Analysis and Exploratory Study of Preventive Maintenance Implementation: A Case Study from Coffee Shops in Bandung, West Java

Riri Fitriana[1], Maya Sukmawati[2], Muhammad Y Salam[3], Tsany N Hidayat[4]
Industrial Engineering Department, Faculty of Engineering
Universitas Indonesia
Depok, West Java, Indonesia
[1]riri.fitriana@ui.ac.id,
[2]maya.sukmawati@ui.ac.id,
[3]muhammad.yaasiin01@ui.ac.id,
[4]tsany.hidayat@ui.ac.id

Abstract

This research paper has the main objective to analyze how a coffee shop industry implement the preventive maintenance concept in their business. Today, coffee shop has been a booming business and almost every region has their own coffee shop. This is credited to the changing lifestyle that currently take place which then create a lot of demands. This create some fierce competition around them; therefore, it is important that the operational of coffee shop can carry out without any glitch. One of the aspects is ensure no unscheduled breakdown that might occur and disturb their operational activity. Therefore, implementation of preventive maintenance is become important aspect in the day-to-day operational of coffee shop.

Keywords
Coffee Shop, Maintenance Management, Preventive Maintenance

1. Introduction
Maintenance is a combination of functional integration to establish operational productivity and high product quality while maintaining tool quality and machine reliability. Maintenance strategy is a strategy that a company follows to manage maintenance according to its context, objectives and limitations. It is usually designed by maintenance managers or outside consultants (Amal et al. 2019). Nowadays the world is competing to gain a world class performance in all manufacturing industry, and all of their focuses to get higher productivity, quality and reducing costs with evaluation in maintenance activity (Rahmat et al.,2017). Ahuja and Khamba (2008) argue that improper maintenance practices have led to quality degradation. The aim of maintenance is to maintain the sweet spot in the production level at the lowest cost without compromising the human side, safety and the environment. To maintain the function of such a system, it is vitally important to identify the necessary maintenance strategy.

Maintenance activity can improve the reliability, availability, and performance of companies (Agustina et al. 2019). According to the BSI standard publication (2017), maintenance activities can be divided into two parts, namely preventive activities and corrective activities. Preventive activities can be carried out prior to the detection of a failure, consisting of fault detection, deterioration diagnosis and preventive work, while corrective actions consist of fault location, fault diagnosis and repair or temporary repair. Due to the increasing importance of maintenance in organizations, maintenance management is and has been widely examined in the literature. However, some authors in the literature found that there is a gap between the maintenance strategies proposed in the literature and the strategies adopted in the industry (Velmurugan and Dhingra, 2015).

Given the relevance of the above problems, the researchers wish to conduct an exploratory study to analyze the practice of preventive maintenance of Coffee Shop using descriptive statistical methods. Therefore, this study conducted 30 Coffee Shops in Bandung, West Java. Starting with the distribution of questionnaires, one led to an understanding of

maintenance management from the industrial context. This research can help develop a preliminary framework for implementing a maintenance model through exploratory analysis and study.

1.1 Objectives

The objectives of this research are formulated to be as follows:

(1) Analyze preventive maintenance implied at the coffee shop
(2) To identify the preventive maintenance level at a coffee shop

By answering aforementioned research objectives, the research will contribute to the knowledge on how Coffee Shop should implement the preventive maintenance to improve the reliability and the performance of the business, which also provides a new perspective for future research.

2. Literature Review

2.1 Maintenance Management

Since the beginning of its creation maintenance management has become very important factor in optimizing asset and production continuity. Thus, nowadays maintenance management often dedicated into centralized unit in an organization (Al-Turki et al., 2014). Due to the increasing competition in global market it is important to make sure that a firm possess the flexibility and efficiency to compete with its competitors while still give good delivery and quality (Yamashina, 1995).

Maintenance management become more significant in an industry which need good product synchronization such as in a make-to-order nature which customer order only will be made after an order is received (Carlson., 2008). However, machines are unavoidably subject to deterioration and failure with the increase of usage. It is no doubt that production synchronization will be influenced by the unexpected breakdowns of machines. On the other hand, by creating good maintenance management, the frequency of machine failures can be significantly reduced (Liu et al., 2021).

