Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA DOI: 10.46254/AN15.20250319
Published: February 18, 2025

Development of a Database System to Support Preventive Maintenance of Machinery in the Electronics Industry

Anusorn Konpang
System engineering program, School of industrial engineering, Institute of engineering, Suranaree University of Technology, Nakhon Ratchasima 30000, Thailand
m6602680@g.sut.ac.th

Paphakorn Pitayachaval
Asst.Prof., School of Industrial Engineering, Institute of Engineering, Suranaree University of Technology, Nakhon Ratchasima, Thailand
paphakorn@g.sut.ac.th

Nichchapat Arpwasinsuk
Industrial Systems and Environmental engineering program, School of industrial engineering, Institute of engineering, Suranaree University of Technology, Nakhon Ratchasima 30000, Thailand
Nichchapat.ar@gmail.com

Abstract

The electronics industry in Thailand heavily relies on machinery for large-scale production to enhance efficiency and reduce costs. As a result, a dedicated maintenance department is crucial to ensure proper machine upkeep, which includes maintaining a record of maintenance history. A study conducted at an electronics printer production unit, part of the plastic parts manufacturing department at an industrial plant in Nakhon Ratchasima, Thailand, identified inefficiencies in managing maintenance data for 21 types of machinery, totaling 833 machines. The maintenance data recording process was found to be time-consuming and lacked a systematic management approach, resulting in operational inefficiencies. This paper aims to improve the process and method of data entry to enhance efficiency and reduce recording time. A Fishbone Diagram was used to identify the root causes of these inefficiencies. Improvements were implemented based on the principles of Eliminate, Combine, Rearrange, and Simplify (ECRS). Microsoft Access was chosen to replace Microsoft Excel for maintenance data recording, as it is better suited for managing complex datasets. After implementation, the average data recording time per session decreased from 66 minutes to 30 minutes, representing a 54.55% reduction. Additionally, the time to record individual machine maintenance data was reduced from 15.1 minutes to 7.2 minutes per session, a reduction of 52.32%. These results demonstrate the effectiveness of the proposed approach in optimizing maintenance data management within the electronics industry.

Keywords

Database, Microsoft Access,7WASTES, ECRS (Eliminate-Combine-Rearrange-Simplify), TPM (Total Preventive Maintenance)

1. Introduction

The electronics industry plays a critical role in the economic development of Thailand by utilizing machinery to enhance production efficiency and reduce costs. However, prolonged use of machinery often leads to wear and tear, requiring continuous maintenance to preserve production quality and minimize process downtime. As such, recording

maintenance data becomes essential for effective maintenance planning and management (Abidi et al., 2022) (Thomer Andrea et al., 2022). Many industrial plants still face challenges in the data recording process, which lacks systematic management, resulting in waste and excessive time consumption (Veerin Arthans, 2024) (Auesiritrakul & Ruangchoengchum, 2024; Jimenez et al., 2020). At a factory in Nakhon Ratchasima, which produces plastic parts for printers, the process of recording maintenance data for 21 types of machinery, totaling 833 machines, was found to be time-consuming and inefficient. This study focuses on improving the maintenance data recording process by applying the Eliminate, Combine, Rearrange and Simplify (ECRS) principles (Auesiritrakul & Ruangchoengchum, 2024; Paphakorn Pitayachaval and Prasan Phaophang, 2024; Sriputtha, 2023), and adopting Microsoft Access instead of Microsoft Excel to improve the efficiency of data recording and storage (Aqlan et al., 2020; Kaeyongkam, 2021) (Dimitrova & Koleva, 2023). This approach aims to increase planning accuracy and reduce the risk of machine downtime. Additionally, effective database management will ensure that the data storage process is sustainable and of high quality (Pitayachaval, 2012) (Duarte et al., 2013; Hallioui et al., 2023).

2.Research Objectives

2.1 To improve the maintenance data recording process by applying the ECRS principles to reduce data recording time by at least 50% compared to the pre-improvement state (Auesiritrakul & Ruangchoengchum, 2024).

