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Application of Failure Mode and Effect Analysis (FMEA) and Ishikawa Diagram In Determining The Damage Aspects and Maintenance Plan of Screw Feeder of Steam Power Plant Company

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Abstract: Screw feeder is a type of material transporter that is widely used in various industrial sectors, where its function is very helpful in facilitating work, such as transporting very large amounts of material and this screw feeder has the advantage of long or sustainable tool operation. In industry, damage often occurs erratically and must undergo component replacement that is not in accordance with the routine maintenance schedule. In designing this maintenance machine, Ishikawa diagrams are used to analyze the causes and effects of component damage to the screw coal feeder, while to analyze other damage parameters and scheduling maintenance and planned component replacements, the Failure Mode and Effect Analysis (FMEA) method can be used. The results of this study indicate that the cause of the damage consists of several factors including humans, machines, materials, and methods. The actions that must be taken on the components include checking for wear and lubrication so that these components are always in good use. Based on the results of the calculation of the reliability of the screw coal feeder machine, the reliability of the screw feeder leaf component is 95.3% and the screw feeder casing component is 94.6%. This can also be seen from the mean time between failure (MBTF) for the leaf screw feeder component of 116.66 hours and the MBTF for the casing screw feeder component of 142.85 hours. With the application of the Ishikawa diagram and FMEA on the screw coal feeder maintenance system at steam power plant company (PLTU) PT XYZ in Indonesia. The maintenance implementation aims for a better planned. The actions that must be taken on the components include checking for wear and lubrication so that these components are always in good use. Based on the results of the calculation of the reliability of the screw coal feeder machine, the reliability of the screw feeder leaf component is 95.3% and the screw feeder casing component is 94.6%. This can also be seen from the mean time between failure (MBTF) for the leaf screw feeder component of 116.66 hours and the MBTF for the casing screw feeder component of 142.85 hours. With the application of the Ishikawa diagram and FMEA on the screw coal feeder maintenance system at PLTU PT XYZ, the maintenance implementation becomes better planned. The actions that must be taken on the components include checking for wear and lubrication so that these components are always in good use. Based on the results of the calculation of the reliability of the screw coal feeder machine, the reliability of the screw feeder leaf component is 95.3% and the screw feeder casing component is 94.6%. This can also be seen from the mean time between failure (MBTF) for the leaf screw feeder component of 116.66 hours and the MBTF for the casing screw feeder component of 142.85 hours. With the application of the Ishikawa diagram and FMEA on the screw coal feeder maintenance system at PT XYZ, the maintenance implementation becomes better planned. the reliability of the screw feeder leaf component is 95.3% and the screw feeder casing component is 94.6%. This can also be seen from the mean time between failure (MBTF) for the leaf screw feeder component of 116.66 hours and the MBTF for the casing screw feeder component of 142.85 hours. With the application of the Ishikawa diagram and FMEA on the screw coal feeder maintenance system at PT XYZ, the maintenance implementation becomes better planned. the reliability of the screw feeder leaf component is 95.3% and the screw feeder casing component is 94.6%. This can also be seen from the mean time between failure (MBTF) for the leaf screw feeder component of 116.66 hours and the MBTF for the casing screw feeder component of 142.85 hours. With the application of the Ishikawa diagram and FMEA on the screw coal feeder maintenance system at PT XYZ, the maintenance implementation becomes better planned.

