Analysis of Preventive Maintenance in Small and Medium Enterprises: Case Study of Coffee Shops in Depok City

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Abstract

Coffee shops are currently developing and becoming a lifestyle for many people in Indonesia, especially the city of Depok. The boom of customers in coffee shops has caused several machines to be overused and damaged. In this paper, we take 30 coffee shop samples to be surveyed in Depok to find out how to plan machine maintenance for each coffee shop and find an ideal way for preventive maintenance. This research paper aims to study preventive maintenance plans and analyze preventive maintenance carried out by each coffee shop by statistical analysis using F-Test in IBM SPSS. The data used descriptive statistical analysis and then continued with testing the validity and reliability of the data. Before being tested using multiple linear regression analysis to prove the hypothesis, the classical assumption test was first carried out.

Keywords
Preventive Maintenance, Small and Medium Enterprises, Coffee Shop, IBM SPSS, F-Test.

1. Introduction
Small and medium enterprises are a dynamic and growing sector in most economies around the world. Global economic conditions have driven the rise of SMEs over the past 10-15 years. It is also a challenge for small and medium enterprises that only compete in the domestic arena in the country territory or even cover only the city area (Nugroho & Nurcahyo. 2018). Small and Medium Industry has an essential role in the national economy. The number can see this of business units that reached 3.4 million units in 2013 and accounted for 90% of the total national industrial units. The development of small and medium industries is targeted to increase the average business unit by 1% or 30 thousand business units per year and increase the absorption of the average workforce by 3% per year (Ministry of Industry of the Republic of Indonesia, 2015). Small and medium industries can also absorb the most labor force than other sectors (Nugroho & Nurcahyo. 2018).

1.1 Objectives
The objectives of this research paper are to study Characteristics of Preventive Maintenance. Maintenance Management, Predetermined Maintenance, Condition Monitoring, Spare Parts were selected as theoretical characteristics to analyze the benefits of implementing the coffee machine that we surveyed. 30 coffee shop outlets in the Depok area were examined specifically for the maintenance of coffee machines, refrigerators, and air conditioners. This research involves a survey mechanism in data collection. The contribution in this paper is expected to be the basis for other coffee shop outlets in determining the maintenance management strategy that the strategy will apply in the process of maintaining machinery and equipment.

2. Literature Review
2.1. Maintenance
According to British standards (2017), maintenance is a collection of technical, administrative, and managerial steps taken throughout an item's life cycle to keep it in or return it to a state where it can perform the needed function. Technical maintenance actions include observing and analyzing the item state (e.g., inspection, monitoring, testing, diagnosis, prognosis, etc.) and active maintenance actions (e.g., repair, refurbishment). Maintenance involves

multidisciplinary arrangements covering planning to execution, and it is one of the essential activities of asset management and engineering. With the rise in acquisition and maintenance expenses, the function of maintenance in retaining asset value over time is becoming increasingly obvious at the company level. (Al-Turki et al., 2014).

Traditionally, maintenance is studied in isolation of other functions such as operations, marketing, etc., and isolation of different supporting and service-providing organizations. Various maintenance strategies were developed over time, such as preventive maintenance, condition-based maintenance, reliability-based maintenance, and so forth. These strategies scored great success in eliminating unexpected failures and unplanned unavailability, which usually cause high costs of operations and restoration (Al-Turki et al., 2014).

2.2. Maintenance Quality

Maintenance quality is high when the production yield is at its peak without unplanned stops, and maintenance costs are minimal. It is generally agreed that maintenance quality has a direct link to product quality. High maintenance quality may result in reducing downtime of equipment. Properly maintained equipment retains its capability over a more extended period, and this results in scrap reduction. Repeat calls for repairing the same defect in a given machine indicate the maintenance quality (Ben Daya et al., 2009).

2.3. Maintenance Activity

According to British standards (2017), Maintenance activity is part of maintenance. Actions are directly carried out on an item to retain it or restore it to a state where it can perform the required function. In Figure 1, you can see the maintenance activity chart. The preventive maintenance can see that active preventive maintenance is the part of preventive maintenance undertaken to restore an item directly or after degradations observed through condition monitoring, inspection, or testing. On the other side, active corrective maintenance is the part of corrective maintenance undertaken to restore an item.