2.2 Preventive Maintenance

Preventive maintenance was introduced in 1951 which is a method to check equipment before it breaks down to extend equipment life cycle. Preventive maintenance contains certain activities which need to be carried out after a certain amount of time or after certain amount of machine use (Herbaty, 1990). Several key factors of preventive maintenance are arranging condition based maintenance and scheduled based maintenance in order to reduce probability of failure and to prolong equipment lifetime (Wang et al., 2019).

Condition based maintenance is an activity of monitoring, inspect, or testing an equipment to produce an analysis and diagnosis regarding equipment lifetime. Meanwhile scheduled based maintenance is a maintenance activity that will be carried out after a certain amount of time or equipment use regardless of its condition (BSI, 2017). This is important to ensure that the equipment which will be used are free from detrimental defects that could cause unsafe condition and major impact to the production due to unscheduled breakdown (Castro 2009). Subsequently this is needed to achieve the goal of preventive maintenance which is to extend the lifetime of an equipment, with regular maintenance to maintain the quality and performance of equipment. This equipment lifetime is also related to productivity and quality of tools in doing their work so that the output produced by the unit still has good quality.

2.3. Research on Coffee Shop

Coffee bean has become such a popular commodity in many years and drink coffee also become a lifestyle in a modern world. Coffee shop is included in Small businesses, or more commonly known as Micro, Small, and Medium Enterprises (SMEs), this type of business has a unique role in developing countries, such as job creation, contribution to revenue, and ensuring the distribution of limited resources (Purwojatmiko and Nurcahyo 2020)

Due to its increasing demand, a coffee shop has become a booming industry in recent years. People often come to the coffee shop only to relax or gather with the community (Kuhon et al., 2016). There were several researches that specifically about coffee shop. Burggräf et al. (2019) proposed to use a sensor to monitoring and implementing predictive maintenance in a coffee machine to prevent from breakdown. Meanwhile some of previous researches were about improving service quality in coffee shop (Lee & Kim, 2021; Insani et al., 2020).

3. Methods

In order to get comprehensive situation, this study is conducted by online survey of 33 coffee shop respondents located in Bandung, West Java. The researchers analyze four characteristic of preventive maintenance with 12 questions. Then, the data was analyzed using descriptive methods and calculated using SPSS tool. Moreover, level of preventive maintenance is categorized based on three level such as inner level, medium level, and good level. Each level will be described deeply in discussion below

4. Data collection

The researchers conducted literature review on several studies to obtain the characteristic of preventive maintenance. Table 1 below showed the characteristic that has been identified.

Table 1. List of Preventive Maintenance Characteristics

Variable Preventive Maintenance	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13
Condition based maintenance	✓	x	x	✓	✓	✓	x	x	x	x	x	✓	x
Scheduled based maintenance	✓	✓	✓	✓	x	✓	✓	x	x	✓	x	✓	✓
Reduce probability of failure	✓	✓	x	✓	✓	x	x	x	x	✓	✓	x	✓
Predetermined maintenance	✓	✓	x	x	x	x	x	x	x	x	x	x	x
Predictive maintenance	✓	✓	x	✓	x	x	x	x	x	x	x	x	x
Extend life equipment	✓	✓	✓	x	x	x	x	✓	x	x	x	x	x
Preventive activity	x	✓	x	✓	x	x	x	x	x	x	x	x	x

From the characteristic of preventive maintenance that has been shown on Table 1, some of the characteristics will be simplified into one factor due to its similarities whether in its activity or properties. From that there are 4 factors that each of them poured into 3 questions in the questionnaire. This is to analyze the level of maintenance management implementation in coffee shop based on 4 main factors as explained below:

(1) Condition Based Maintenance and predictive maintenance
Condition Based Maintenance is a preventive maintenance which include a combination of condition monitoring and/or inspection and/or testing, analysis and the ensuing maintenance actions (BSI, 2017). While, Predictive Maintenance Condition-based maintenance carried out following a forecast derived from repeated analysis or known characteristics and evaluation of the significant parameters of the degradation of the item (BSI, 2017).

(2) Scheduled Based Maintenance and Predetermined Maintenance
Scheduled Based Maintenance: Maintenance carried out in accordance with a specified time schedule or specified number of units of use (BSI, 2017) before failure (Turki et al.,2014). While Predetermined Maintenance is a preventive maintenance that carried out in accordance with established intervals of time or number of units of use but without previous condition investigation (BSI, 2017)

(3) Preventive Activity
Preventive activity is a maintenance activity carried out before the failure of a product or equipment occur.