2.2 To implement information technology by using Microsoft Access instead of Microsoft Excel for data recording, with the aim of making the data recording process more convenient, faster, and reducing the time required for data entry by at least 50% compared to the pre-improvement state (Dimitrova & Koleva, 2023; Hassan et al., 2024).

3.Scope of the Study

3.1This study focuses on the operational data of machines used in the production line for plastic parts at a printer manufacturing plant located in Nakhon Ratchasima, Thailand. The production line includes a total of 833 machines, which are classified into 21 distinct data categories based on their operational and maintenance characteristics.

3.2Microsoft Access 2016 serves as the primary tool for developing a relational database, integrating data from various machine types, and generating reports. These reports are designed to support the implementation of a preventive maintenance strategy for the machines, ensuring improved operational reliability and efficiency (Aqlan et al., 2020; Dimitrova & Koleva, 2023; Kaeyongkham, 2021).

4.Research Methodology

4.1 The research involved studying and collecting data on the time required for recording and archiving individual entries and documents. The process began with recording data at the initial stage and extended to the storage of corresponding documents. This study measured and analyzed the time required for each activity by conducting a time-tracking exercise during July 2024. Data collection was focused on documenting the duration of various tasks, with an emphasis on identifying process bottlenecks.

The average time for each activity was calculated, revealing that the recording of repair data for machines required the longest duration. This observation aligns with the findings presented in Table 1, which provides a detailed comparison of the average times required for each task type.

Table 1. Time for Data Entry and Documentation of Machine Maintenance

Data Entry and Documentation Items	Time (minutes)
Machine repair data (Repair)	66
Spare part issuance data (Spare part)	12
Machine inspection data (Check sheet)	47
Machine maintenance data (PM Machine)	34

Flow Chart Representation of Machine Repair Data Recording Process. The repair data recording process is broken down into 10 sequential steps, each with a specified time allocation. This detailed flow chart helps visualize the workflow from receiving a repair request to filing related documents. Notably, Step 9, "Record Data in System", is identified as the most time-consuming step (Figure 1).

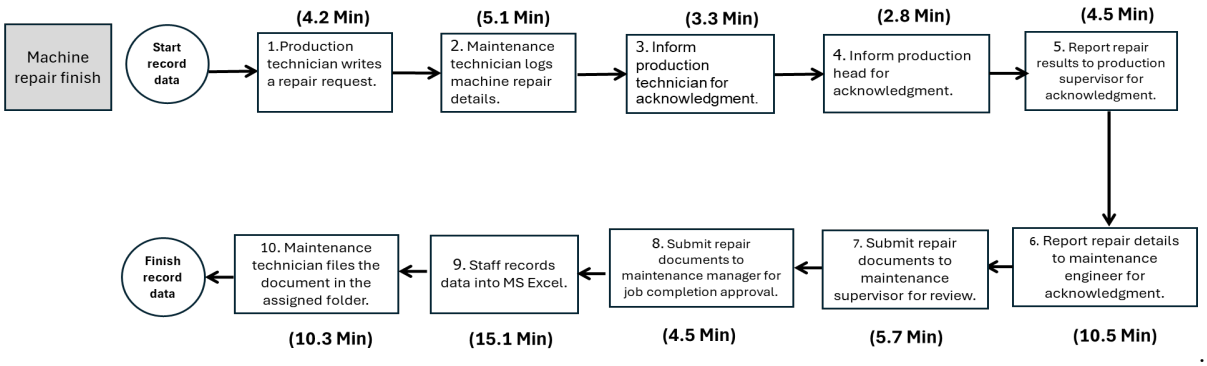

Figure 1. shows the Flow Chart of each step and the time taken for recording machine repair data.

4.2 Problem Analysis Using a Fishbone Diagram.

The issue of prolonged data recording time during Step 9, "Record Data in System", was identified as the most time-consuming step in the machine repair data recording process, as shown in Figure 1 (Flow Chart). To address this problem, a Fishbone Diagram was employed to systematically analyze the root causes, categorizing them into six key areas. The analysis results are presented in Figure 2.

