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Analysis of the Causes of Failure and Damage to Conveyor Scraper for Transporting Oil Palm Bunches at PT. Socfindo Seunagan Plantation using the FMEA Method (Failure Modes Effect Analysis)

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ABSTRACT

PT. Socfindo Kebun seunagan is a company engaged in the plantation and processing of Fresh Fruit Bunches (FFB) into Crude Palm Oil (CPO). Fresh Fruit Bunches before processing, are first transported using a conveyor to be processed into oil (CPO) from a sterilizer. Based on the analysis of damage and failure that often occurs in scrapper conveyor parts, damage is hampered by the productivity of the company. The purpose of this study is to analyze the causes of failure and damage that occur on the scrapper conveyor by calculating the RPN (Risk Priority Number) value of each failure and damage that occurs to determine maintenance actions that need to be followed up. The results of the analysis showed that there were failures and potential damage to the scrapper conveyor, including the release of the scrapper conveyor chain connecting of 135 RPN, the wear of the scrapper conveyor chain of 40 RPN, and the rupture of the bearing of 56 RPN. Connecting the scrapper conveyor chain is more often damaged than other parts, so monitoring and repair are prioritized. Overall, the factors causing damage and failure are caused by lack of routine maintenance so that they are damaged.

I. Introduction

Oil palm plantations are one of the communities developed by the Indonesian state. The use of palm oil today continues to be developed to meet market needs such as: soap, butter, frying fat, coffee bleach, milk filler, biscuit creamer, and can also be used as biodiesel fuel. PT. Socfindo seunagan is one of the companies engaged in processing Fresh Fruit Bunches (FFB) into Crude Palm Oil (CPO). Socfindo Kebun Seunagan for processing fresh fruit bunches into oil (CPO), using a Scrapper station as a means of transporting fruit that has been boiled from a sterilizer to be poured into tippler and transported using a scrapper conveyor [1].

During the scrapper process, there are several supporting components that act like scrapper conveyors. The type of conveyor used at PT. Socfindo Kebun Seunagan is a chain conveyor. The conveyor chain consists of chains that are tied to each other and connected to the electromotor as a drive. The use of scrappers often fails on the scrapper conveyor which causes delays in the production process [2].

The problem that often occurs is the failure and damage to the scrapper machine. Based on the results of the analysis, failures and damage often occur to scrapper conveyor parts. The failure and damage are caused by the detachment of the scrapper conveyor chain connector, the scrapper conveyor chain is worn, and the bearing is broken [3].

The method used in this study uses the Failure Modes Effect Analysis (FMEA) method. This FMEA method is a technique in the industrial world to analyze and identify failures that occur from

a system, design, and production process. The use of the FMEA (Failure Modes Effect Analysis) method aims to determine the cause of damage and the level of risk of failure on the scrapper conveyor [4][5].

The FMEA method has been applied to detect damage to the 350 RPN Al Pin type Lathe. The results of the analysis revealed that there were 6 components that were damaged with RPN values as follows: Tailstock 120 RPN, Tool post 90 RPN, Lathe Light 63 RPN, Tailstock Bolt 60 RPN, Carriage Shaft 60 RPN, and Carriage Rail 60 RPN [6]. Other studies have also been conducted to analyze the failure of fuel carriers or scrapper incline fiber using the FMEA method. In this study, it was found that 5 parts failed, namely the bucket chain broke, the bucket iron broke, bearings, the drop chain broke, and the electromotor was scorched. The highest RPN occurs in electro motors with a value of 160 RPN, which is caused by lack of maintenance on the engine, causing the electric motor on the incline fiber scraper machine to be damaged.

II. Research Methods

A. Time and Place

This research was carried out with a monitoring period of four months on the PKS scrapper conveyor, (PT. Socfindo Kebun Seunagan located in Purwodadi Village, Kuala Coastal District, Nagan Raya Regency, West Aceh.

B. Object of Research

Analysis of failure and damage of the scrapper conveyor station at PT. Socfindo Kebun Seunagan on certain components can cause a decrease in the company's production performance. Such components include conveyor chain wear, conveyor chain connector, and bearings. The FMEA method is used to evaluate the risk level of scrapper conveyor failure with the aim of identifying the causes of damage and failure and assessing the level of risk using the RPN (Risk Priority Number) value. The RPN value is obtained by multiplying three indicators: severity (S), incidence rate (O), and detection rate (D). [8].

