Finally, the institution wishes to minimize unforeseen events resulting from not planning preventive maintenance of official vehicles. Therefore, it was necessary to improve the preventive maintenance program through the RCM methodology, in order to have a relevant maintenance program.

Methodology to be developed

The object of study was the institutional vehicle fleet. The methodology developed was the adaptation of the study of Naula and Tapia (2019), implementation of the Reliability Centered Maintenance methodology.

The procedure was: 1) to evaluate the object under study; 2) to collect data; 3) to identify occurrences and potential failures; 4) to propose a preventive maintenance program; 5) to design a training protocol; and 6) to deliver results.

Results

The result obtained is presented. It contains large tables, which due to their size, only a part will be presented.

Describing the area under study

A list of data families was made for each vehicle, including purchase invoice, insurance policy, list of claims, brand, model, type of vehicle, type of engine, fuel consumption, maintenance history, description of activities performed, maintenance cost history, criteria for scheduling maintenance and maintenance projections.

Data collection

This stage started with the evaluation of the object of study. For this purpose, a form was designed using the Google Forms platform, which has the function of collecting yet unknown information by filling in the fields indicated in the tool. In order to improve the accuracy of the collection, a space was assigned for attaching an image of each element requested in the form. The format presented in Table 1 was also prepared in order to calculate the percentage known, which is 37.5% (the calculation is made by dividing the number of known entries by the total number), which indicates that 62.5% of the data is unknown. This information is necessary to complement the database and indicate the possible potential source of the required data.

No. of entries	No. Lista	Family	Source			
			Current Database	Form	Invoices	Internet
1	1	Brand				
2	2	Model				
3	3	Serial No.				
4	4.1	Vehicle type				
5	4.2	Number of windows (tinted)				
6	5	Tire code				
7	6	Battery type				
8	7.1	Engine type				
9	7.2	Fuel consumption				
10	8	Fuel type				
11	9	Type and size of windshield wipers				
12	10	Capacity				
13	11	Transmission type				
14	12	Drive type				
15	13	Color				
16	16	Mileage capture				

Table 1 ITSON fleet data identification

The checked boxes in the "Current Database" column will come from the organization's current database; the checked boxes in the "Forms" column will come from the Google Forms form designed for fleet data collection; the boxes marked in the column "Invoices" will be extracted from the invoice of each vehicle; the checked boxes in the column "Internet" will be obtained through research on the Internet.

Identifying past and potential failures

After collecting the pertinent data and supported by the interview with the fleet inspector, a list of recurring failures and their possible causes was created (see Table 2).

Recurring faults	Possible causes
Puncture Low tire pressure	Visual inspection of each tire is recommended / Lack of movement.
Premature tire wear Vehicle does not start Air conditioning is not working Engine overheating	Alignment and balancing Required Battery, alternator and starter Compressor, condenser, fan Leaks, lack of refrigerant, thermostat failure

Table 2 List of failures (only a few)

This list of recurring faults and possible causes serves as a support resource to know which are the possible failures or breakdowns that could present each of the vehicles and that should be taken into account in periodic reviews by the user.

Proposal of a preventive maintenance program

After the identification of recurrent failures and their possible causes, the preventive maintenance program was developed with its four main buttons or books with the support of Microsoft Excel software, see Figure 1, which shows: (a) front page, which directs the user to enter the Maintenance program, which at the client's request, users and passwords could be created to manage its use, see Figure 1; (b) main menu, which describes in general terms each vehicle (truck, sedan, pick-up, bus, motorcycle), see Figure 2; (c) complete fleet summary; directs to the summary of each unit showing the economic number of the unit, last registration date, registered mileage, and the direct link to the maintenance plan of each unit; and (d) segmented database, shows: economic number of the vehicle, description/occupants, serial number, vehicle type, area of assignment, asset number, caretaker and license plate.

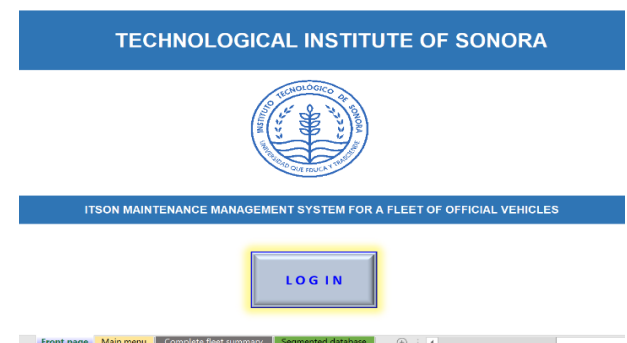


Figure 1 Preventive maintenance program

Figure 2 shows the main menu, which is very visually appealing and user-friendly.

