International journal of science, engineering, and information technology
Volume 07, Issue 01, December 2022
Journal homepage: https://journal.trunojoyo.ac.id/ijseit

Reability Analysis and Scedulling Preventive Maintenance for Spray Dryer Machine

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ABSTRACT

The activity of implementing proper machine maintenance is a must in a company. PT Arwana Citramulia Tbk is a company that produces ceramic tiles. The machine used is a spray dryer machine. The company aims to determine whether there is a schedule or time interval for machine maintenance. The method used is (RCM) Reliability Centered Maintenance. RCM is a process for determining the actions that must be taken so that the system is in good condition. Components are reviewed from FMEA (Failure Mode and Effect Analysis). The risk assessment is obtained from calculating the RPN (Risk Priority Number), then determining the distribution of each component. Calculation of MTTR and MTBF values, and finally determines the maintenance time interval. From the FMEA results, three risk priority components were obtained, namely the nozzle, piston pump, and vibration filter slip tank. Maintenance intervals on the nozzle component with a maintenance interval of 694 hours, piston pump with a maintenance interval of 758 hours, vibration filter slip tank with a maintenance interval of 292 hours per year. The results of this study indicate that there are three components that have a high failure rate and must receive scheduled maintenance to reduce the failure of the spray dryer machine.

Keyword : FMEA, RCM, Spray dryer.

Article History
Recevied 07 December 2022 Received in revised form 09 December 22 Accepted 24 December 22

1. Introduction

Quality assurance is a part that must exist in every production line, so that the products received by consumers are quality products for consumption, and do not harm health in the short or long term. In achieving this, it is necessary to have integration between production components. According to (Gaspersz, 1998) in his machine maintenance. The components that make up the production system consist of materials, machinery and equipment, labor, capital, energy, information, land, and others, while the functional components consist of *supervision* , planning, control, coordination, and leadership. According to (Daryus, 2008) in his book machine maintenance management. The main objective of machine maintenance is to extend the usefulness of assets, ensure the optimum availability of equipment installed for production and get the maximum possible return on investment, and ensure the safety of people who use these facilities. In carrying out a mass manufacturing industrial process, it is necessary to be supported by machines to produce quickly, in large quantities, and safely. A machine is an equipment that is driven by a force or energy that is used to assist humans in working on certain products or product parts (Assauri, 2004). Machines as human helpers certainly have a performance period to work optimally, to maintain machine performance it is necessary to have scheduled machine maintenance and be integrated with production scheduling.

Research conducted by Nushron 2019 using the RCM method to analyze WTP machine repair scheduling shows that the results of the analysis are as follows: Mean Time To Repair(MTTR) for the three components above is sand filter with an average of 0.48 hours, bag filter with an average - 0.68 hours on average, and cartridge filters with an average of 1.22 hours per year. Mean Time To Failure(MTTF) for the three components above are sand filters with an average of 684 hours, bag filters with an average of 190.3 hours and cartridge filters with an average of 236.8 hours per year. The results of The Mean Time Between Failure (MTBF) for the three components above are sand filters with an average of 708 hours, bag filters with an average of 214.8 hours and cartridge filters with an average of 260.8 hours per year. The results of the reliability analysis for the three components above are sand filters with a value of 0.178527412, bag filters with a value of 0.005394050, and cartridge filters with a value of 0.008884653 (Nushron and Antonius, 2019).

Lukodono et al. (2013), conducted research by analyzing the application of the RCM and MVSM methods which aim to increase the reliability of the maintenance system. Case studies conducted on PG. X Malang uses several data collection methods such as observation, interviews and documentation. The RCM approach is carried out to minimize failures on critical components.

Reability Centered Maintenance(RCM) is a more advanced technique for specifying preventive maintenance activities , ensuring assets operate according to their original design and perform their functions as intended by the user. Failure mode and effects analysis(FMEA) is the key to RCM which applies the process to each asset in terms of the desired function and performance (Berger, 2007). RCM is a way to develop alternative maintenance and design strategies, based on operational, economic and safety as well as environmental friendliness (Anon, 2006).

2. Literature review

2.1. Definition of Maintenance

According to Assauri (2008), maintenance is an activity to maintain or maintain factory facilities or equipment by making necessary repairs or adjustments or replacements in order to create a satisfactory production operational condition in accordance with what has been planned.

According to Patrick (2001), maintenance is an activity to maintain and maintain existing facilities as well as repair, make adjustments or replacements needed to obtain a production operating condition in accordance with existing plans.