(4) Extend Life Equipment and Reduce Probability of Failure

Extend Life Equipment is one of the goals of preventive maintenance. It aims extend the lifetime of an equipment, with regular maintenance, then the quality of tool performance can be maintained. This equipment lifetime is also related to productivity and quality of tools in doing their work so that the output produced by the unit still has good quality. Whereas, Reduce Probability of Failure is Repairs to a faulty system that are very expensive and have a major impact, so it is important that there is a preventive measure to reduce the risk of damage and unscheduled maintenance (Castro, 2009).

Those 4 main factors are then poured into 3 questions for each factor as shown in Table 2 below. Then the questionnaire is given to owner/person-in-charge who is well know regarding maintenance management in the coffee shop.

Table 2. List of Questionnaire based on Preventive Maintenance Characteristics

Main Factors	Questions
Condition Based Maintenance and predictive maintenance	1. I made observations on the equipment in the coffee shop 2. How often are observations made on supporting equipment (Freezer/Refrigerator/AC, etc.) 3. How often are observations made on the coffee maker (interval)
Scheduled Based Maintenance and Predetermined Maintenance	1. I schedule maintenance on equipment at the coffee shop 2. How often is maintenance carried out based on a schedule on supporting equipment (Freezer/Refrigerator/AC etc.) 3. How often maintenance is carried out based on the schedule on the coffee maker (interval)
Preventive Activity	1. How often is periodic cleaning of all equipment in the coffee shop 2. How often is component replacement done? 3. How often to control the condition of the coffee maker to keep it dry
Extend Life Equipment and Reduce Probability of Failure	1. How often the support equipment is damaged 2. How often does the coffee maker fail 3. How often is tool replacement done

5. Results and Discussion

5.1 Validity and Reliability test

To measure the reliability of data which are generate from the questionnaire validity and reliability test conducted using measurement of Cronbach Alpha. According to Hair et al. (2019) the acceptable value is 0,7 although decrease of the value to 0,6 is acceptable in exploratory research. In this research reliability test was conducted using SPSS tool. From this the Cronbach's Alpha 0,754 > r-table 0,296 is obtained as shown in Table 3 below.

Table 3. Cronbach Alpha value

Reliability Statistics	
Cronbach's Alpha	N of Items
0,754	12

5.2 Survey result

Based on the answers to the questionnaire that has been filled in by 33 coffee shop respondents in Bandung, West Java, the following results were obtained for the main factors shown in Table 2 above.