***Keywords*:** FEMA method, ISHIKAWA diagram, material transporter, screw coal feeder

1. Introduction

The steam power plant (PLTU) industry generally has three main components, namely: boilers, turbines and generators. Where in the process of generating energy, the boiler becomes a combustion device with coal media so that it can heat water until it becomes steam (steam) with high pressure which is flowed to the turbine blades to rotate the turbine which is connected to a shaft or shaft with a generator so as to produce electrical energy. In the process of implementing the PLTU system, there is an important part, namely the screw coal feeder machine whose function is to carry coal that is ready to use from the hopper to the furnace for combustion as well as fuel to heat water so that it can turn water into steam (Effendi, 2014). Damage to the screw coal feeder can have a direct impact on the continuity of the energy generation process at the PLTU, so the process of maintaining and repairing this machine is very important. Due to frequent damage to the screw coal feeder, it is important to carry out damage analysis and maintenance to optimize the coal mining operation process so that it runs well and all the main components in combustion and energy generation activities can function properly and optimally. This study aims to analyze the working mechanism of the tools and components on the screw coal feeder machine and determine the causes and effects of damage and repair planning of the screw coal feeder machine. Due to frequent damage to the screw coal feeder, it is important to carry out damage analysis and maintenance to optimize the coal mining operation process so that it runs well and all the main components in combustion and energy generation activities can function properly and optimally. This study aims to analyze the working mechanism of the tools and components on the screw coal feeder machine and determine the causes and effects of damage and repair planning of the screw coal feeder machine. Due to frequent damage to the screw coal feeder, it is important to carry out damage analysis and maintenance to optimize the coal mining operation process so that it runs well and all the main components in combustion and energy generation activities can function properly and optimally. This study aims to analyze the working mechanism of the tools and components on the screw coal feeder machine and determine the causes and effects of damage and repair planning of the screw coal feeder machine.

2. Materials and Methods

Screw Feeders

The screw feeder consists of a cylinder, a shaft whose surface has threads wrapped around it. The material that can be moved by the screw feeder is generally of the bulk material type. This material will pass through the screw gradually following the groove of the screw with units per volume of the material from it. The use of screw feeders is not limited to conveying materials in the horizontal direction. But there are also able to transport materials at a certain angle. The advantage of using a screw feeder is that the material flow rate can be adjusted.

How Screw Feeders Work

The screw coal feeder component consists of several important parts, namely, hopper, valve, bearing, motor, gear box, shaft, screw leaf, and cover. Where the components have their respective parts. The way the screw coal feeder machine works is that the refined coal is stored in the hopper down by opening a valve connected to the screw coal feeder, then the coal is pushed or transported by screw where the drive is a motor with the power needed or as needed just. The power that the motor provides is not channeled directly to the shaft but is channeled to the gear box which works as a power converter from the motor so that it becomes lighter and does not heat up easily so that its performance is more optimal.

Material Damage and Wear Theory

Damage or wear on the elements usually occurs due to errors in operation and also damage caused by factors such as corrosion, cracks and fractures. So that there is wear and tear which will cause losses in production, damage to machines, work accidents, noise and so on. The types of wear and tear, including are:

a) Friction wear (Sliding wear) that occurs on two metal or different surfaces that contact each other and move relative to each other and experience loading.
b) Abrasive wear generally occurs when metal surfaces are in contact with soil, or rock, coal sand and other particles.
c) Fritting wear is wear and tear that occurs when two objects or surfaces that are shaped to move back and forth between each other can occur in pressfied bearing joints, and
d) Wear and tear Corrosion that occurs when two metal objects are subjected to hard particles with a certain speed

Definition of Screw Coal Feeder

In the combustion technique, the materials or solid particles used are sometimes solid materials that are harmful to humans. For this reason, it is necessary to have tools for importing these materials, bearing in mind the limitations of human capabilities, both in terms of the capacity of the materials to be transported and work safety. One type of transport that is often used is a conveyor which functions to transport industrial materials in solid form, while the fuel feeder itself is the application of a conveyor in a smaller form. According to (Rantawi, 2013) The choice of means of injecting solid material fuels depends, among other things: the capacity of the material being handled, the distance the material is moved, the transport conditions: horizontal, vertical or inclination, size, shape, and material properties (properties),

The feeder is a short conveyor that serves to feed fuel into the combustion chamber. Screw Conveyor (Screw Conveyor) is the most appropriate type of conveyor for transporting small and light solid materials. Its use in the capacity of moving small solid fuels that can be modified in dimensions is called a screw conveyor feeder.

Consideration of Tool Operation Functions

According to (Sajima, 2012), several considerations that must be met in designing technical related tools include:

a) Tool constructionas simple as possible.
b) Has the ability to work more than the previous tool.
c) Strong, safe and comfortable in operation.
d) Does not cause adverse side effects.
e) Easy in maintenance.