From some of the descriptions of the opinions above, it can be concluded that maintenance activities are carried out for the maintenance or repair of electronic equipment so that they can carry out production activities or other activities so that they can be carried out optimally. Lack of attention to maintenance (maintenance), among others, is caused by the large amount of funds needed. However, for the company's operational activities, maintenance already has uses for carrying out maintenance of production facilities.

2.2. Reliability Centered Maintenance

Reliability Centered Maintenance (RCM) is a logical engineering process for determining maintenance tasks that will ensure a reliable system design with specific operating conditions in a specific operating environment. The greatest emphasis on Reliability Centered Maintenance (RCM) is recognizing that the consequences or risks of failure are far more important than the characteristics of the technique itself. Reliability Centered Maintenance (RCM) is a process used to determine what must be done to ensure that physical assets can continue to fulfill the expected functions in the context of their current operations (Pranoto, 2015). The research steps with the RCM method are as shown in Figure 1 below

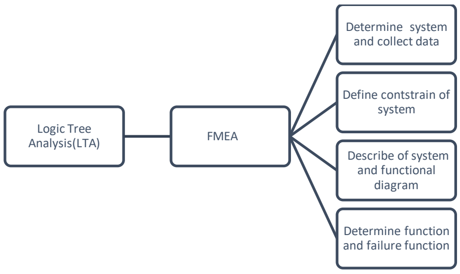

Figure 1 Stages of the RCM Method

From the picture above we can find out the stages of the RCM method:

a. **System selection and information gathering.** In choosing a system, the system to be chosen is a system that has a high frequency of *corrective maintenance* , is expensive and has a major effect on the smooth running of the process in its environment.

b. **System boundary definition.** The definition of system boundaries is carried out to find out what is included and what is not included in the observed system.

c. **System description and *Functional Block Diagram* (FDB).** After the system is selected and the system boundaries have been made, then the system description is carried out. Aims to identify and document the important details of the *system* .

d. **Functional determination and functional failure.** Function can be interpreted as what is done by a device which is the user's expectation. Functions related to issues of speed, output, capacity and product quality. Failure *can* be interpreted as the inability of an equipment to do what is expected by the user. While functional failure can be interpreted as the inability of an equipment to fulfill its function at a standard performance that can be accepted by the user. A function can have one or more functional failures.

e. ***Failure Mode and Effect Analysis* (FMEA).** A failure mode is a state that can cause a functional failure. If the failure mode is known, it is possible to know the impact of failure which describes what will happen when the failure mode occurs, then it is used to determine the consequences and decide what to do to anticipate, prevent, detect or fix it.

f. ***Logic Tree Analysis* (LTA).** *Logic Tree Analysis* is a qualitative measure to classify failure modes. Failure modes can be classified into 4 categories namely:

1. Safety Problem (category A) The failure mode has consequences that can injure or threaten someone's life.

2. Outage Problem (category B) The failure mode can shut down the system.
3. Minor to Infestigation Economic Problem (category C) The failure mode has no impact on security or shutdown of the system. The impact is relatively small and can be neglected.
4. Hidden Failure (category D) Failures that occur cannot be detected by the operator.

g. **Task selection (Selection of maintenance policies).**

Task Selection is done to determine possible policies to be applied (effective) and choose the most efficient task for each failure mode. Effective means that the maintenance policy that is implemented can prevent, detect failure or find Hidden Failure and Efficient means that the maintenance policy that is carried out is economical when viewed from the total cost of maintenance.

3. Method

The method used in this research is using RCM which can be defined as the probability of an equipment to be able to function according to the desired specifications, conditions and certain times without failing. The Reliability Centered Maintenance (RCM) method can be defined as the probability that a component or system will inform a required function within a certain period of time when used in operating conditions.

Based on the data obtained from the company, then analyze the calculation data to support the research, as follows:

a. Calculation of Failure Modes and Effect Analyze (FMEA)
b. Mean Time To Repair (MTTR) Calculation
c. Mean Time Between Failure (MTBF) Calculation
d. Calculation of the average value of treatment time. Data Processing With RCM

After the data is collected, then the data is collected and entered into the following :

$$R = S \times O \times D \quad (2.1)$$

Information :
RPN = Risk Priority Number
S = Severity
O = Occurance
D = Detect

After obtaining the RPN, you can determine which components require a maintenance schedule. After being able to determine the components that need to be scheduled for maintenance, then make a component schedule by calculating the MTBF and MTTR from the data obtained using the following methods:

$$\text{MTTR} = \frac{\sum t}{n} \quad (2.2)$$

Information
MTTR = Mean Time To Repair
t = Time needed to repair
n = Number of repairs done conducted

$$\text{MTBF} = \frac{\sum \text{tUptime}}{n} \quad (2.3)$$

Information
MTBF = Mean To Between Failures
tUptime = Optimum time
n = Number of repairs done conducted