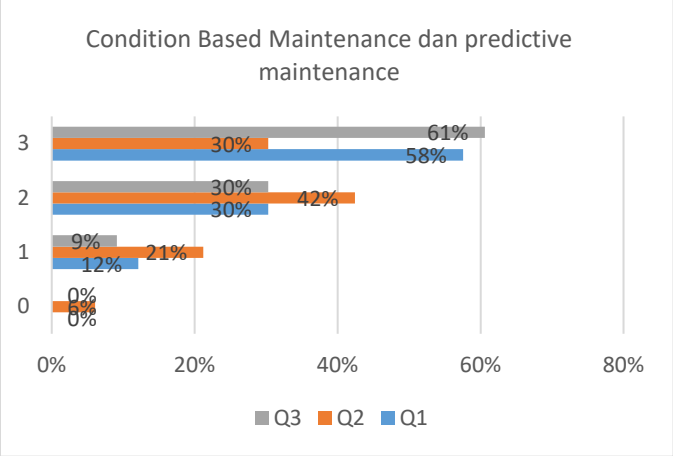

Figure 1. Condition Based Maintenance dan predictive maintenance

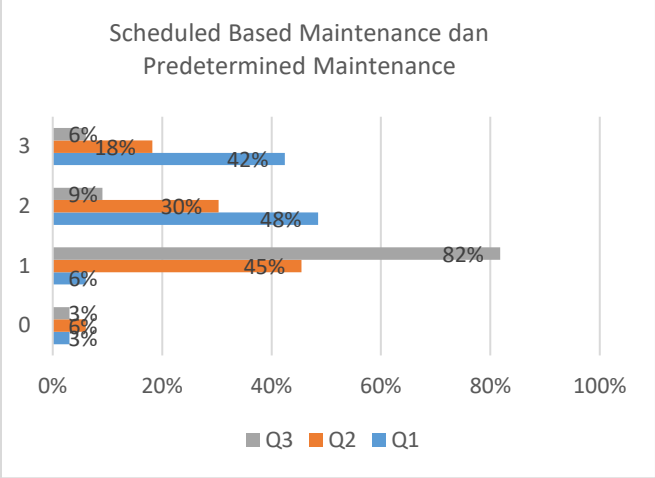

Figure 2. Scheduled Based Maintenance dan Predetermined Maintenance

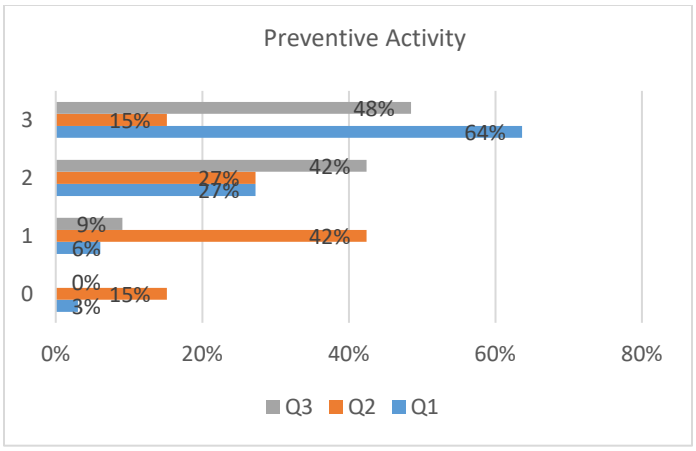

Figure 3. Preventive Activity

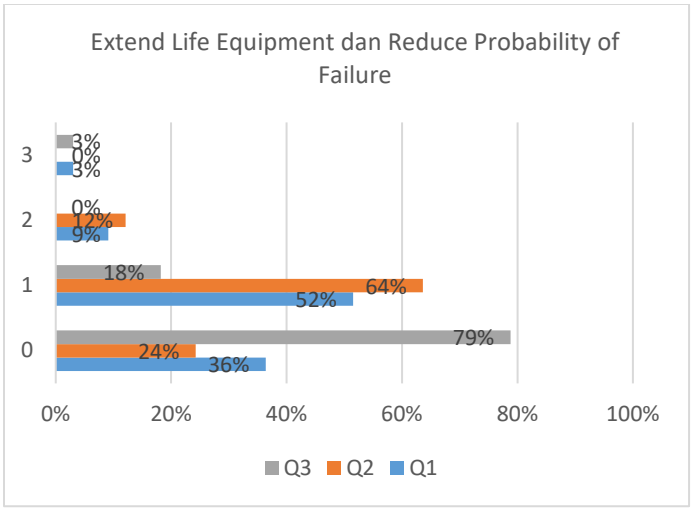

Figure 4. Extend Life Equipment dan Reduce Probability of Failure

From figure 1 we get an indication that coffee shops in Bandung, West Java has certain scales of familiarities with condition based and predictive maintenance. This indicates that coffee shops often use their observation then use the result of it to decide whether it is needed to conduct routine maintenance activity or not. It also shows that coffee shop put a lot of attention to the condition of their equipment to prevent it from breakdown by using their observatory analysis.

Then from figure 2 we get indication that coffee shops in Bandung, West Java rarely maintenance program using a schedule. The result from questionnaire shows that almost all coffee shops rarely make scheduled maintenance for their coffee maker or their supportive equipment such as air conditioner, refrigerator, or freezer.

Meanwhile from figure 3 coffee shop in Bandung, West Java has conducted simple activity to prevent their machine breakdown by doing routine care to their equipment. This indicate that coffee shops are to some extent put their attention on preventive activity. They did not want any unscheduled breakdown on their equipment whether it is their main equipment or supporting equipment. This result is in accordance with figure 4 where most of the observed coffee shop stated that their equipment are rarely beaks down.

According to Naji et al. (2020) there are 3 levels of category regarding the implementation of maintenance management in an industry. Those three categories are:
(1) Inner level;
(2) Medium level; and

(3) Good level.
The inner level means that either a company without clear written maintenance procedures from their top management vision or a company already has a written procedure but the effect of this procedure is still low in regards to their performance. Then medium level refers to a company which either have clear written procedure from their top management and bring positive result because of it or a company that still not have any clear written procedure for maintenance management but adopt a good maintenance practice. Lastly, good level refers to company which their top management has been fully aware regarding the positive effect and importance of maintenance management.