Material handling equipment is equipment used to move heavy loads from one place to another within a short distance. Material transfer machines only move loads in a certain amount and size and a certain distance by moving materials in a vertical, horizontal direction, and or a combination of both(Suhairi, 2019).

Transfer machines (material transporters) can be divided into three groups, namely:

a. Lifting equipment, namely equipment intended for moving unit loads in the form of batches, egThese are: lifting machines, windlass, jacks, mobile cranes, tower cranes and elevators
b. Transfer equipment (conveyor),is equipment intended for the transfer of bulk loads (many particles, homogeneous) as well as unit loads continuously. Examples of transfer machines include: screw conveyor, belt conveyor, pneumatic conveyor, and vibrator conveyor.
c. Surface and overhead equipment, namely equipment intended for moving bulk and unit loads, both batch and continuous, for example scappers, excavators, bulldozers, and others.

FMEA method

The Failure Mode and Effect Analysis (FMEA) method is a structured procedure and action to identify and prevent as many failure modes as possible. FMEA is used to identify the sources and root causes of a quality problem. A failure mode is anything that includes defects and failures in design, conditions outside the limits of predetermined specifications, or changes in the product that cause disruption of the function of the product.

There are many variations in the FMEA details, but all of them aim to make improvements by including:

a) Identify failure models in components, equipment, and systems.
b) Determine the potential impact on the equipment, systems associated with each failure mode, and.
c) Make recommendations to increase the reliability of components, equipment, and systems.

There are four main steps in the performance of the FMEA, namely:

a) Defining the system, its functions and components.
b) Identify the cause of component failure.
c) Studying the consequences of causing component damage, and
d) Conclusions and recommendations.

The consequences of each cause of failure in the functioning of a system as well as in components can be studied systematically and predictably. As a result described it can be assumed that there is one cause of the error and the other components can operate normally(Suparjo, 2018).

After carrying out all the steps above, the analysis will describe the conclusions in the object of research. With the results shownto determine the entire picture of the causes of failure and the consequences that arise in the operating system that have been taken into account in the design, identification of a damage, the causes of failure are widely considered from the consequences that arise in system functions, identify secondary damage and other damages, and design appropriate maintenance procedures relationship between each cause of failure.

Cause Failure Mode Effect (CFME)

*Cause Failure Mode Effect*is the development of a cause and effect diagram and is used to detect the root causes of problems. The data for making CFME is the data used in the cause and effect diagram. For each cause on the causal diagram, look again at what the cause is as the root cause, by continuously asking why this happened until there are no more answers that can be given. The CFME results will make it easier to create a Cause Failure Mode Effect Analysis. CFME aims to help identify effects, failure modes, and root causes of problems. Cause and Effect This diagram is also called a fishbone diagram because it looks like a fish, or it is also called an Ishikawa diagram, according to the illustration in fig. 1 (Tansah, 2017).

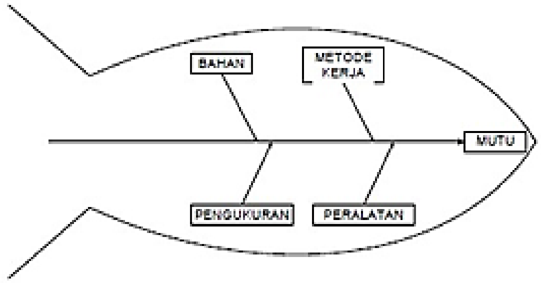

Image 1. Cause and Effect Diagram (Winaya, 2009)

Calculation of the Reliability Function

Mathematically, the magnitude of machine reliability for a certain processing time (t) is obtained from one minus the probability of damage occurring during the operating time t. The reliability function is according to the following equation:

$$R(t) = e^{-\lambda t} \quad (1)$$

$$R(t) = 1 - f(t) \quad (2)$$

Where:

R(t) = Reliability Function
Q = Overall Operating Time
F(t) = Damage Probability
F = Total Damage
λ = Damage Rate

Furthermore, if t goes to infinity, then R(t) goes to zero. F(t) is the distribution of the damage function or the unreliability function.