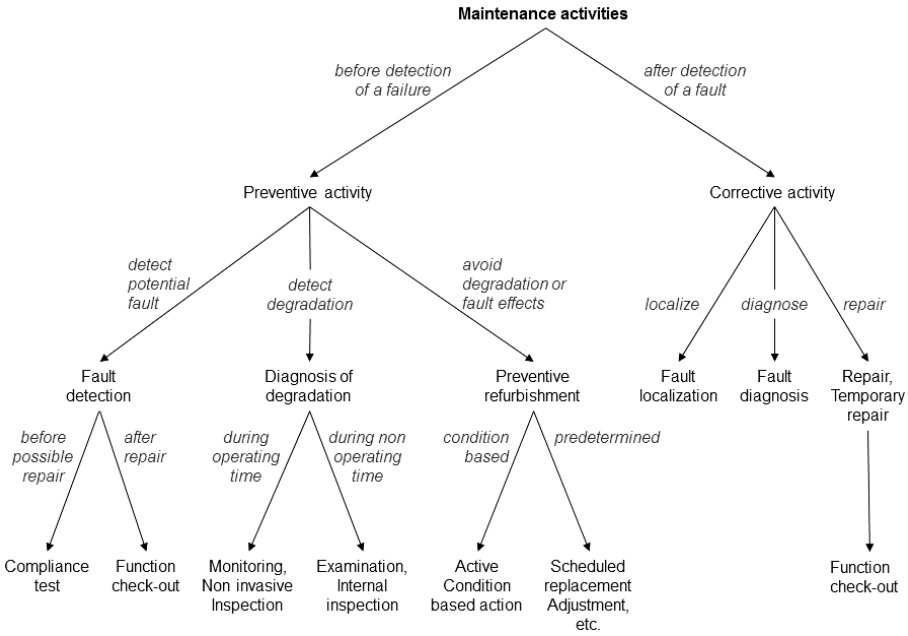

Figure 1. Maintenance activities.

2.4. Preventive Maintenance

Preventive maintenance introduced the concept of Preventive Maintenance in 1951, a kind of physical check-up of the equipment to prevent equipment breakdown and prolong equipment service life. Preventive maintenance comprises maintenance activities undertaken after a specified period or amount of machine used. This type of maintenance relies on the estimated probability that the equipment will break down or experience deterioration in performance in the specified interval. The preventive work undertaken may include equipment lubrication, cleaning, parts replacement, tightening, and adjustment (Ahuja & Khamba. 2008).

Au-Yong et al. (2014) argued preventive maintenance is a practical approach to enhancing a system's reliability, quality, and components. In order to prevent failure from occurring, preventive maintenance practice should be able to indicate when a maintenance work needs to be performed. Eti et al (2006) supported that maximizing components reliability and extending the components' life are the main purpose of preventive maintenance(See Figure 2). It also provides a critical service function that minimizes interruptions to the core business of an organization. Thus, the implementation of preventive maintenance is necessary to replace the need of corrective maintenance.

2.5. Characteristics of Preventive Maintenance

The characteristics are likely to influence the overall maintenance performance. Thus, they must be concerned with maintenance management. An effective maintenance management always puts a lot of effort towards these characteristics. Through literature review, the characteristics of preventive maintenance are identified as follows (Au-Yong et al. 2014):

2.5.1 Maintenance Management

All management activities that define maintenance requirements, objectives, strategies and responsibilities, and their implementation in such a manner as maintenance planning, maintenance control, and improvement of maintenance activities and the economy (BS EN 13306:2017).

2.5.2 Predetermined Maintenance

Preventive maintenance carried out according to specified time intervals or number of units of use but without prior investigation of conditions (BS EN 13306:2017). The time interval or number of units of use can be determined from knowledge of the item's failure mechanism.