The results of the processing from the responses of 33 coffee shop respondents, the largest percentage was obtained at the medium level, which was 67% (Figure 5). This can be interpreted that preventive maintenance at coffee shops in the Bandung area is moderate condition and refers to "medium level, category 2: Companies that do not have clear written procedures regarding maintenance management but adopt good maintenance practices. This category concerns three companies. It may be explained by individual initiatives of maintenance managers rather than top management vision.

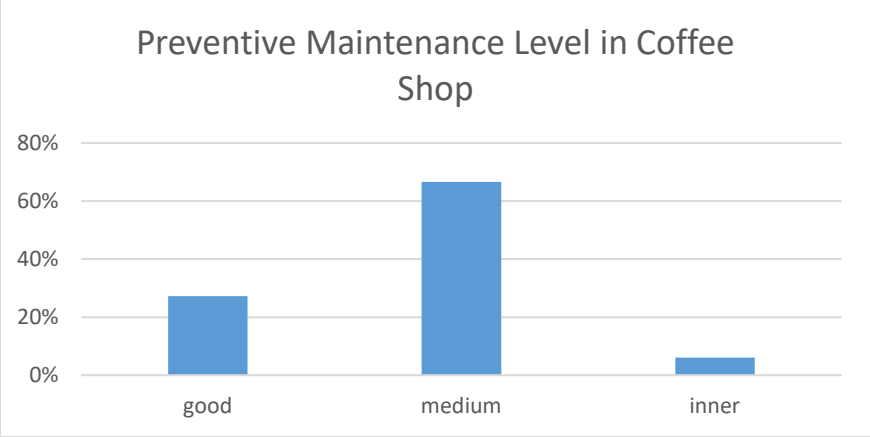

Figure 5. Preventive Maintenance Level in Coffee Shop

6. Conclusion
From the result above there are some interesting points regarding the implementation of maintenance management in coffee shops. Although coffee shop rarely makes a maintenance schedule for their main equipment and supporting equipment but they use extensive observation as a tool to prevent breakdown by using observed data as a reference for their maintenance activity. Furthermore, coffee shops are often put a lot of their attention to daily care of their equipment to prevent it from breakdown. This indicate that coffee shops are care about the lifetime and condition of their equipment so there will be no unscheduled breakdown. This results in rare breakdown that occur on their equipment's.

This result only focus on coffee shops in Bandung, West Java, Indonesia. Therefore, there might be some differences on other region due to differences in their demographic characteristic. Extensive study might also be conducted in other region to explore some differences and compare it to one another and what factor that might affect those differences.

References
Al-Turki, U., M., Ayar, T., Yilbas, B., S., Sahin, A., Z. (2014). Integrated Maintenance Planning in Manufacturing Systems. Springer Cham Heidelberg, NY: Springer.

Arisaputra,A. Farizal.,Nurcahyo, R..,2017. Development of maintenance program with Markov-Simulation method in aviation industry. *International Conference on Engineering Technologies and Applied Sciences (ICETAS)*, doi: 10.1109/ICETAS.2017.8277888

Ben Daya, et al. 2019. Handbook of Maintenance Management and Engineering.

British Standard. (2017). Maintenance – Maintenance Terminology (BS EN 13306:2017). BSI Standard Publication.

Burggräf, P., Wagner, J., Koke, B., Manoharan, K. (2019). Sensor retrofit for a coffee machine as condition monitoring and predictive maintenance use case. 14th International Conference on Wirtschaftsinformatik.

Carlson J G, Yao A C. Simulating an agile, synchronized manufacturing system. Int J Prod Econ 2008;112(2):714–22.

Castro, I.T., 2009. "A model of imperfect preventive maintenance with dependent failure modes," European Journal of Operational Research, Elsevier, vol. 196(1), pages 217-224, July.

Farizal. Nurcahyo, R.,Rahayu, A, P.,2019. Hazards from the Maintenance Outsource Operation of Container Material Handling Equipment in Port. *International Conference on Engineering Technologies and Applied Sciences (ICETAS)*, doi: 10.1109/ICETAS48360.2019.9117306.

Hair, J., F., Black, W., C., Babin B., J., Anderson, R., E. (2019). Multivariate Data Analysis 8th ed. Hampshire, UK: Cengage Learning, EMEA.

Herbaty, F. (1990), Handbook of Maintenance Management: Cost Effective Practices, 2nd ed.,Noyes Publications, Park Ridge, NJ.