The Unreliability function F(t) is as follows:

$$F(t) = 1 - e^{-\lambda t} \quad (3)$$

Unreliable Function

Mathematically, the magnitude of machine unreliability for a certain processing time (t) is obtained from one minus the probability of damage occurring during the t operating time. The damage probability function refers to the reliability parameter as the following equation:

$$R(t) = e^{-\lambda t} \quad (4)$$

$$R(t) = 1 - f(t) \quad (5)$$

Where:

R(t) = Reliability of function

t = Overall Operating Time
F(t) = probability of damage
F = amount of damage
λ = damage rate

If t goes to infinity, then R(t) goes to zero. F(t) is the distribution of the damage function or the unreliability function. The unreliability function F (t) is as follows:

$$F(t) = 1\text{-}e\text{-}\lambda t \quad (6)$$

Calculation of Average Time Between Maintenance (MTBM)

The average time between maintenance or the mean time between maintenance can be calculated based on the need for preventive maintenance (scheduled) and corrective maintenance (unscheduled), according to the following equation:

$$MTBM = \frac{Total\ Waktu\ Efektif\ Oprasi\ Mesin}{Frekuensi\ Maintenance\ Preventif + Korektif} \quad (7)$$

$$fpt = \frac{1-(\lambda\ x\ MTBM)}{2!} \quad (8)$$

$$MTBF = \frac{1}{\lambda} \quad (9)$$

Where :
MTBM = average time between maintenance(Mean Time Between Maintenance)
λ = damage rate
fpt = preventive maintenance rate
MTBF = average time between failures (Mean Time Between Failures)

Furthermore, it can be calculated as the following equation:

$$M = MTBM\ (\lambda\ x\ Mct) + (fpt\ x\ Mpt) \quad (10)$$

Where:
Mct = Average time of corrective maintenance
Mpt = Average preventive maintenance time
M = Active maintenance time

Rate of Damage (Failure Rate)

The failure rate is the rate at which failure occurs at a specified time interval. Damage rate (λ) is formulated as follows:

$$\lambda = \frac{f}{t} \quad (11)$$

Where:
λ= Damage Rate
F = Total Damage incurred
Q = Overall Operation Time

3. Results

Component damage data

Data on damage to the screw coal feeder machine components in the last 6 (six) months at PT. XYZ is as table 1.

Table 1. Damage Data on Screw Coal Feeder Components

N. Komponen	Bulan						Total
	Juli	Agus	Sep	Okt	Nov	Des	
Daun *Srew Feeder*	1	2	1	1	2	1	8
Casing Screw Feeder	2	1	1	2	1	2	9

The above data was obtained through the Screw Coal Feeder Oprating document and the Screw Coal Feeder Sperpart catalog provided by PT XYZ's maintenance department during the period to be reviewed.

Machine effective working hours data

Furthermore, data on the time (number) of effective working hours of PT XYZ's screw coal feeder machine operation are as shown in table 2.

Table 2. Data on Effective Working Hours of Screw Coal Feeder Machines

Bulan	Hari Kerja	Jam Kerja	Total Jam Kerja Efektif (Jam)
Juli	25	8	200
Agustus	26	8	208
September	25	8	200
Oktober	26	8	208
November	26	8	208
Desember	24	8	192
Jumlah			1216

The data above was obtained through interviews with employees and the document Oprating Inst Screw Coal Feeder and Sperpart catalog Screw Coal Feeder provided by maintenance.

Machine corrective maintenance data

Corrective maintenance data that has been carried out on the screw coal feeder machine at PT XYZ is as shown in table 3.

Table 3. Corrective maintenance data of screw coal feeder machine

Jenis Komponen	Total Waktu Pemeliharaan Korektif (Jam)	Banyaknya Pemeliharaan Korektif (Kali)
Daun *Srew Feeder*	16	8
Casing Screw Feeder	18	9
Jumlah	34	17

The data above was obtained through interviews with employees and documents on the Oprating Inst Screw Coal Feeder and Sperepart catalogs of the Screw Coal Feeder provided by maintenance. Furthermore, based on the data above, the mean time corrective maintenance (MCT) can be calculated as follows:

$$\text{MCT} = \frac{Total\ Waktu\ Pemeliharaan\ Korektif}{Banyaknya\ Pemeliharaan\ Korektif} = \frac{34}{17} = 2\ \text{Jam}$$

Preventive maintenance data

Furthermore, the preventive maintenance data for the screw coal feeder machine components is as shown in table 4.