2.5.3Condition Monitoring

Activities carried out either manually or automatically, are intended to measure at predetermined intervals the characteristics and parameters of the actual physical state of an item (BS EN 13306:2017).

2.5.4Spare Parts

Goods that are intended to replace goods that are suitable to maintain or maintain the original functionality required of the goods (BS EN 13306:2017).

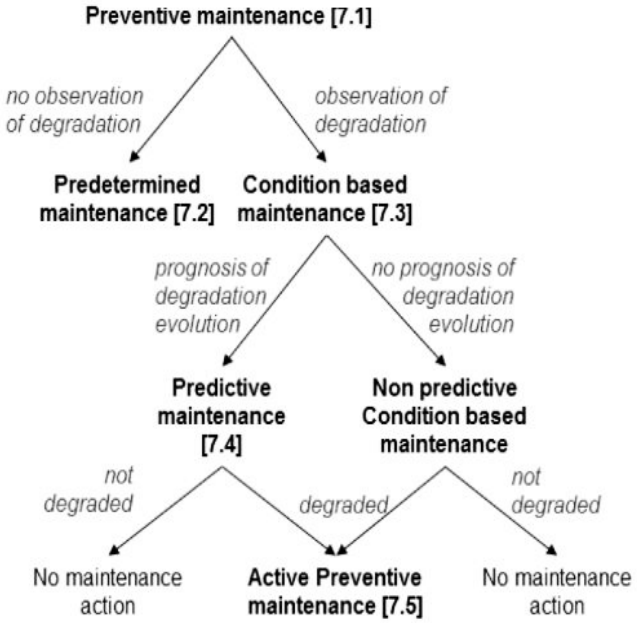

Figure 2 Preventive Maintenance.

2.6. Qualitative and Quantitative Analysis

Combining qualitative (descriptive) information and quantitative (numeric) information ensures that all the relevant details on the damage experienced by the structure are considered. The qualitative data has deemed the judgment used with the engineering calculations to provide data outside a known range and compensate for insufficient data (Mansour et al., 2019). Thus, the proposed model developed by combining qualitative and quantitative methods will enhance the credibility of the results.

To prove the result, the data obtained will be analyzed using descriptive statistical analysis and then continued with testing the validity and reliability of the data. And before being tested using multiple linear regression analysis to prove the hypothesis, the classical assumption test is first carried out.

2.7. IBM SPSS (F-Test)

IBM SPSS Modeler is one of the info mining software applications from IBM. It's an information mining and text analytics tool for building predictive models (Abdar 2015). IBM SPSS Modeler has many sorts of modeling methods taken from AI, machine learning, and statistics. The methods available on the Modeling menu allow you to deduce new information from your data and to form predictive models (Soodeh et al., 2020).

3. Methods

The method used in this study is based on primary data from a survey of 30 coffee shop outlets in the Depok area. We collect data regarding Maintenance Management, Predetermined Maintenance, Condition Monitoring, and Spare parts for the use of Coffee Machines, Refrigerators, and air conditioners. In this methodology, we combine qualitative and quantitative methods that causality with productive activity in the coffee shop. Qualitative methods include records of interviews, content analysis, and previous cases and studies. On the other hand, quantitative methods utilize questionnaires, statistical analysis, and structured evaluation.

The methodology of this project started with case identification. Data collected was analyzed using quantitative and qualitative methods. Data was collected from various resources such as observation in coffee shops, interview and discussion sessions. Figure 3 shows the detailed flow chart of this project methodology.