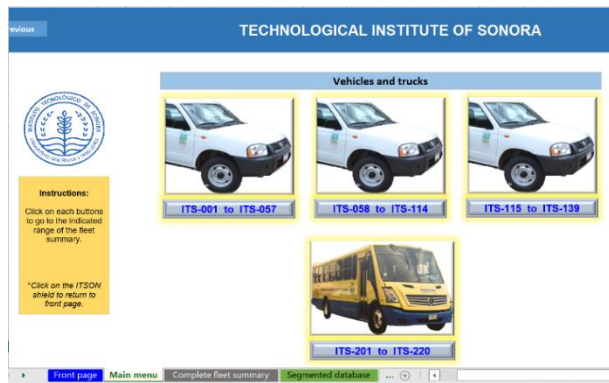


Figure 2 Vehicles main menu

The maintenance program is designed with a traffic light system that allows easy identification of the maintenance status of each vehicle, since a frequency of attention is established for each specific type of service.

Designing a training protocol

With information obtained from the fleet inspector, a training protocol was designed to provide all members of the JDSGyM and fleet users with the knowledge to perform the prelease inspection themselves, the information on preventive maintenance of each vehicle, the frequency of inspections, the detection of failures, and the criteria for sending the vehicle for expert review. The training protocol is a document consisting of the elements: (a) company activity, (b) justification; (c) scope; (d) program purposes; (e) general and specific training process objective; (f) goals; (g) strategies; (h) types of training (inductive, preventive, corrective, for career development); (i) training modalities (training, updating, specialization, improvement and complementation); (j) training levels (basic, intermediate and advanced); (k) actions to be developed; (l) frequency; (m) duration; and (n) material resources.

Delivery of results

The results presented are (a) preventive maintenance program (Excel database, which includes the list of customer requirements, requirements checklist, critical data collection form and list of recurrent failures); and (b) user training protocol.

Conclusions

To ensure that the vehicles that make up the fleet are in optimal operating conditions, that the lease process is not interrupted and that there are no inconveniences for users during a trip, errand or commission, a training protocol and a database containing the preventive maintenance program were developed thanks to the support of the project's stakeholders and academic contributors. Likewise, the percentage of known data was increased from 37.5% to 100% through the timely feeding of the database. In the short and medium term, the impact would be the timely performance of preventive maintenance. In the long term, a considerable amount of information will be stored, generating a robust data analysis system for the maintenance of the fleet for subsequent studies, thus fulfilling the objective of this research.

Recommendations

Continue with the preventive maintenance protocol for the fleet. When replacing components, ensure that they meet and/or exceed the specifications of the original parts. Create awareness among users (through the training protocol) about periodic inspections, preventive care, defensive driving and timely reporting of failures.

References

- Aguirre, M. (2018). *Mejora del proceso de llenado de escoria para reducir los costos en el área generación de vapor, de la empresa Casa Grande S.A.A., 2018*. Tesis de grado obtenido no publicada. Universidad César Vallejo, Trujillo, Perú. Recuperado el 10 de agosto de 2022 de https://repositorio.ucv.edu.pe/bitstream/handle/20.500.12692/25230/aguirre_mj.pdf?sequence=1&isAllowed=y
- Arcidiacono, J. (2021). *Base de datos: qué es, para qué sirven y cómo elegir la mejor para su empresa. Innovación Digital 360*. Recuperado el 10 de agosto de 2022 de <https://www.innovaciondigital360.com/big-data/base-de-datos-que-es-para-que-sirven-y-como-elegir-la-mejor-para-su-empresa/>

Bermúdez-Puente, J.D. (2019). *Gestión de mantenimiento para los equipos productivos de la empresa Publicidad & Impresos, usando algunos pilares de la filosofía TPM (Mantenimiento Productivo Total)*. Tesis de grado obtenido no publicada. Universitaria Agustiniiana, Bogotá, Colombia. Recuperado el 10 de agosto de 2022 de <http://repositorio.uniagustiniana.edu.co/bitstream/handle/123456789/1112/BermudezPuentes-JulianDavid-2019.pdf?sequence=4&isAllowed=y>

Chanta, C. (2017). *Análisis para la gestión de activos fijos en función del mantenimiento centrado en la confiabilidad (RCM) y la norma ISO 55 000 para una planta de producción de alimentos*. Tesis de grado obtenido no publicada. Universidad de San Carlos de Guatemala, Guatemala. Recuperado el 10 de agosto de 2022 de http://biblioteca.usac.edu.gt/tesis/08/08_0975_M.pdf

Evans, J. R. y Lindsay, W. M. (2020). *Administración y control de la calidad* (10ma ed). Cengage Learning.