Table 4. Data on Preventive Maintenance of PT XYZ's screw coal feeder machine components

Jenis Komponen	Total Waktu Pemeliharaan Preventif (Jam)	Banyaknya Pemeliharaan Preventif (Kali)
Pemeliharaan Mingguan	8	1

The data in table 4 above were taken for 6 months which were included in the calculation range and were sampled based on damage data on 2 (two) types of components, namely screw feeder leaves and screw feeder casing.

Failure Mode and Effect Analysis (FMEA)

FMEA is a method that aims to evaluate system design by considering various types of damage from the system by considering various types of damage from the system that occurs from components, analyzing the effects of component damage from critical systems can be assessed and the actions needed to improve design and eliminate or reduce the probability of critical damage methods can be seen in table 5.

Table 5.FMEA screw coal feeder components

Komponen	Function	Functional Failure	Failure Mode	Failure Effect
Daun screw feeder	Untuk mendorong atau mengangkut batubara menuju ke ruang bakar	Terjadinya pecah atau rusak di bagian daun screw atau lepasnya sambungan las pada poros	Menyebabkan putaran motor menjadi berat dan mudah panas selain itu tenaga motorpun berkurang	Batubara yang diangkut tidak maksimall trangkut ke ruang bakar akibat putaran motor yang berkurang atau daun screw yang pecah atau terlepas dari poros sehingga pembakaran tidak optimal
Casing screw feeder	Untuk menjaga pengangkutan batubara tetap berada di jalurnya	Terjadinya pecah atau robek dibagian casting	Menyebabkan batubara keluar dari jalurnya membuat bearing lebih cepat aus akibat tertekan poros dan mengakibatkan poros tertekan	Batubara yang diangkut tidak maksimal terangkut ke ruang bakar akibat keluar dari jalurnya dan dapat menyebabkan kerusakan pada komponen lainnya.

Failure mode analysis and effect analysis is carried out to see the various types of damage to the system that occur from components, analyze the effects on system constraints by tracing the effects of component damage from critical systems can be assessed and the actions needed to repair critical component damage .

In the corrective action taken, the components were damaged which resulted in the engine not working optimally. From the results of FMEA processing, damaged components must be replaced immediately. In this replacement, it must be done as soon as possible so that the damaged component does not damage other components. The actions that must be taken on these two components include Srew Feeder Leaves and Screw Feeder Casing, which must be checked for wear and lubrication so that these components are always good in their use and the need for planned maintenance and regular replacement (Winaya, 2009).

Damage Rate

Damage rate (λ) of the Screw Coal Feeder machine components and the mathematical equations used to find the damage rate using the formula are as follows:

$$\lambda = \frac{Banyak\ Pemeliharaan\ Korektif}{Jumlah\ Jam\ Efektif\ Oprasi\ Mesin}$$

Breakage rate for Coal feeder srew leaf components:

$$\lambda = \frac{8}{1216} = 0{,}006\ \text{kerusakan/jam}$$

Damage rate for screw feeder casing components

$$\lambda = \frac{9}{1216} = 0{,}007\ \text{kerusakan/jam}$$

Based on the calculation above, the Leaf Srew Feeder component will suffer damage of

0.006 damage/hour and Casing Screw Feeder will suffer damage of 0.007 damage/hour.