C. Stages of Research

The stages of this research are as follows:

The stages of the course of this research start from the preliminary stage, the stage of determining the formulation of the problem, the purpose of research, the limitation of the problem, the stage of data collection or data processing, the analysis stage, the discussion stage, the stage of drawing conclusions, and the stage of making articles.

D. Scrapper Machine

Scrapper Machine is a tool that has many functions in transferring fresh fruit bunches at PT. Socfindo Kebun Seunagan, which is to load, transport and unload cargo at once through a scrapper conveyor [9].

Fig. 1. Scrapper Machine

Scrapper Machine Specifications	
Chain Brand	Brooks Andel
Payload Capacity	2 Ton
Quantity (units)	1
Rotation axle (rpm)	21
Electromotor Power Hp/rpm	15/1460

E. Chain Conveyor Scrapper

The type of scrapper conveyor used at PT. Socfindo Kebun Seunagan is a Chain Conveyor Scrapper. Chain Conveyor Scrapper is a conveyor with chains that are bonded to each other to pull from the driving electromotor. The use of this conveyor chain has decreased due to high maintenance and many problems faced [10].

Fig. 2. Chain Conveyor Scrapper

F. How to Calculate RPN Using the FMEA Method

How to calculate the Risk Priority Number (RPN) using the FMEA method is as follows:

a. Identify failures and potential damage that occurs
b. Determine the severity of the effects (severity) of the failure and the potential damage that occurs. The assessment is based on the severity rating indicator on a scale of 1-10 in Table 1 below [11]:

Table 1. Ratings Severity

Effect	Criteria	Ranking
None	Realized by the operator not by the consumer	1
Very Slight	No effect on smooth production Does not have a significant effect on the product	2
Slight	Users may be aware of the influence on production but the effect is very small	3
Minor	Smooth production may be disrupted, consumers realize little effect on the product	4
Moderate	The influence seen through the production process performance will decline slowly – slowly dissatisfied customers	5
Severe	Smooth production is disrupted, production is running but performance is declining, consumers are not satisfied	6
High Severity	Downtime has increased significantly, product performance has decreased, consumers have been very dissatisfied	7
Very High Severity	Downtime increases significantly and has an impact on finances, products cannot be used but are safe, consumers are very dissatisfied	8
Extreme severity	Failures that occur are likely to cause danger, work safety must be considered	9
Maximum Severity	Failures that occur inevitably pose danger	10

c. Determine the frequency rate of possible failures and damage that can occur (occurrence). The assessment is based on the occurrence rating indicator on a scale of 1-10 in Table 2 below:

Table 2. Ratings Occurrence

Effect	**Criteria**	**Ranking**
Extremely unlikely	Failure is highly unlikely	1
Remote Likelihood	The possibility of failure is rare	2
Very low likelihood	Very few failures are possible	3
low likelihood	A slight failure is possible	4
Moderately low likelihood	The probability of failure is moderate	5
Medium likelihood	Sufficient probability of High failure	6
Moderately High likelihood	High probability of failure rate	7
High Likelihood	The probability of failure rates is very high	8
Very High likelihood	Possible failures	9
Extremely unlikely	Failure is almost certain	10

d. Determine the level of effectiveness of detection of a control against failures and damage that occurs (Detection). The assessment is based on rating detection indicators on a scale of 1-10 in Table 3 below:

Table 3. Ratings Detection

Effect	**Criteria**	**Ranking**
Extremely unlikely	Controls needed to be aware of defects	1
Very High Likelihood	Control is indispensable for detecting failures	2
High likelihood	The control has high effectiveness to detect	3
Moderately high likelihood	The control has a rather high effectiveness for detecting	4
Medium likelihood	Control has moderate effectiveness to detect	5
Moderately low likelihood	The control has a rather low effectiveness to detect	6
Low likelihood	Low probability of detection	7
Very low likelihood	The probability of detection is very low	8
Remote likelihood	Control has little effect on detecting defects	9
Extremely unlikely	The control will not be able to detect defects	10

Then calculate the value of Risk Priority Number (RPN), the estimated risk that occurs is calculated using the formula or RPN formula as follows [12].

$$\boldsymbol{RPN} = \text{Severity x Occurrence x Detection}$$

Where:

Severity = The seriousness of the effect
Occurrence = How often causes appear
Detection = How to detect the cause of the failure

III. Results And Discussion

A. Analysis of Types and Causes of Failure on Scrapper Conveyor

Based on the results of research, often failures on the scrapper conveyor are caused by several factors. One of the main factors is the scrapper conveyor load that exceeds the predetermined capacity, resulting in detachment of the scrapper conveyor chain connector, chain wear, and bearing damage.