Insani, S., F., Wijayanti, A., W., Cahyaningrum, B., N. (2020). Pendampingan Pelaksanaan Survey Kepuasan Pelanggan Pada Coffee Shop Cekopi di Mendungan, Kartasura. Jurnal Warta LPM. Vol. 23, No. 2, September 2020.

I.P.S. Ahuja, and J.S. Khamba, (2008) "Total productive maintenance: literature review and directions",International Journal of Quality & Reliability Management, Vol. 25 Issue: 7, pp.709-756

Kuhon, C., K., Lapian, J., Tumiwa, J. (2016). Evaluating the Service Quality of Coffee Shop Using Importance and Performance Analysis (Case Study: Excelso Coffee Manado Town Square). Jurnal Berkala Ilmiah Efisiensi. Vol. 16 No. 04.

Liu, Y., Zhang, Q., Ouyang, Z., & Huang, H.-Z. (2021). Integrated production planning and preventive maintenance scheduling for synchronized parallel machines. Reliability Engineering & System Safety, 215, 107869. doi:10.1016/j.ress.2021.107869.

Naji, A., EL Oumami, M., Bouksour, O. and Beidouri, Z. (2020), "A mixed methods research toward a framework of a maintenance management model: A survey in Moroccan industries", Journal of Quality in Maintenance Engineering, Vol. 26 No. 2, pp. 260-289. https://doi.org/10.1108/JQME-10-2018-0079.

Purwojatmiko B.H., and Rahmat Nurcahyo, 2020. Total Quality Management Implementation in Small Business: Case Study in Depok, Indonesia. In Proceeding of APCORISE'20, June, 2020, Depok, West Java

Sun-Min, L., Ha-Kyun, K. (2021). A Study on the Impact of Coffee Service Quality on Customer Satisfaction and Loyalty. Turkish Journal of Computer and Mathematics Education. Vol.12 No.10 (2021), 978- 986.

Velmurugan, R.S. and Dhingra, T. (2015), "Maintenance strategy selection and its impact in maintenance function: a conceptual framework", International Journal of Operations Production Management, Vol. 35 No. 12, pp. 1622-1661.

Wang, J., Makis, V., & Zhao, X. (2019). Optimal condition-based and age-based opportunistic maintenance policy for a two-unit series system. Computers & Industrial Engineering. doi:10.1016/j.cie.2019.05.020.

Yamashina, H. (1995), "Japanese manufacturing strategy and the role of total productive maintenance "Journal of Quality in Maintenance Engineering, Vol. 1 No. 1, pp. 27-38.

Biography

Riri Fitriana is presently pursuing her Master Degree program in Industrial Engineering Departement, focusing on Industrial Management at Universitas Indonesia and a full-time worker in a multinational company as an R&D supervisor. She completed her bachelor degree from Mining Engineering, Faculty of Earth and Energy Technology, Universitas Trisakti in 2019. She was born in Jakarta, February 23rd 1998. This research was conducted as a part of Industrial Maintenance Management researches in Industrial Engineering Department, Faculty of Engineering, Universitas Indonesia.

Maya Sukmawati is Bachelor Degree of Industrial Engineering at Universitas Jenderal Achmad Yani, Bandung, Indonesia. She is a student of Master Degree in the same field, Industrial Engineering at Universitas Indonesia, Jakarta, Indonesia. She interest in the field of Project Management areas and has completed various projects as a Project Engineer since 2017.

Muhammad Yaasiin Salam is currently active as a Master Degree student in Industrial Engineering Department, Faculty of Engineering Universitas Indonesia with major focus on Industrial Management. He took his bachelor degree from Metallurgy and Materials Engineering, Faculty of Engineering, Universitas Indonesia in 2017. He was born on

Sangatta, December 24th, 1995. This research was conducted as a part of Industrial Maintenance Management researches in Industrial Engineering Department, Faculty of Engineering, Universitas Indonesia.

Tsany Naufal Hidayat is a Master Degree student in the field of Industrial Engineering at the Universitas Indonesia, Jakarta, Indonesia. He earned his bachelor degree in Ocean Engineering at Institut Teknologi Sepuluh Nopember (ITS), Surabaya, Indonesia. Currently he is in charge at a manufacture company in Indonesia since 2019 as a Project Team Leader. His current research is in strategic management for Small and Medium Enterprises for the completion of his Master Degree.