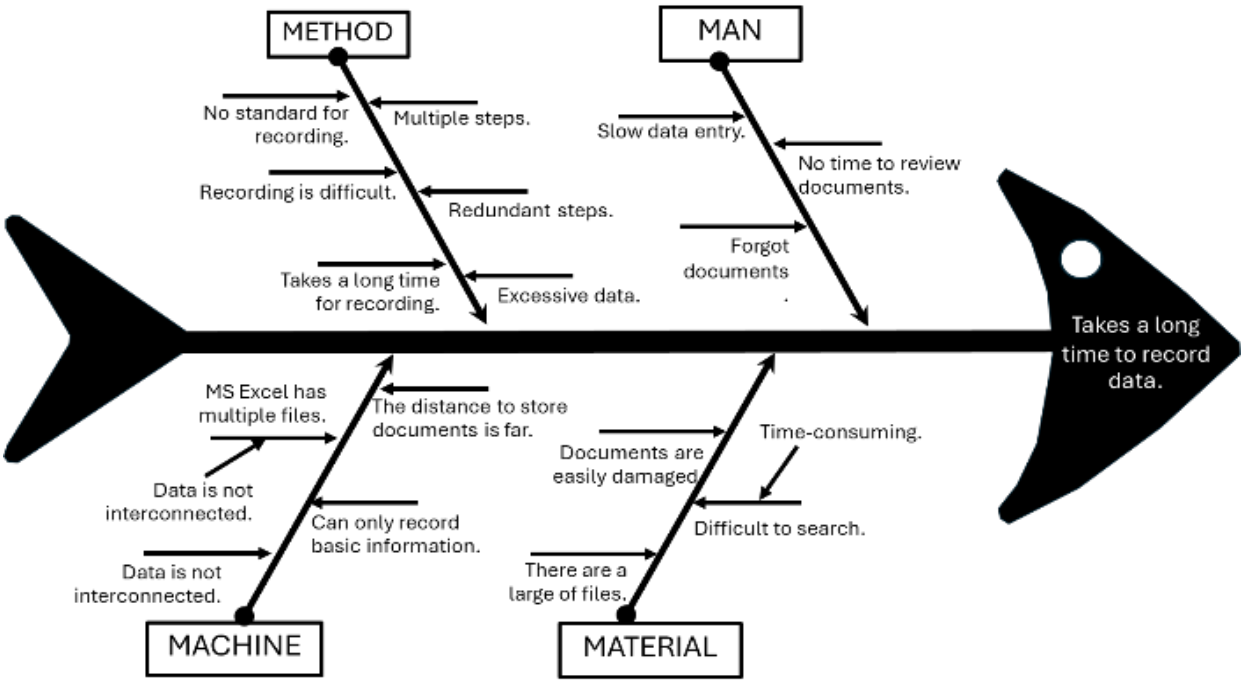

Figure 2. The Fishbone Diagram illustrating the analysis of the problem of excessive time taken for data recording.

4.3 Redesigning the Data Storage System

Based on the analysis of Figure 1 (Flow Chart of each step and the time required for recording machine repair data) and Figure 2 (Fishbone Diagram analyzing the root causes of prolonged recording time), a redesigned data storage system has been proposed. The analysis revealed that delays were primarily caused by complex procedures, fragmented data storage across multiple files, and inefficient workflows.

To address these issues, the ECRS methodology (Eliminate, Combine, Rearrange, Simplify) was applied. This approach focuses on streamlining processes, minimizing complexity, and improving efficiency in data recording and

retrieval. Additionally, the redesigned system aims to significantly reduce the time required for data searches (Korbuakaew et al., 2024; Sriputtha, 2023).

4.3.1 Eliminate

Eliminate redundancies as identified in Figure 1 by removing Steps 4 and 5. Modify the workflow so that production technicians directly report repair details to the production department head and supervisor, consolidating communication within the same unit. To ensure a smooth transition, a meeting will be conducted to align all parties on the updated process. Additionally, the requirement for signed acknowledgment documents will be abolished, thereby further simplifying the process. These changes are reflected in Figure 3.

4.3.2 Combine

From Figure 1:

I. **Combine Steps 1 and 2:**
Maintenance technicians will independently document the issue and provide repair details in a single step, eliminating the need for a separate problem identification phase.