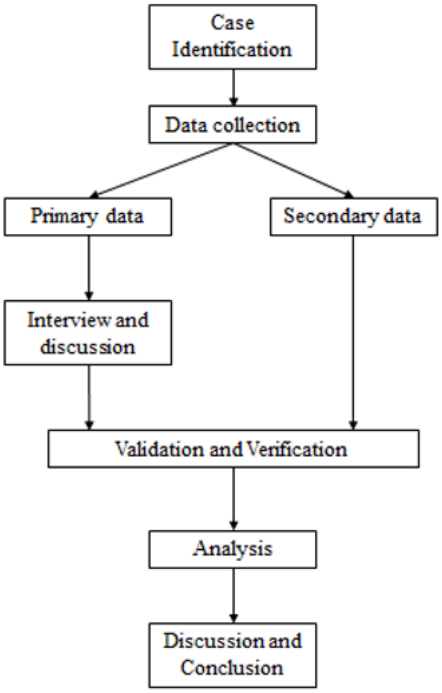

Figure 3. Flow chart for methodology of the project

4. Data Collection

The data collection that we collected from 30 coffee shops in Depok city, Indonesia. The coffee shops consist of several places in Depok city, West Java, Indonesia. The number of coffee shops in Depok city is quite high because Depok city has the most cities that have a lot of students around because Depok has a few public universities around. Usually the coffee shops do the preventive maintenance a monthly check and the check is almost done by the barista and also machine vendor technician.

Figure 4 shows there are three main issues found on coffee shops machines. The first is age-related, which is almost about the machine age used. When the machine is used for more than a year, the machine should set the device for a routine check. The second issue is the boiler issue. The boiler issue is the highest issue around the three issues found. Boilers usually used to be the main things to make the coffee. According to barista information, the issue found in the boiler machines is the heater not working correctly, sometimes overheating, and sometimes the heater not working. The last issue is machine system constraint, which is the system sometimes doesn't allow the instruction when it's used. Usually, preventive maintenance should be scheduled due to routine checks and anticipate machine error before breakdown. Norddin & Saman (2012) said the goal of preventive maintenance is to anticipate, prevent, prolong or delay the process of failure from occurring. Pinto *et al.* (2020), through the analysis of maintenance manuals and internal know-how, autonomous maintenance procedures and preventive maintenance plans have been created to be executed following a given timeframe. The below Table 1 gives the classification of machine failure in coffee shops.

Table 1. Classification of the machine failure in Coffee Shops place in Depok city.

No.	Coffee Shop	Location	Type of Failure
1	OI Coffe & Eatery	Depok	Boiler issue
2	Yummy choice coffe gold	Depok	Machine system contraint
3	Hojja coffe sawangan	Depok	Age-related
4	Selayang Pandang Kitchen Gallery	Depok	Boiler issue
5	Kopi Nako Sawangan	Depok	Age-related
6	Mat Dudung Café and Resto	Depok	Machine system contraint
7	Kanopi kopii	Depok	Machine system contraint
8	Urip Urup Coffe	Depok	Age-related
9	Kopi Bar	Depok	Boiler issue
10	Kopi Kotak	Depok	Boiler issue
11	Cuci Mulut	Depok	Machine system contraint
12	Coffith	Depok	Boiler issue
13	Koba	Depok	Boiler issue
14	Waroeng Noesantara	Depok	Machine system contraint
15	Waroeng Noesantara	Depok	Boiler issue
16	Tempat Bercakap Kopi	Depok	Age-related
17	Breadnow	Depok	Boiler issue
18	Transitory	Depok	Age-related
19	Golden Black Coffee	Depok	Boiler issue
20	Tuah Doa	Depok	Machine system contraint
21	Kopium	Depok	Age-related
22	Coffee Toffee	Depok	Machine system contraint
23	Aiko	Depok	Machine system contraint
24	MAOI	Depok	Boiler issue
25	Saturday	Depok	Boiler issue
26	Nyambi	Depok	Boiler issue
27	Yellow Truck	Depok	Boiler issue
28	Delysh	Depok	Boiler issue
29	Jacob Koffie	Depok	Machine system contraint
30	Nako	Depok	Boiler issue

