Application of reliability engineering method in machine maintenance

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Abstract. This study was conducted in an industry resin from block rubber with the quality specifications of the SIR (Standard Indonesian Rubber)-10. Problems occurred because the company is still doing corrective maintenance and do not have a planned machine maintenance schedule. It disrupted the exhibition process. This study’s purpose is designing a preventive maintenance machine system with reliability engineering method. Data needed in study is machine breakdown and downtime, damaged frequency, and interval damaged of machine details. The critical details on the machine were Reactors with its details, namely packing valve Codogno, packing main-hole, and propeller. Determining the distribution of failure, reliability, Mean Time to Failure, the study results show the interval of replaced part packing valve Codogno is a 109-day with reliability value the of details 0.5007; packing main-hole is 120 days with reliability 0.5070; propeller details is 172 days with reliability 0.5028.

1. Introduction
Due to increase competition then the management of the company should save expenses for maintaining the stability of the company in achieving its vision. One of the company's challenges is machine maintenance [1]. Machine maintenance approach has changed over the decades. Machine maintenance activities can minimize losses that could be caused by failure of this. Many companies still were more worried about his concern for the exhibition of machine maintenance. Extended machine downtime dramatically affects the productivity of the exhibition. Machine maintenance is a regular routine necessary to maintain the equipment in good shape in which the equipment can perform following with its functions. Machine maintenance is carried out to ensure the availability of equipment in the industry to compete in the global market [2, 3]. Machine maintenance system has relied on planned maintenance and predictive maintenance on. The machine maintenance strategy is an integral part of an effective maintenance program. Then the machine maintenance can minimize costs. Other machine maintenance activities will ensure the health of the machine [4, 5].

Reliability techniques for maintenance of the machine are the company's strategy of improving the care implemented to optimize the machine maintenance program. Reliability has been focusing on the reliability of its products and warranties to be reliable. Reliability can be trusted to do or give what is needed [6, 7]. The company that study was conducted has two working shifts. Data for machine failure can be shown in Table 1.
Table 1. Data machine failure

| No | Machine Name      | Total Failure |
|----|-------------------|---------------|
| 1  | Cutting Machine 1 | 6             |
| 2  | Cutting Machine 2 | 8             |
| 3  | Reaktor Machine 1 | 21            |
| 4  | Reaktor Machine 2 | 23            |
| 5  | Reaktor Machine 3 | 22            |
| 6  | Reaktor Machine 4 | 23            |
| 7  | Reaktor Machine 5 | 21            |
| 8  | Destination Machine 1 | 11          |
| 9  | Destination Machine 2 | 10          |
| 10 | Destination Machine 3 | 8             |
| 11 | Destination Machine 4 | 10            |
| 12 | Destination Machine 5 | 9             |
| 13 | Destination Machine 6 | 12            |
| 14 | Destination Machine 7 | 9             |
| 15 | Separator Machine 1 | 10            |
| 16 | Separator Machine 2 | 5             |
| 17 | Separator Machine 3 | 7             |
| 18 | Separator Machine 4 | 6             |
| 19 | Separator Machine 5 | 7             |
| 20 | Grinder Machine   | 6             |

Based on table 1, shows that the number of damaged machines operates at PT. XYZ as seen from the highest downtime which can affect the exhibition process. Then it needs to be fixed machine maintenance scheduling activities on the company to run optimally. The real maintenance application on PT. XYZ is corrective maintenance to support the course of the activities of the exhibition process. This is very unsafe for the production company to recall hours of operation 24 hours/day. This study is done to analyze the damaged to exhibition machines. In this case, the researchers use the method of reliability engineering to determine machine maintenance intervals of activity that has damaged.

2. Research methods

Research about the exhibition of Resiprene 35 conducted at the PT. XYZ. Descriptive study is chosen as the methods which factual, systematic, and accurate about an item or specific populations. The research aims to provide a proposed schedule for the machine details that need to be replaced. The item of the research is reactor because the machine observed has the dominant failure frequency. The method starts with the identification of data, from the company's information (machine breakdown, downtime, interval, and frequency damaged). Data retrieved from interviews with the staff of the maintenance department. Other testing such as the parameters, distribution, find the interval time of replaced, values of MTTF, and the reliability [8], [9]. The flow of research can be seen in figure 1.

![Figure 1. The flow of research](image-url)
Formula to calculate the reliability value of the chosen part as refer from [12, 13, 14, 15].

3. Results

3.1. Determination of critical part

Data frequency of damaged to reactor critical machine details is collected based on documents or historical data from department maintenance. Historical data, damaged to critical machine details reactors shown in table 2.