II. **Combine Steps 6 and 7:**
The engineer or supervisor in the maintenance department will inspect the repair and prepare the documentation simultaneously, merging these tasks into one step for efficiency.

III. **Combine Steps 9 and 10:**
Assign the responsibility of document filing to the data recording staff, who will manage both data entry and filing. This adjustment replaces the current task of maintenance technicians filing documents and reduces duplication of effort.

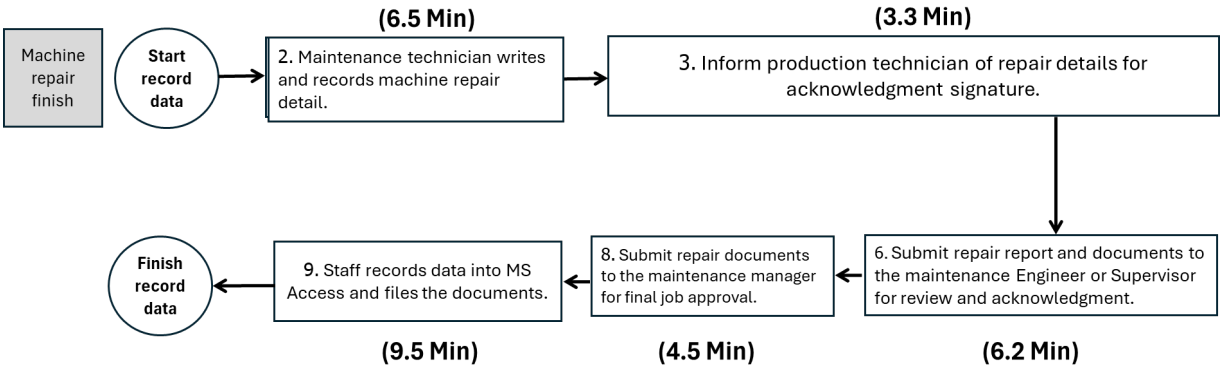

Figure 3. Flow Chart after implementing the Eliminate and Combine steps in the machine repair data recording process.

4.3.3 Rearrange

Reorganize the system by creating a machine database using MS Access 2016 to replace the data previously recorded in MS Excel. This includes integrating the following files: machine repair data (Repair), spare part issuance data (Spare Part), and preventive maintenance data (PM Machine). The new system is designed with a Flow Chart to demonstrate the interconnected data structure, reducing steps and improving efficiency compared to the previous workflow. The updated process is illustrated in Figure 4.

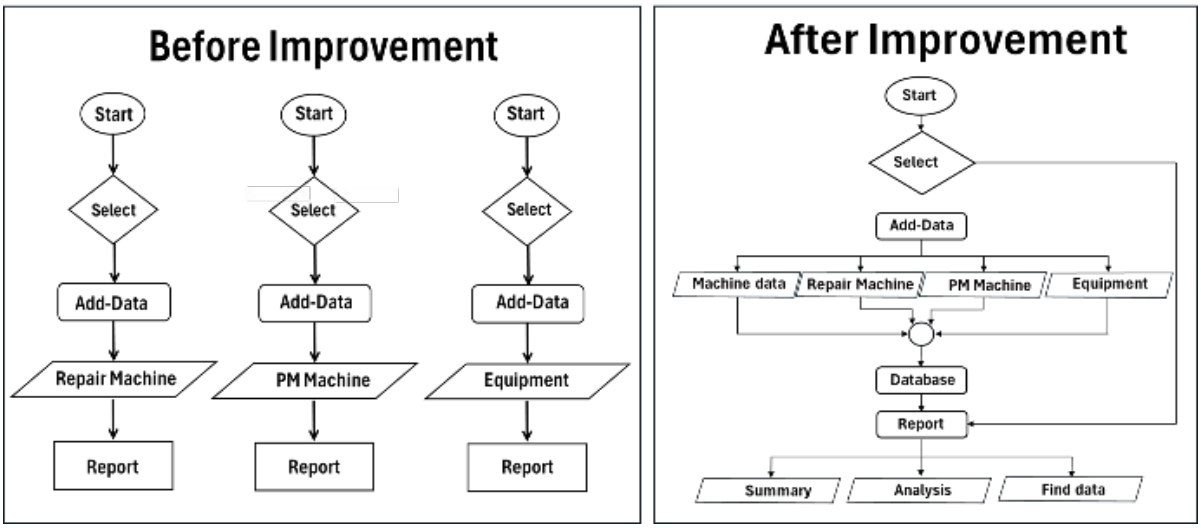

Figure 4. Flow Chart with improved data linkages compared to the previous system.