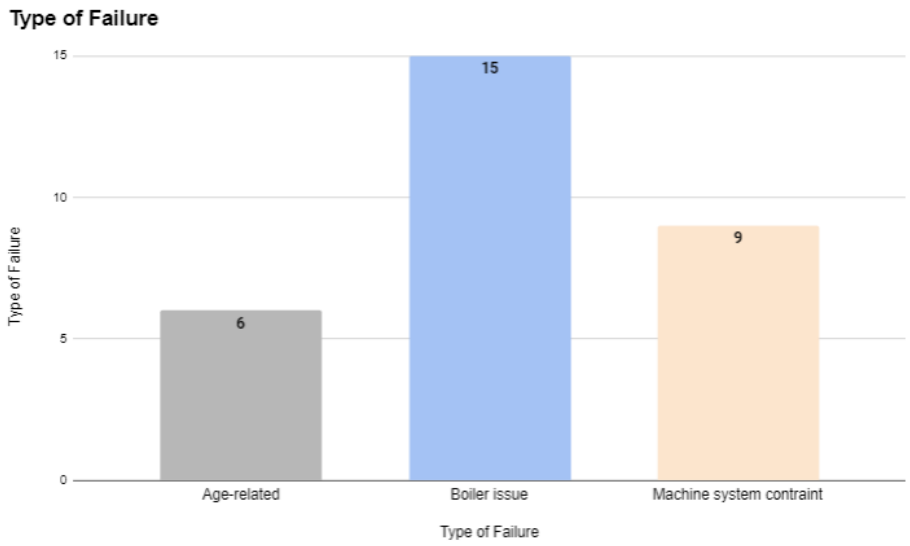

Figure 4. The type of machine issue in coffee shops (2021)

5. Results and Discussion

According to Kattan & Hassan (2010), The characteristics of successful maintainability are often determined by equipment's design, which can dictate a set of maintenance procedures and decide the length of the period generally required for repairs. The main factor for maintainability is the meantime to repair. Preventive maintenance should be treated as a profit center. This view has been driven by financial aspects of maintenance strategy, which are determined by increasing availability. The role of an effective preventive maintenance program is to achieve required levels of feed pump availability. This is true because the PMP could impact reliability and maintainability when accurately planned and conducted. The right preventive maintenance tasks could, for instance, be the central part of keeping an item of equipment in top running order tasks.

The total of the breakdown times can be classified into three types, considering the causes of breakdown. These types are noted below, including relevant investigation.

1. Age-related breakdown times contain scheduled maintenance according to routine checks.
2. Boiler issue that contains machine breakdown, plate error, and power failure.
3. Machine systems constraints due to process deficiencies, and the systems didn't work properly

Table 2. Total of breakdown time based on PM Schedule

PM in Coffee Shops

No.	Coffee Shop	Location	Issue	PM Schedule	Total Breakdown Time Schedule (per hour)	Total PM Coffee Machine	Breakdown Count (in a year)
1	OI Coffe & Eatery	Depok	Boiler issue	Randomize	20	5	4
2	Yummy choice coffe gold	Depok	Machine system contraint	Half of the Year	12	6	2
3	Hojja coffe sawangan	Depok	Age-related	Randomize	15	5	3
4	Selayang Pandang Kitchen Gallery	Depok	Boiler issue	Half of the Year	12	6	2
5	Kopi Nako Sawangan	Depok	Age-related	Half of the Year	12	6	2
6	Mat Dudung Café and Resto	Depok	Machine system contraint	Yearly	8	8	1
7	Kanopi kopii	Depok	Machine system contraint	Randomize	20	5	4
8	Urip Urup Coffe	Depok	Age-related	Half of the Year	10	5	2
9	Kopi Bar	Depok	Boiler issue	Half of the Year	12	6	2
10	Kopi Kotak	Depok	Boiler issue	Randomize	15	5	3
11	Cuci Mulut	Depok	Machine system contraint	Yearly	8	8	1
12	Coffith	Depok	Boiler issue	Half of the Year	12	6	2
13	Koba	Depok	Boiler issue	Yearly	8	8	1
14	Waroeng Noesantara	Depok	Machine system contraint	Randomize	15	3	5
15	Waroeng Noesantara	Depok	Boiler issue	Half of the Year	10	5	2
16	Tempat Bercakap Kopi	Depok	Age-related	Half of the Year	16	8	2
17	Breadnow	Depok	Boiler issue	Randomize	20	5	4
18	Transitory	Depok	Age-related	Yearly	12	6	2
19	Golden Black Coffee	Depok	Boiler issue	Randomize	20	4	5
20	Tuah Doa	Depok	Machine system contraint	Yearly	10	10	1
21	Kopium	Depok	Age-related	Randomize	18	6	3
22	Coffee Toffee	Depok	Machine system contraint	Half of the Year	12	6	2
23	Aiko	Depok	Machine system contraint	Randomize	18	6	3
24	MAOI	Depok	Boiler issue	Half of the Year	16	8	2
25	Saturday	Depok	Boiler issue	Randomize	15	5	3
26	Nyambi	Depok	Boiler issue	Yearly	9	9	1
27	Yellow Truck	Depok	Boiler issue	Yearly	11	11	1
28	Delysh	Depok	Boiler issue	Randomize	20	5	4
29	Jacob Koffie	Depok	Machine system contraint	Half of the Year	10	5	2
30	Nako	Depok	Boiler issue	Half of the Year	12	6	2