After obtaining the average value of damage time, the average value of reliability can be calculated into the following equation:

a. Normal Distribution
$$R(t) = 1 - \emptyset \left(\frac{t-\mu}{\sigma}\right) \quad (2.4)$$
MTTF = μ

b. Lognormal Distribution
$$R(t) = 1 - \emptyset \left(\frac{1}{s} \ln \frac{t}{t_{med}}\right) \quad (2.5)$$
MTTF = expμ

c. Exponential Distribution
$$R = e^{\lambda t} \quad (2.6)$$
$$\text{MTTF} = \int_0^{\infty} R(t)dt = \frac{1}{\lambda}$$

d. Weibull Distribution
$$R(t) = e^{\left[-\left(\frac{t}{\beta}\right)^{\alpha}\right]} \quad (2.7)$$

$$\text{MTTF} = \beta\Gamma\left[\frac{1}{\alpha} + 1\right]$$

The value coefficient Øis 1.1090 (Gumayri, 2014).

4. Results and Discussion

The data presented in this study are based on conditions according to what happened at the company PT Arwana Citramulia Tbk. Presentation of data in research based on data obtained through questionnaires, documents and direct analysis in the field

Table 1. FMEA Spray Dryer Machine

Component Name	Potency	Effect	Reason	Handling	S	O	D	RPN	rank
Vibration filter slip tanks	Clogged	Damaged	Coarse powder particle size	Replace with a new filter (mess size 50x1.5m)	8	6	7	336	3
Daily tanks	viscosity	Clogged	Abnormal rotation of the propeller	Consider powder capacity	5	6	5	150	8
Air pump	Sound Rough	Pipe broke	Vibration too strong	Replace with a new one	6	5	7	210	4
control panel burners	Dirty	An error occurred	Not clean enough	Control panel cleaning	7	4	6	168	7
Blower combustion	Clogged	Damaged	Suction system stops	Replace new	7	5	5	175	6
Piston pump	Leaking	Less cooling	Water slip does not come out	Change basketball new	8	6	8	384	2
Confeyor	Dirty	Rusty	Dirty chain	Chain lubrication	5	7	4	140	10
Nozzles	Clogged (dead end)	Bursts don't optimal	Oval-shaped	Replace nozzles new	8	7	7	392	1
	Dirty	Capacity	Coarse residue	Cleaning nozzles	6	5	6	180	5
Nozzle stick	Broken	Wet powder	Abnormal temperature	Nozzle stick welding and routine checks	6	6	4	144	9

Based on the results of the RPN table in above, then the one with the highest RPN value is found in:

1. Nozzle with a rating of 392
2. Piston pump rated 384
3. Slip tank vibrating screen rated 336

With the results from the table in above, this study aims to schedule maintenance for spray dryer machine components . The reason for only taking these 3 components is that part of a spray driyer machine often experiences performance problems, therefore this research will schedule maintenance on these components and require intensive maintenance.

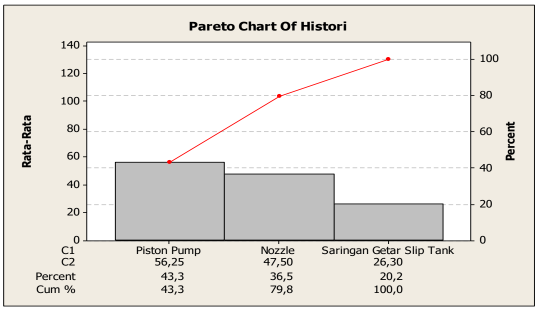

Figure 2 Pareto Diagram Data MTTR Nozzle, Piston Pump , Slip Tank Vibrating Filter on a Spray machine dryer

From the table in above it can be seen that the average MTTR is highest in between the three histories is on the Piston Pump which is equal to 56.25 minutes and the smallest average between the three histories is on the Slip Tank Vibrating Sieve which is equal to 26.30 minutes.

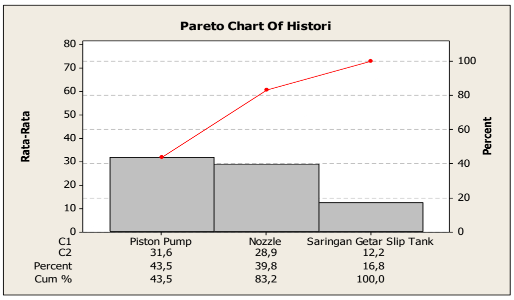

Figure 3 Pareto Diagram Data MTBF Noozle, Piston Pump , Vibrating Sieve Slip Tank on a Spray Drier machine

From the pareto table data above it can be seen that the highest value is the Piston Pump with a value of 31.6 and the lowest is the Slip Tank Vibrating Filter with a value of 12.2.