4.3.4 Simplify

Simplify the system by creating an MS Access database with interconnected data that is easy to use. Store the database on a centralized server (Center Server) to enable easier and faster data entry. The average data entry time has been reduced from 15.1 minutes to 7.2 minutes compared to the previous system. Testing has been conducted to ensure functionality, address issues, and further improve the system to meet objectives. The post-improvement workflow is illustrated in the updated Flow Chart shown in Figure 4.

5. Summary of Improvements and Recommendations

The research applied a data management system for machine maintenance in the electronics industry, specifically in the production of printers within the plastic components manufacturing division. The results and recommendations are summarized as follows

5.1 Results

The results from redesigning the data storage system using the ECRS methodology for machine repair data recording and developing a database system with Microsoft Access to support preventive maintenance in the electronics industry demonstrated significant efficiency improvements (Mohad et al., 2024; Paphakorn Pitayachaval and Prasan Phaophang, 2024; Pitayachaval, 2012). The enhanced data storage system for machine maintenance achieved the following:

5.1.1 Reduction in Data Recording Time:

Following the improvement of the machine repair data recording process based on the ECRS principles, the steps were reduced from 10 steps to 5 steps. This optimization resulted in a significant decrease in the average time required per recording session, from 66 minutes before the improvement to 30 minutes after the improvement. This represents a time reduction of 36 minutes, equivalent to a 54.55% decrease, as shown in Table 2. These results clearly demonstrate the effectiveness of the implemented solutions in addressing the identified issues and achieving the set objectives.

Table 2. Comparison of time before and after the data search for machine maintenance.

Steps in Machine Repair Data Recording	Time Before Improvement (Minutes)	Time After Improvement (Minutes)
1. Production technician writes repair request document	4.2	6.5
2. Maintenance technician fills in machine repair details	5.1	
3. Communicate repair details to the production technician for sign	3.3	3.3
4. Communicate repair details to production head for sign	2.8	-
5. Communicate repair results to production supervisor for sign	4.5	-
6. Report repair to maintenance engineer for sign-off	10.5	6.2
7. Submit repair documents to maintenance supervisor for review	5.7	
8. Submit repair documents to maintenance manager for final approval	4.5	4.5
9. Data entry staff records repair information in MS Excel	15.1	9.5
10. Maintenance technician files the document in the appropriate folder	10.3	
Total time	66.0	30.0
Reduces time	36.0	
Percentage	54.55%	

5.1.2 Application of Information Technology through Microsoft Access

The newly developed system replaces the use of MS Excel by integrating machine repair data (Repair), spare part issuance records (Spare Part), and preventive maintenance schedules (PM Machine) into a single MS Access database, meeting the defined objectives. An example of the MS Access program is shown in Figure 5. The system significantly improves data recording efficiency, reducing the average time per session from 15.1 minutes to 7.2 minutes, a decrease of 7.9 minutes or 52.32%. This demonstrates the effectiveness of the system in achieving faster data recording and improving operational efficiency, aligning with the established objectives.