MTBF Machine Components

Mean Time Between Failure (the average time between failures) can be calculated as follows:

$$\text{MTBF} = \frac{1}{\lambda}$$

where, the MTBF for the screw feeder leaf component is:

$$\text{MTBF} = \frac{1}{0{,}006} = 116{,}66 \text{ jam} = 6{,}94 \text{ x } 3 \text{ minggu}$$
$$= 21 \text{ hari}$$

And MTBF for screw feeder casing components

$$\text{MTBF} = \frac{1}{0{,}007} = 142{,}85 \text{ jam} = 5{,}95 \text{ x } 3 \text{ minggu}$$
$$= 18 \text{ hari}$$

Based on the calculation above, the Daun Srew Feeder component will be damaged after 21 days of operation, while the Casing Screw Feeder will be damaged after 18 days of operation.

Unreliability function

The unreliability function can be defined as the probability of a component failure occurring within a time span (t), and can be calculated as follows:

F(t)= 1-e-λt

Where the unreliability function for the screw feeder leaf component for t = 8 hours is:

F(8) = 1-e-0.006x8 = 0.047 = 4.7 %

Furthermore, the unreliability function for the Casing Screw Feeder component for t = 8 hours is:

F(8) = 1-e-0.007x8 = 0.054 = 5.4 %

From the calculation above, the probability of damage occurring to the Leaf Screw Feeder component is 4.7% in percentage, while the probability of damage occurring to the Casing Screw Feeder component is 5.4% in percentage.

Reliability Function

The reliability function can be interpreted how often the component is damaged at time (t) and the mathematical equation is as follows:

R(t) = e-λt

Where is the reliability function for the Leaf Screw Feeder component for t = 8 is:

R(8) = e-0.006x8 = 0.953 = 95.3 %

Furthermore, the reliability function for the Casing Screw Feeder component for t = 8 is:

R(8) = e-0.007x8 = 0.946 = 94.6 %

Based on the calculation above, for the screw feeder leaf component the frequency of damage is 95.3% which is classified as often damaged, then for the screw feeder casing component it is 94.6%. The reliability value of the screw feeder casing components is slightly lower than the screw feeder leaves. In general, the level of frequency of damage to the two components can be classified as high or often experience damage.

Average Time Between Maintenance

The mean time between maintenance (MBTM) includes preventive maintenance (scheduled) and corrective maintenance (unscheduled).

The calculation of the machine's MBTM is as follows:

$$\text{MTBM} = \frac{Total\ Waktu\ Efektif\ Oprasi\ Mesin}{Frequensi\ Pemeliharaan\ Preverentif + Korektif}$$

MTBM for Leaf Screw Feeder components:

$$\text{MTBM} = \frac{1216}{28+8} = \frac{1216}{36} = 33{,}8 \text{ jam} = 1{,}4 \text{ hari}$$

Furthermore, the MTBM for the Casing Screw Feeder component is:

$$\text{MTBM} = \frac{1216}{28+9} = \frac{1216}{37} = 32{,}8 \text{ jam} = 1{,}3 \text{ hari}$$

Mean Time Between Failure (average time) From the calculation results above, the Leaf Screw Feeder component must be maintained every 33.3 hours or 1.4 days once a day, and for the Casing Screw Feeder component, maintenance must be carried out every 32.8 hours. or 1.3 days 1 time.

Fpt Damage to Machine Components

Fpt or active maintenance frequency can be calculated as follows:

$$\text{Fpt} = \frac{1-(MTBM\ x\ \lambda)}{MTBM}$$

Fpt for Leaf Screw Feeder components

$$\text{Fpt} = \frac{1-(33{,}8\ x 0{,}006)}{33{,}8} = 0{,}0235$$

Furthermore, the Fpt for the Casing Screw Feeder component is:

$$\text{Fpt} = \frac{1-(32{,}8\ x 0{,}007)}{32{,}8} = 0{,}0234$$

Based on the calculation results for the Screw Feeder Leaf component, 0.0235 maintenance/hour preventive maintenance must be carried out, while for the Casing Screw Feeder component, 0.0234 maintenance/hour preventive maintenance must be carried out.