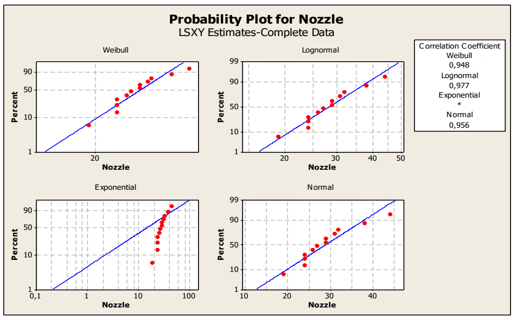

Figure 4 Index Of Fit Data MTBF Nozzle Components

From these calculations it shows that the lowest value is Weibull while the highest value is lognormal, the largest value for the nozzle component MTBF data is by using the lognormal distribution with r = 0.977.

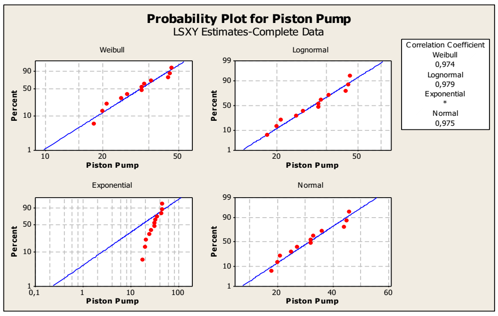

Figure 5 Index of Fit Data MTBF Piston Pump Components

From the calculations in above shows, the largest value for MTBF data for piston pump components is to use a lognormal distribution with r = 0.979.

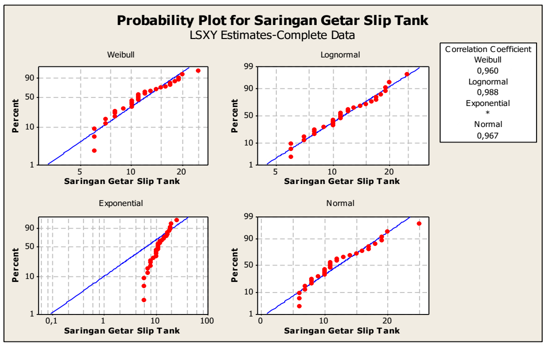

Figure 6 Index of Fit MTBF Data for Slip Tank Vibrating Screen Components .

Then the biggest value for the MTBF data of the slip tank vibrating filter component is using the Lognormal distribution with r = 0.988 . Data that has been processed using Minitab, then to look for realibility. The data is calculated as below I this:

Reliability data nozzle using lognormal distribution

$$R(t) = 1 - \emptyset \left(\frac{1}{s} \text{ In } \frac{t}{t_{med}}\right) = 1 - 0{,}01 \left(\frac{1}{0{,}977} \text{ In } \frac{12}{6{,}5}\right) = 0.056478405$$

The reliability of the piston pump data uses a lognormal distribution

$$R(t) = 1 - \emptyset \left(\frac{1}{s} \text{ In } \frac{t}{t_{med}}\right) = 1 - 0{,}01 \left(\frac{1}{0{,}979} \text{ In } \frac{12}{6{,}5}\right) = 0.056363026$$

Reliability of slip tank vibrating sieve data using lognormal distribution

$$R(t) = 1 - \emptyset \left(\frac{1}{s} \text{ In } \frac{t}{t_{med}}\right) = 1 - 0{,}01 \left(\frac{1}{0{,}988} \text{ In } \frac{30}{16}\right) = 0.057261922$$

Component Name	Damage	MTTR (hours)	MTBF (hours)	reliability
Nozzles	12	0.79	694	,056478405
Piston Pumps	12	0.94	758	,056363026
lightweight Vibrating Slip Tank	30	0.44	292	,057261922

Table 2. MTTR and MTBF calculation table

5. Conclusion

From the components that have experienced damage to the spray driyer, we look for the critical components that most frequently occur with FMEA (Failure Mode and Effect Analyze) and using Reliability Centered Maintenance (RCM) . The components with the highest failure rate were obtained, namely the nozzle with a value of 392, the piston pump with a value of 384, and the slip tank vibrating filter with a value of 336. Time interval results repair MTTR on third component in on is nozzles with average of 0.79 hours, piston pump with an average of 0.94 hours and vibrating filter slip tank with an average of 0.44 o'clock. The results of the MTBF checking time interval for the three components above are nozzle with an average of 28.9 days = 694 hours, piston pump with an average of 31.6 days = 758 hours, and slip tank vibrating filter with an average of 12, 2 days = 292 hours per year.

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