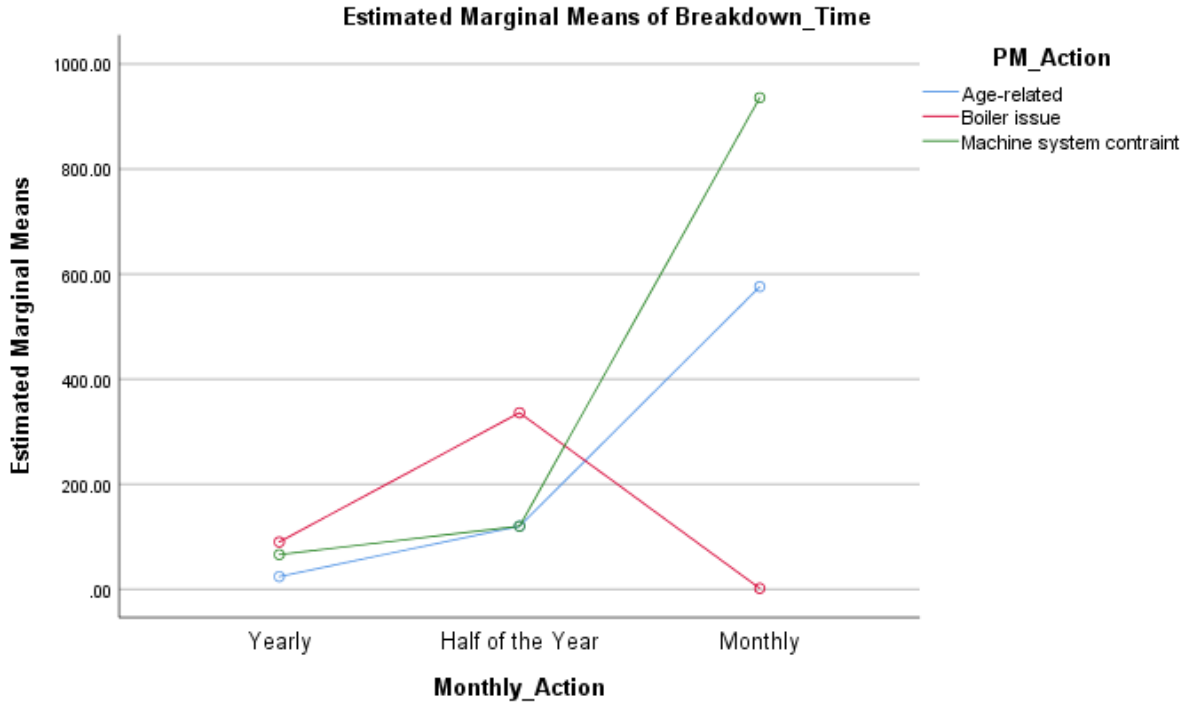

Figure 5. Estimate of breakdown time

Based on figure 5, the coffee machine in the coffee shop usually does a preventive maintenance routine. The preventive maintenance scheduled due to stabilizing the performance of the machines. The table 2 shows the preventive maintenance scheduled half a year the most because the machines found system constraint issues during about six months. In Figure 6, the statistical data of predictive maintenance of the coffee shops with descriptive analysis.