Table 2. Total damaged the details of reactor's machine

| No | Details             | Total |
|----|---------------------|-------|
| 1  | Packing Manhole     | 26    |
| 2  | Tank Condensor      | 1     |
| 3  | Body                | 1     |
| 4  | Manometer           | 1     |
| 5  | Stay End Holk       | 1     |
| 6  | Light Bulb          | 16    |
| 7  | Packing Valve       | 30    |
| 8  | Codogno             |       |
| 9  | Double Nepal        | 1     |
| 10 | Glacial             | 1     |
| 11 | Faint Belt          | 1     |
| 12 | Packing Condensor   | 5     |
| 13 | Steller             | 1     |
| 14 | Propeller           | 19    |
| 15 | Astier              | 1     |
| 16 | Build               | 4     |
|    | Bottom              | 1     |

Based on the data above, the damaged frequency to get the sequence of details that have the most significant damaged is analyzed with the chart, shown seen in Figure 2.

Figure 2. Pareto analysis graphics reactor machine part damaged

This diagram results from damaged of the machine by using the principle of 80%-20%. A critical part of the machine Reactor that will be the priority of the deliberations of the research is the most extended continuous damaged with the frequency details, as shown in table 3.
Table 3. Recapitulation of critical part details (in reactor)

| No. | Part        | Total |
|-----|-------------|-------|
| 1   | Packing Valve | 26    |
|     | Codogno     |       |
| 2   | Packing Manhole | 30    |
| 3   | Propeller   | 19    |

From Table 3, we can see that the part that has the most damaged was packing Manhole; the second is packing value Codogno, and then the last one propeller.

3.2. Distribution testing
In reliability engineering, testing the distribution on each critical machine details are integral. The recapitulation distribution pattern of test results, all of the a normal distribution.

3.3. Calculation of MTTF (mean time to failure) part machine
Another step of the machine part replaced is done by determining the MTTF (Mean Time to Failure). The results of the MTTF value obtained the interval time of each part replaced; the details of a Valve Codogno with an amount of MTTF 109 days. It means if the machine is operated during the 109 days, Packing Valve Codogno details must be replaced. The substantial part must be available in the warehouse because it had been planned earlier. The details of packing manhole with an amount of MTTF 120 days, means at the moment the machine is operated for 120 days. Details Packing Manhole should already be replaced. Then the details of the propeller with an amount of MTTF 172 days, which means after the machine is operated for 172 days, Propeller details must be replaced.

3.4. Calculation of the reliability on a schedule interval of replaced details
The value of reliability critical machine details is used to determine the incredible rate of machine details reliability. The calculation is done from the distribution pattern that selected for each position. Recapitulation of the value of reliability for a scheduled interval of a part that after 109 times of use, a reliability value of part packing valve Codogno is 0.5007. This shows the rate of reliability machine part on a schedule this part is 0.5007. while manhole packing details after use 120 days obtained a reliability value is 0.5070, and the last piece propeller after use 172 days has reliability value 0.5028.

4. Discussion
4.1. Analysis of critical machine details and types
The reactor has the highest frequency machine damaged. The machine reactor is used for whisking chunks of rubber raw materials continuously. These machines often suffered damaged caused by a few things [14]:

a. Age of details that are used that have exceeded the usage.
b. Incorrect installation machine details by operators will accelerate damaged to the machine.
c. Wear and tear happen due to two surfaces rubbing against the inside of the part at the time of operation.

The more extended machine is used, the faster device details wear out. The type of machine reactor at PT. XYZ has an average frequency of damaged. The company has five units machines reactor. Based on the principal diagram of Pareto's 80%-20%, the detail of Reactor has a frequency of machine damaged critical details. The biggest failure of a machine that subsequently became a priority discussion. The main details into the discussion are derived from three details namely packing valve Codogno, packing main-hole and propeller. This failure affects on the machine so it could not operate and result in lost exhibition time.
4.2. Analysis of part replaced schedule
Distribution pattern for critical details of the Packing Valve Codogno is a normal distribution and values for MTTF a critical features of the Packing Valve Codogno is 109 days. Distribution patterns for critical details of Packing Manhole are the normal distribution, and the value of the critical details for MTTF Packing Manhole is 120 days. Distribution patterns for critical details Propellor is a normal distribution, and critical details for the MTTF Propellor is 172 days.

4.3. Analysis of the critical part reliability on the schedule details replaced
The value of a critical machine details reliability is used to determine the great value. The reliability of Packing Valve Codogno is 0.5007. The machine details reliability value of Packing main hole each part replaced schedule 120 days is 0.5070. The reliability of the propeller machine details is 0.5028. Due to the machine maintenance schedule, replaced of machine details should be replaced at a time when the machine is operated during the time interval specified. This will eliminate costs due to lost exhibition time.

5. Conclusion
A critical machine which became the item of the research is a machine reactor with crucial machine details that are packing main-hole, packing Codogno valve, and propeller. Replaced schedule of essential details for part packing valve Codogno is 109 days, part packing the main-hole 120 days, and propeller details 172 days. The value for reliability of the valve packing machine factors Codogno is 0.5007, the reliability of Manhole packing a machine is 0.5070, and the reliability of details propellor 0.5028.

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