Mean Maintenance Time (Mct)

Mean Maintenance Time (Mct) is the time required for corrective maintenance or component replacement per 1 component, the equation used is as follows:

$$\text{Mct} = \frac{Total\ Waktu\ Pemeliharaan\ korektif}{Banyaknya\ Pemeliharaan\ Korektif}$$

For Leaf Screw Feeder components

$$\text{Mct} = \frac{16}{8} = 2\ \text{jam}$$

For Screw Feeder Casing components

$$\text{Mct} = \frac{18}{9} = 2\ \text{jam}$$

From the calculation above, to replace 1 component of the Leaf Screw Feeder it takes an average of 2 hours, while to replace 1 component of the Casing Screw Feeder it takes an average of 2 hours.

Average Active Maintenance Time (M)

The average time of active maintenance (M) is the time needed to carry out preventive and corrective maintenance.

$$\text{M} = \frac{(\lambda\ x\ Mct) + (Fpt\ x\ Mpt)}{\lambda + Fpt}$$

Average time of active maintenance for Leaf Screw Feeder components

$$\text{M} = \frac{(0{,}006\ x\ 2) + (0{,}0235\ x\ 8)}{0{,}006 + 0{,}0235} = 6{,}77\ \text{jam}$$

The average active maintenance time for the Casing Screw Feeder component

$$\text{M} = \frac{(0{,}007\ x\ 2) + (0{,}0234\ x\ 8)}{0{,}007 + 0{,}0234} = 6{,}61\ \text{jam}$$

From the results of the calculation above, it takes 6.77 hours to carry out preventive and corrective maintenance (routine maintenance + replacement) of the Screw Feeder Casing component, while to carry out preventive and corrective maintenance (routine maintenance + replacement) of the Casing Screw Feeder component it takes 6.61 hours.

Maintainability are factors that show a characteristic of system engineering and have characteristics to facilitate maintenance, accuracy, safety and economic factors in carrying out functions. The maintaininibility analysis includes the following functions:

a) Leaf Screw Feeder Components

- The average corrective maintenance time (Mct) = 2 hours
- The average preventive maintenance time (Mpt) = 8 hours
- The average time between maintenance (including corrective and preventive) mean time between maintenance (MTBM) = 33.8 hours. So the Screw Coal Feeder machine must be maintained for damage to the Screw Feeder Leaf components every 33.8 hours.
- Scheduled individual maintenance frequency / frequency preventive time (Fpt) = 0.0235 hours.
- The mean maintenance time (M) = 6.77 hours.

b) Casing Screw Feeder Components

- The average corrective maintenance time (Mct) = 2 hours
- The average preventive maintenance time (Mpt) = 8 hours
- The average time between maintenance (including corrective and preventive) mean time between maintenance (MTBM) = 32.8 hours. So the Screw Coal Feeder machine must be maintained for damage to the Casing Screw Feeder components every 32.8 hours.
- Scheduled individual maintenance frequency / frequency preventive time (Fpt) = 0.0234 hours.
- The mean maintenance time (M) = 6.61 hours

4. Discussion

Ishikawa Diagrams (Cuase and Effect diagrams)

In determining the damage that occurs, 4 possible factors are taken that affect the components resulting in non-compliance or damage whether the factor (machine, human, material, or method). In identifying the root cause of the problem from the component that was damaged and assisting in the preparation of this practical work report, a fishbone diagram (cause and effect diagram) is used.

The causes that affect the damage to the components of the Leaf Srew Feeder and Casing Screw Feeder can be seen in the cause and effect diagram in gbr. 2.

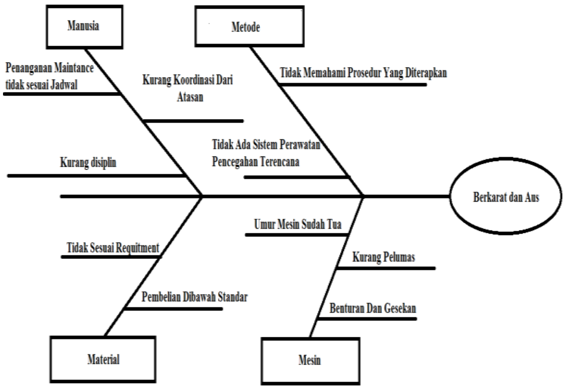

Figure 2. Cause and Effect Diagram of Srew Feeder Leaf Components and Screw Feeder Casing