Fernández, E. (2018). *Gestión de Mantenimiento: Lean Maintenance y TPM*. Tesis de grado obtenido no publicada. Universidad de Oviedo, Oviedo, España. Recuperado el 10 de agosto de 2022 de <https://digibuo.uniovi.es/dspace/bitstream/handle/10651/47868/Gesti%F3n%20de%20Mantenimiento.%20Lean%20Maintenance%20y%20TPM.pdf;jsessionid=7AE019F42FDB1B51E1EF835F9406BF01?sequence=1>

Gutiérrez, R. C. y Valencia, J. G. (2020). *Sistemas de Gestión en Mantenimiento: Propuesta de un TPM en una empresa dedicada a la elaboración de marcos y molduras de la región*. Tesis de grado obtenido no publicada. Instituto Tecnológico de Sonora, Cd. Obregón, México.

IMG. (2020). *Importancia del Mantenimiento Industrial como mejora de la Productividad*. Revista IMG. Recuperado el 9 de agosto de 2022 de <https://www.revistaimg.com/importancia-del-mantenimiento-industrial-como-mejora-de-la-productividad/>

IONOS Digital Guide. (2019). *Bases de datos: qué tipos hay y para qué se usan*. IONOS Digitalguide. Recuperado el 9 de agosto de 2022 de <https://www.ionos.mx/digitalguide/hosting/cuestiones-tecnicas/bases-de-datos/>

ISO 9001. (2015). *ISO 9001:2015. Sistemas de gestión de la calidad -Requisitos*. Recuperado el 9 de agosto de 2022 de <https://www.iso.org/obp/ui/#iso:std:iso:9001:ed-5:v1:es>

ITSON. (2021). *Estructura organizacional de la Jefatura del Departamento de Servicios Generales y Mantenimiento (JDSGyM)*. Recuperado el 9 de agosto de 2022 de <https://www.itson.mx/universidad/Paginas/dsgm.aspx>

Leyva, V. (2018). *Mejoras al proceso de planeación de la producción en la línea del aluminio en el área de ensamble final de una empresa de giro aeroespacial*. Tesis de grado obtenido no publicada. Instituto Tecnológico de Sonora, Cd. Obregón, México. Recuperado el 9 de agosto de 2022 de http://biblioteca.itson.mx/dac_new/tesis/2210.pdf

López, R. R. (2019). *Análisis de los elementos del costo*. Instituto Mexicano de Contadores Públicos. Recuperado el 9 de agosto de 2022 de <https://books.google.es/books?hl=es&lr=&id=5pGpDwAAQBAJ&oi=fnd&pg=PT13&dq=definicion+de+costos&ots=c-5empdYw4&sig=6W500P8Si0AN6UoIVeo8c7sulso>

López, R. & Valdiviezo, C. (2017). *Optimización del sistema de gestión de mantenimiento de la maquinaria pesada del Gobierno autónomo descentralizado de la provincia del Cañar, a través de la gestión por procesos*. Tesis de grado obtenido no publicada. Universidad Politécnica Salesiana, Cuenca, Ecuador. Recuperado el 10 de agosto de 2022 de <https://dspace.ups.edu.ec/bitstream/123456789/14308/1/UPS-CT007027.pdf>

López, Z. (2018). *Cultura organizacional y productividad. Estudio de caso en una microempresa productora de botanas* Tesis de grado obtenido no publicada. Universidad Autónoma del Estado de México, Toluca, México. Recuperado el 10 de agosto de 2022 de <http://ri.uaemex.mx/bitstream/handle/20.500.11799/95193/TESIS%20Omar%20L%C3%B3pez.pdf?sequence=1&isAllowed=y>

Melendres-Quispe, K. A. (2019). *Mantenimiento centrado en confiabilidad (RCM)*. Universidad Continental. Recuperado el 9 de agosto de 2022 de <https://hdl.handle.net/20.500.12394/5908>

