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.

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.

2.5.3 Condition 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).

2.5.4 Spare 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](image_url)
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.

![Flow chart for methodology of the project](image-url)
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>
<thead>
<tr>
<th>No.</th>
<th>Coffee Shop</th>
<th>Location</th>
<th>Type of Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OI Coffe &amp; Eatery</td>
<td>Depok</td>
<td>Boiler issue</td>
</tr>
<tr>
<td>2</td>
<td>Yummy choice coffee gold</td>
<td>Depok</td>
<td>Machine system contraint</td>
</tr>
<tr>
<td>3</td>
<td>Hoja coffe sawangan</td>
<td>Depok</td>
<td>Age-related</td>
</tr>
<tr>
<td>4</td>
<td>Selayang Pandang Kitchen Gallery</td>
<td>Depok</td>
<td>Boiler issue</td>
</tr>
<tr>
<td>5</td>
<td>Kopi Nako Sawangan</td>
<td>Depok</td>
<td>Age-related</td>
</tr>
<tr>
<td>6</td>
<td>Mat Djudang Cafe and Resto</td>
<td>Depok</td>
<td>Machine system contraint</td>
</tr>
<tr>
<td>7</td>
<td>Kicopi kopi</td>
<td>Depok</td>
<td>Machine system contraint</td>
</tr>
<tr>
<td>8</td>
<td>Urip Urup Coffe</td>
<td>Depok</td>
<td>Age-related</td>
</tr>
<tr>
<td>9</td>
<td>Kopi Bar</td>
<td>Depok</td>
<td>Boiler issue</td>
</tr>
<tr>
<td>10</td>
<td>Kopi Korak</td>
<td>Depok</td>
<td>Boiler issue</td>
</tr>
<tr>
<td>11</td>
<td>Cuci Mulut</td>
<td>Depok</td>
<td>Machine system contraint</td>
</tr>
<tr>
<td>12</td>
<td>Coffith</td>
<td>Depok</td>
<td>Boiler issue</td>
</tr>
<tr>
<td>13</td>
<td>Koba</td>
<td>Depok</td>
<td>Boiler issue</td>
</tr>
<tr>
<td>14</td>
<td>Warong Noesantara</td>
<td>Depok</td>
<td>Machine system contraint</td>
</tr>
<tr>
<td>15</td>
<td>Warong Noesantara</td>
<td>Depok</td>
<td>Boiler issue</td>
</tr>
<tr>
<td>16</td>
<td>Tempat Bercakap Kopi</td>
<td>Depok</td>
<td>Age-related</td>
</tr>
<tr>
<td>17</td>
<td>Breathor</td>
<td>Depok</td>
<td>Boiler issue</td>
</tr>
<tr>
<td>18</td>
<td>Transitory</td>
<td>Depok</td>
<td>Age-related</td>
</tr>
<tr>
<td>19</td>
<td>Golden Black Coffee</td>
<td>Depok</td>
<td>Boiler issue</td>
</tr>
<tr>
<td>20</td>
<td>Tuah Doa</td>
<td>Depok</td>
<td>Machine system contraint</td>
</tr>
<tr>
<td>21</td>
<td>Koprman</td>
<td>Depok</td>
<td>Age-related</td>
</tr>
<tr>
<td>22</td>
<td>Coffee Toffee</td>
<td>Depok</td>
<td>Machine system contraint</td>
</tr>
<tr>
<td>23</td>
<td>Atko</td>
<td>Depok</td>
<td>Machine system contraint</td>
</tr>
<tr>
<td>24</td>
<td>MAO</td>
<td>Depok</td>
<td>Boiler issue</td>
</tr>
<tr>
<td>25</td>
<td>Saturday</td>
<td>Depok</td>
<td>Boiler issue</td>
</tr>
<tr>
<td>26</td>
<td>Nyambi</td>
<td>Depok</td>
<td>Boiler issue</td>
</tr>
<tr>
<td>27</td>
<td>Yellow Truck</td>
<td>Depok</td>
<td>Boiler issue</td>
</tr>
<tr>
<td>28</td>
<td>Delyak</td>
<td>Depok</td>
<td>Boiler issue</td>
</tr>
<tr>
<td>29</td>
<td>Jacob Koffie</td>
<td>Depok</td>
<td>Machine system contraint</td>
</tr>
<tr>
<td>30</td>
<td>Nako</td>
<td>Depok</td>
<td>Boiler issue</td>
</tr>
</tbody>
</table>
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.