Based on the Ishikawa diagram above, several causes that affect damage can be described, namely:

a) The causes that affect the components of the Srew Feeder Leaf wear and rust are as follows:

- Material factors, namely due to substandard purchases, and not appropriaterequests or requirements.
- The method factor is not complying with the procedures applied, and there is a planned preventive replacement maintenance system.
- Human factors, namely handling maintenance not according to schedule, lack of coordination from superiors, and lack of mechanical discipline.
- Machine factors, namely collision and friction between casing and screw leaves, lack of lubrication on bearings and gear box, rust or wear on the gear box andbearings, and the age of old machines or components.

b) The causes that affect the components of the Casing Screw Feeder are worn out and corroded are as follows:

- Material factors, namely due to substandard purchases, and not appropriaterequests or requirements.
- The method factor is not complying with the procedures applied, and there is a planned preventive replacement maintenance system.
- Human factors, namely handling maintenance not according to schedule, lack of coordination from superiors, and lack of mechanical discipline.
- Machine factors, namely collision and friction between the Casing and the Screw Leaf, lack of lubrication on the bearings and Gear box, rust or wear on the gear box and bearings, and the age of the machine or components that are old.

5. Conclusion

Damage that occurs in the Screw Coal Feeder machine, especially the components of the Screw Feeder Leaf and the Casing Screw Feeder are generally caused by several factors, such as: humans, machines, foreign materials, and the method of maintaining the machine. Based on the FMEA method, the effects of the failure of the screw coal feeder machine are: damage/tears in the screw leaf and loose welding joints on the shaft, the result is that the coal being transported is not optimal due to reduced motor rotation and damage to the casing which can result in rock transport paths embers become inconsistent. The low reliability of the Leaf Screw Feeder component is 95.3% and the Casing Screw Feeder component is 94.6%. The MTBF of the Screw Feeder leaf component is 116.66 hours and the Casing Screw Feeder component is 142.85 hours.

Referances

1. Effendi, I. (2014). Penerapan Variable Frequency Drive Pada Motor Fuel Screw Feeder untuk Bahan Bakar Pada Sistem Boiler di PT. Lontar Papyrus Pulp & Paper Industry. Jurnal Desiminasi Teknologi, 2(1).
2. Prabowo, D.M., 2018. Analisis Pengaruh Kecepatan Dan Massa Beban Pada Conveyor Belt Terhadap Kualitas Pengemasan Dan Kebutuhan Daya Dan Arus Listrik Di Bagian

Produksi Pt. Indopintan Sukses Mandiri Semarang (Doctoral dissertation, Universitas Muhammadiyah Semarang).

3. Rantawi, A. B. (2013). Perancangan Unit Transfer (Screw Conveyor) pada Mesin Pengisi Polibag untuk Meningkatkan Efektvitas Kinerja di Bidang Pembibitan. Jurnal Citra Widya Edukasi, 5(1), 60-67.
4. Sajima, S., Husnurrofiq, D. and Sudaryadi, S., 2012. Rancang Bangun Screw Feeder Sebagai Perangkat Dukung Peleburan Konsentrat Zirkon.
5. Suhairi, M., 2019. Analisis Variasi Pembebanan Dan Sudut Kemiringan Pada Mesin Screw Conveyor (Doctoral dissertation).
6. Suparjo, A.R. and Rochman, A., 2018. Manajemen Risiko Operasional Pada PT. ABC Dengan Menggunakan Metode FMEA. J. Has. Penelit. Untag Surabaya, 3(02), pp.106-112.
7. Tansah Lugina, L. (2017). Analisis Kerusakan Komponen Pada Mesin Goss Universal 50 Dengan Menggunakan Failure Modes And Effect Analysis (FMEA) Di PT. Pikiran Rakyat Bandung (Doctoral dissertation, Universitas Komputer Indonesia).
8. Winaya, I. N. S., Ardhikayana, I. B., & Tenaya, I. G. N. P. (2009). Fuel Feeder Tipe Ulir Untuk Bahan Bakar Biomasa. Jurnal Ilmiah Teknik Mesin CakraM Vol, 3(2), 176-183.