Moubray, J. (2021). *Mantenimiento centrado en Confiabilidad. Soporte & Compañía*. Recuperado el 9 de agosto de 2022 de <https://soporteycia.com/system/files/articulos-pdf/rcm-articulo-mantenimiento-centrado-confiabilidad-03-dic-2021.pdf>

Muyulema-Allaica, C. A., Muyulema-Allaica, J. C., Pucha-Medina, P. M., & Ocaña-Parra S. V. (2020, 01, 04). *Los costos de producción y su incidencia en la rentabilidad de una empresa avícola integrada del Ecuador: caso de estudio. Visionario Digital*. Recuperado el 9 de agosto de 2022 de <https://doi.org/10.33262/visionariodigital.v4i1.1089>

Naula, C. A. y Tapia, J. M. (2019). *Propuesta de una metodología para el Mantenimiento Centrado en la Confiabilidad en la línea de corte de materia prima en la empresa Tugali*. Tesis de grado obtenido no publicada. Universidad Politécnica Salesiana, Cuenca, Ecuador. Recuperado el 10 de agosto de 2022 de <https://dspace.ups.edu.ec/bitstream/123456789/18078/1/UPS-CT008586.pdf>

Nissan Business & Fleet. (2022). *Flotilla de vehículos corporativos y comerciales* Recuperado el 10 de agosto de 2022 de <https://es.nissanusa.com/business-fleet/fleet.html>

Quintana, S. (2020). *La Operacionalización de variables; “clave” para armar una Tesis Parte 1*. Recuperado el 10 de agosto de 2022 de <https://unsm.edu.pe/wp-content/uploads/2020/05/silvestre-quintana-articulo-unsm-13-05-2020.pdf>

Real Academia Española. (2021). *Definición de Mantenimiento. Diccionario de la lengua española. Real Academia Española*. Recuperado el 10 de agosto de 2022 de <https://dle.rae.es/mantenimiento?m=form>

Silva-Astudillo, A. (2019). *Importancia de los Indicadores*. Recuperado el 10 de agosto de 2022 de <https://agrocolun.cl/importancia-de-los-indicadores/#:~:text=Los%20indicadores%20son%20variables%20que,%2C%20simplicidad%2C%20especificidad%20y%20confiabilidad>

Suárez, M. M. (2019). *¿Cómo realizar una gestión de costos en el rubro hotelero para la mejor toma de decisiones?* *Inquietud Empresarial*, 19(2), 39-51. Recuperado el 10 de agosto de 2022 de <https://doi.org/10.19053/01211048.8939>

Tambra-Sanchez, L. (2021). *Gestión de mantenimiento. CITE energía*. Recuperado el 10 de agosto de 2022 de http://www.citeenergia.com.pe/wp-content/uploads/2021/08/gestion_de_mantenimiento.pdf

The OMS. (2021). *Base de datos ¿Qué es y para qué sirve?* – immune institute. Immune. Technology Institute. Recuperado el 10 de agosto de 2022 De <https://immune.institute/base-de-datos-que-es-usos/>

Torres, R. (2017). *Propuesta de implementación de un programa de mantenimiento preventivo para la disminución de costos de mantenimiento, aplicado en planta de pulpa en la empresa Trupal S.A.* Tesis de grado obtenido no publicada. Universidad Privada del Norte, Trujillo, Perú. Recuperado el 10 de agosto de 2022 de <https://repositorio.upn.edu.pe/bitstream/handle/11537/13603/Torres%20Rojas%20Jaime%20Paul.pdf?sequence=1&isAllowed=y>

Todo Seguros. (2022). *¿Qué es una flotilla de autos?* Recuperado el 10 de agosto de 2022 de <https://todoseguros.com.mx/blog/flotilla-de-autos/#:~:text=Una%20flotilla%20de%20autos%20o,seg%C3%BAAn%20el%20giro%20de%20%C3%A9sta.>

Vásquez, P. (2018). *Estudio realizado con agentes de la PMT de la municipalidad de San Pedro Sacatepéquez, San Marcos*. Tesis de grado obtenido no publicada. Universidad Rafael Landívar. Guatemala. Recuperado el 10 de agosto de 2022 de <http://recursosbiblio.url.edu.gt/tesiseortiz/2018/05/43/Vasquez-Mayra.pdf>.