Descriptive Statistics

	Mean	Std. Deviation	N
Total_Breakdown_Time	13.6000	3.97058	30
Total_PM_Coffee_Machine	6.2333	1.77499	30
Breakdown_Count_in_a_year	2.4333	1.16511	30

Figure 6. Descriptive Statistic data of 30 samples of Coffee shops in Depok City.

These results in the Anova (Figure 7) analysis indicate that the coefficient of the direction of the regression is maximal, almost showing there is an effect of the preventive maintenance means. While the coefficient value correlation shows r = 0.905, it means that there is a positive role between preventive maintenance schedule in coffee shops, where the preventive maintenance schedule has an impact, because it reaches r2 = 0.820 or 82% Yield the test shows that the value of F = 61.456 is significant enough for accept H1, meaning preventive maintenance have a considerable role on breakdown schedule.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	374.856	2	187.428	61.456	.000[b]
	Residual	82.344	27	3.050		
	Total	457.200	29			

a. Dependent Variable: Total_Breakdown_Time

b. Predictors: (Constant), Breakdown_Count_in_a_year, Total_PM_Coffee_Machine

Figure 7. ANOVA analysis result of coffee shops preventive maintenance.

6. Conclusion

TPM has been widely known in the industrial environment. This proactive maintenance strategy contributed to manufacturing performance improvements highlighted by the various researchers. Through TPM process focus, the cost and quality were improved significantly by reducing and minimizing equipment deterioration and failures. Cost of rework and repairs declined due to minimal products rejected due to equipment failure. Thus, the overall effectiveness of equipment also improved significantly based on thirty Coffee shops in Depok city. Additionally, machines eliminated equipment deterioration as the equipment operated efficiently. The engine carried out autonomous maintenance activities with total barista or employee participation. Analysis statistic result indicates that the coefficient of the direction of the regression is maximal, almost showing there is an effect of the preventive maintenance means. While the coefficient value correlation shows r = 0.905, it means that there is a positive role between preventive maintenance schedule in coffee shops, where the preventive maintenance schedule has an impact, because it reaches r2 = 0.820 or 82% Yield the test shows that the value of F = 61.456 is significant enough for accept H1, meaning preventive maintenance have a considerable role on breakdown schedule. The investment in training and education boosted the operator or technician morale and the commitment towards the management team goals.

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Biography

Ayu Mandasari N, S.Pi. is a master's degree student in the Industrial Engineering department at Universitas Indonesia, concentrating in Industrial Management. She completed her bachelor's degree at Universitas Brawijaya, Indonesia, majoring in Fisheries Product Technology, Faculty of Fisheries and Marine Science. She's experienced PPIC (Production Planning and Inventory Control) for over 4 years in the FMCG Industry which is her first experience was in the coconut milk and pineapple Industry for 1 year and 3 months. She continued her career in sugar refinery companies in Indonesia till present as a PPIC & Logistic section head part of Supply Chain Management Department.

Yafiazmi Dhaniswara, S.T. is a Master of Engineering candidate in the Faculty of Engineering at Universitas Indonesia. He holds a Bachelor's degree in Industrial Engineering. He has several experiences working in different sectors such as tobacco, construction, electricity and commodity futures companies. His research interests are in the areas of project management, supply chain management and HSE (health, safety, environment). He has scientific research entitled "Studying the Procurement of Cement Raw Materials for Making Box Piles (Non-Centrifugal) at PT. WIKA Beton PPB Bogor" and the title of his undergraduate research paper entitled "Analysis Occupational Health and Safety Hazards for Operators in the Mechanical Division by Using the Job Safety Analysis (JSA) Method".

Wildan Firdaus, S.Sc. is a Master of Engineering candidate of Universitas Indonesia. He holds a Bachelor Science of Degree in Physics from Universitas Indonesia. Having work experience background knowledge of Procurement. He will explore this knowledge to become a reliable in the field of Procurement and Supply Chain Management.