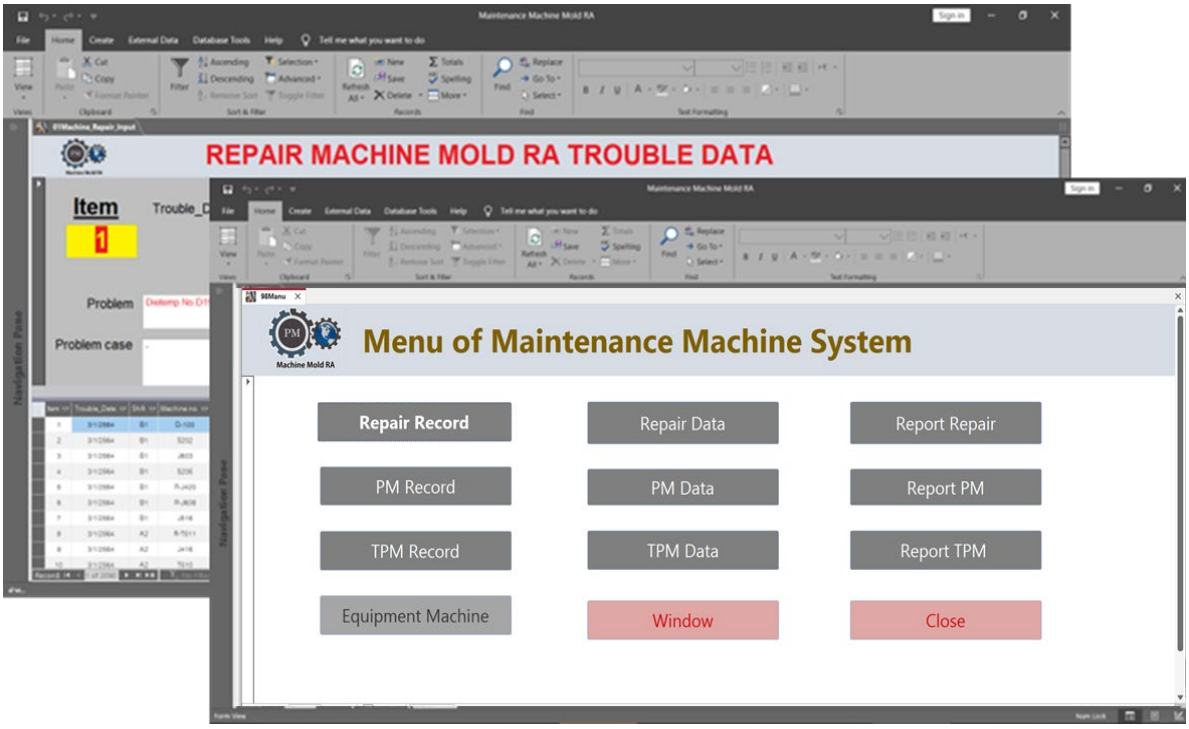

Figure 5. shows part of the MS Access system developed according to the objectives and the defined Flow Chart.

5.2 Conclusions

The development of a database system to support preventive maintenance for machines demonstrates that an efficient database system can enhance the management of maintenance data, reduce process steps, and decrease data recording time as per the objectives. Additionally, the system provides valuable information for decision-making in machine repair processes and minimizes the risk of production disruptions in the electronics industry. The application of information technology through this database system effectively supports preventive maintenance and meets the needs of the industrial sector.

However, this research was limited to a single sample factory, which may not fully represent the context of other industries. Future research could focus on developing systems adaptable to various industrial contexts or integrating advanced technologies such as AI and Machine Learning to further improve the accuracy and efficiency of maintenance processes.

References

Abidi, M. H., Mohammed, M. K., & Alkhalefah, H, Predictive Maintenance Planning for Industry 4.0 Using Machine Learning for Sustainable Manufacturing. *Sustainability, 14*(6).2022.

Aqlan, F., Nwokeji, J. C., & Shamsan, A,Teaching an Introductory Data Analytics Course Using Microsoft Access® and Excel®. *2020 IEEE Frontiers in Education Conference (FIE).2020.*

Auesiritrakul, S., & Ruangchoengchum, P, Streamlining Engine Parts Procurement in Agricultural Machinery: Integrating ECRS and Digital Lean Concepts in Thailand's Industry.2024.