Figure 4. The type of machine issue in coffee shops (2021)
Table 2. Total of breakdown time based on PM Schedule

<table>
<thead>
<tr>
<th>No.</th>
<th>Coffee Shop</th>
<th>Location</th>
<th>Issue</th>
<th>PM Schedule</th>
<th>Total Breakdown Time Schedule (per hour)</th>
<th>Total PM Coffee Machine</th>
<th>Breakdown Count (in a year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Caffe &amp; Estee</td>
<td>Depot</td>
<td>Boiler issue</td>
<td>Randomize</td>
<td>20</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Yu Men's Choice</td>
<td>Depot</td>
<td>Machine system constraint</td>
<td>Half of the Year</td>
<td>12</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Kaffeine</td>
<td>Depot</td>
<td>Age-related</td>
<td>Randomize</td>
<td>15</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Selecting Peking Kitchen Gallery</td>
<td>Depot</td>
<td>Boiler issue</td>
<td>Half of the Year</td>
<td>12</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Kopek</td>
<td>Depot</td>
<td>Age-related</td>
<td>Half of the Year</td>
<td>12</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>Nat Dinding Cafe and Raso</td>
<td>Depot</td>
<td>Machine system constraint</td>
<td>Yearly</td>
<td>8</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Namoi Kopi</td>
<td>Depot</td>
<td>Machine system constraint</td>
<td>Randomize</td>
<td>20</td>
<td>5</td>
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<tr>
<td>8</td>
<td>Cig Limon Coffee</td>
<td>Depot</td>
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<td>Half of the Year</td>
<td>10</td>
<td>5</td>
<td>2</td>
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<tr>
<td>9</td>
<td>Koopi Bar</td>
<td>Depot</td>
<td>Boiler issue</td>
<td>Half of the Year</td>
<td>12</td>
<td>6</td>
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</tr>
<tr>
<td>10</td>
<td>Hina Koun</td>
<td>Depot</td>
<td>Boiler issue</td>
<td>Randomize</td>
<td>15</td>
<td>5</td>
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<tr>
<td>11</td>
<td>Caco Matar</td>
<td>Depot</td>
<td>Machine system constraint</td>
<td>Yearly</td>
<td>8</td>
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<tr>
<td>12</td>
<td>Cofin</td>
<td>Depot</td>
<td>Boiler issue</td>
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<td>6</td>
<td>2</td>
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<td>13</td>
<td>Koba</td>
<td>Depot</td>
<td>Boiler issue</td>
<td>Yearly</td>
<td>8</td>
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<td>14</td>
<td>Warung Nesentra</td>
<td>Depot</td>
<td>Machine system constraint</td>
<td>Randomize</td>
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<td>3</td>
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<tr>
<td>15</td>
<td>Warung Nesantara</td>
<td>Depot</td>
<td>Boiler issue</td>
<td>Half of the Year</td>
<td>10</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>Tampak Bencak Kops</td>
<td>Depot</td>
<td>Age-related</td>
<td>Half of the Year</td>
<td>10</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>17</td>
<td>Brechturu</td>
<td>Depot</td>
<td>Boiler issue</td>
<td>Randomize</td>
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<td>5</td>
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<td>18</td>
<td>Traniaryy</td>
<td>Depot</td>
<td>Age-related</td>
<td>Yearly</td>
<td>12</td>
<td>0</td>
<td>2</td>
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<tr>
<td>19</td>
<td>Goldens Black Coffee</td>
<td>Depot</td>
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<td>Randomize</td>
<td>20</td>
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<tr>
<td>20</td>
<td>Tosh Dui</td>
<td>Depot</td>
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<td>10</td>
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<tr>
<td>21</td>
<td>Royalan</td>
<td>Depot</td>
<td>Age-related</td>
<td>Randomize</td>
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<td>2</td>
</tr>
<tr>
<td>22</td>
<td>Coffee Toffee</td>
<td>Depot</td>
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<td>2</td>
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<td>Aiko</td>
<td>Depot</td>
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<td>3</td>
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<tr>
<td>24</td>
<td>Mameg</td>
<td>Depot</td>
<td>Boiler issue</td>
<td>Half of the Year</td>
<td>16</td>
<td>9</td>
<td>2</td>
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<tr>
<td>25</td>
<td>Saturdayy</td>
<td>Depot</td>
<td>Boiler issue</td>
<td>Randomize</td>
<td>15</td>
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<td>Boiler issue</td>
<td>Yearly</td>
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<td>9</td>
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</tr>
<tr>
<td>27</td>
<td>Yellow Teapot</td>
<td>Depot</td>
<td>Boiler issue</td>
<td>Yearly</td>
<td>11</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>28</td>
<td>Dadya</td>
<td>Depot</td>
<td>Boiler issue</td>
<td>Randomize</td>
<td>20</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>29</td>
<td>Noa Kaffe</td>
<td>Depot</td>
<td>Machine system constraint</td>
<td>Half of the Year</td>
<td>10</td>
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<td>2</td>
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<tr>
<td>30</td>
<td>Naka Kaffe</td>
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<td>Boiler issue</td>
<td>Half of the Year</td>
<td>12</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Breakdown Time</td>
<td>13.6000</td>
<td>3.97058</td>
<td>30</td>
</tr>
<tr>
<td>Total PM Coffee Machine</td>
<td>6.2333</td>
<td>1.77499</td>
<td>30</td>
</tr>
<tr>
<td>Breakdown Count in a Year</td>
<td>2.4333</td>
<td>1.16511</td>
<td>30</td>
</tr>
</tbody>
</table>

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 $r^2 = 0.820$ 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.

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>374.856</td>
<td>2</td>
<td>187.428</td>
<td>61.456</td>
<td>.000&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Residual</td>
<td>82.344</td>
<td>27</td>
<td>3.050</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>457.200</td>
<td>29</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Dependent Variable: Total_Breakdown_Time
<sup>b</sup> 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 $r^2 = 0.820$ 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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