Dimitrova, V. V., & Koleva, L. S, Development and implementation of a national conference relational database in MS Access. *Electrotechnica & Electronica (E+E), 58*(1), 8–11, 2023. https://search.sut.ac.th/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=aps&AN=163770738&site=eds-live&scope=site

Duarte, J. C., Cunha, P. F., & Craveiro, J. T, Maintenance Database. *Procedia CIRP, 7,* 551–556, 2013. https://doi.org/10.1016/j.procir.2013.06.031

Hallioui, A., Herrou, B., Katina, P. F., Santos, R. S., Egbue, O., Jasiulewicz-Kaczmarek, M., Soares, J. M., & Marques, P. C, A Review of Sustainable Total Productive Maintenance (STPM). *Sustainability, 15*(16), 12362, 2023.

Hassan, G. A., Ali Faraj, K. H., & Sidqi, H., Automated recommendation backend web database tier architecture benchmarking. *International Journal of Nonlinear Analysis & Applications, 15*(1), 137–150, 2024. https://doi.org/10.22075/ijnaa.2023.28139.4207

Jimenez, V. J., Bouhmala, N., & Gausdal, A. H, Developing a predictive maintenance model for vessel machinery. *Journal of Ocean Engineering and Science, 5*(4), 358–386, 2020.

Korbuakaew, S., Chotithammapon, W., & Suttiprapha, A, Reducing the Wastage of the Process of Assembling Heat Pump Dryers of the ABC Engineering Co., Ltd. Under the ECRS Principle. *International Academic Multidisciplinary Research Conference in Tokyo 2024.*

Mohad, F. T., Gomes, L. d. C., Tortorella, G. d. L., & Lermen, F. H, Operational excellence in total productive maintenance: statistical reliability as support for planned maintenance pillar. *International Journal of Quality & Reliability Management. 2024.*

Paphakorn Pitayachaval and Prasan Phaophang, Improving the Maintenance Management System of Buildings Departments. Case Study: Defense Technology Institute. *The 18th South East Asian Technical University Consortium (SEATUC) Symposium 2024, Shibaura Institute of Technology (SIT), Japan.2024.*

Pitayachaval, P. , *433411 การบริหารงานบำรุงรักษา Maintenance Management.* สาขาวิชาวิศวกรรมอุตสาหการ สำนักวิชาวิศวกรรมศาสตร์ มหาวิทยาลัยเทคโนโลยีสุรนารี.

Sriputtha, N., Improving Overall Equipment Effectiveness of the Plaster Mold Process Using Lean Manufacturing Principles. *Engineering Access, 9*(2), 133–139, 2023.

Thomer Andrea, K., Starks Joseph, R., Alexandria, R., & Lenard Michael, C, Maintaining Repositories, Databases, and Digital Collections in Memory Institutions: An Integrative Review. *Proceedings of the Association for Information Science & Technology, 59*(1), 310–323, 2022. https://doi.org/10.1002/pra2.755

Veerin Arthans, P. P., & P. J, Utilizing Lean Principles to Enhance Efficiency in Engineering Project Expense Reimbursement Processes of the Institute of Engineering, Suranaree University of Technology. *The 18th South East Asian Technical University Consortium (SEATUC) Symposium 2024, Shibaura Institute of Technology (SIT), Japan.*

Biographies

Anusorn Konpang received the B.B.A Management. (2010) degrees in Industrial Management from Rajamangala University of Technology Isan. , M.Eng.(2022) degree in Civil Engineering and Construction Management from Suranaree University of Technology. He is currently an assistant manager in the engineering and quality department at a leading printer manufacturing company. His current interests include automation innovation, lean manufacturing, Machine maintenance Technology and organizational management.

Asst.Prof.Dr.Paphakorn Pitayachaval received the B.Eng. (1998) degrees in Industrial Engineering from Suranaree University of Technology, M. Eng. (2011) degrees in Production Engineering from King Mongkut's University of Technology Thonburi and Ph.D. (2009) degrees in Design and Manufacturing Engineering from Asian Institute of Technology. She is a Lecturer, School of Industrial Engineering, Institute of Engineering, Suranaree University of Technology. Her current interests are Manufacturing System, 3D Printing Designs, Lean Manufacturing and Innovation Management.

Nichchapat Arpawasinsuk received her bachelor degree of Industrial Engineering from Suranaree University of Technology in 2015. She also completed master degree in Industrial Systems and Environmental Engineering from Suranaree University of Technology in 2017. She is currently working as an industrial engineer.