The following is the result of the classification of types of failures and damage along with their causes that occur on the scrapper conveyor.

Fig. 3. Failure Analysis on Conveyor Scrapper

Table 4. Classification of types and causative factors of failure

Part	Failures and Malfunctions	Cause
Conveyor Scrapper	Connecting the detached conveyor chain	Rusty and overcapacity connecting pins
	Conveyor chain wear	Fresh Fruit Bunches (FFB) input load that exceeds conveyor capacity
	Ruptured bearings	Improper lubrication

After conducting an analysis of the types and factors that cause failure in scrapper machines at PT. Socfindo Kebun Seunagan, several factors causing failure on the scrapper conveyor can be identified, namely:

- The detachment of the scrapper conveyor chain connector is caused by rust on the connecting pins and exceeded capacity.
- Wear on the conveyor occurs due to the input load of Fresh Fruit Bunches (FFB) that exceeds the capacity of the conveyor.
- Bearing damage is caused by lubrication errors.

Overall, the main factors causing these breakdowns and failures can be attributed to human operators not paying enough attention to conveyor conditions, lack of maintenance measures, and non-compliance with established standard operating procedures (SOPs).

B. Analysis Using Failure Mode and Effect Analysis (FMEA) Method

After analyzing the failure and damage to the scrapper conveyor, the severity, occurrence, and detection values obtained are as follows:

Table 5. Determination of Severity, Occurrence, and Detection Values

No	Failure	Severity (S)	Occurrence (O)	Detection (D)
1.	Connecting the detached conveyor chain	9	3	5
2.	Conveyor chain wear	5	4	2
3.	Ruptured bearings	7	2	4

RPN Value Calculation

After obtaining the Severity, Occurrence, and Detection values, the RPN value will be calculated, along with the calculation:

a. Detachment of Chain Connecting Conveyor Scrapper

$$RPN = SxOxD = 9x3x5 = 125$$

b. Scrapper conveyor chain wears

$$RPN = SxOxD = 5x4x5 = 40$$

c. Ruptured bearings

$$PN = SxOxD = 7x2x4 = 56$$

The following is a recapitulation of the results of calculating the RPN value of the FMEA method.

Table 6. RPN Calculation Recapitulation

No	Failure	Severity (S)	Occurrence (O)	Detection (D)	RPN
1.	Connecting the detached conveyor chain	9	3	5	135
2.	Conveyor chain wear	5	4	2	40
3.	Ruptured bearings	7	2	4	56

From Table 6, it can be seen that each failure shows a different RPN value. At the detachment of the conveyor chain connector, the recorded RPN value is 135, while the wear of the conveyor chain has an RPN value of 40, and the ruptured bearing has an RPN value of 56. The failure with the highest RPN is the detachment of the conveyor chain connector with a value of 135.

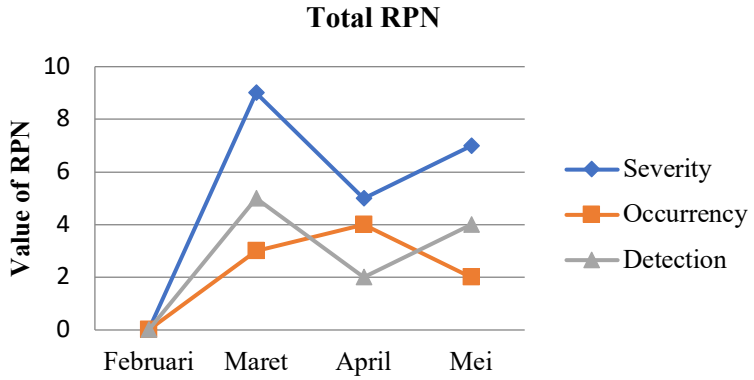

Fig. 4. Failure risk (RPN) value graph

Based on Figure 4, it can be seen that failure and damage to the scrapper conveyor began to occur in the second month to the fourth month, where in the second month there was failure and damage to the scrapper conveyor caused by the detachment of the connecting conveyor chain with values of Severity 9, Occurrence 3, and Detection 5. To get the RPN value requires the formula (S × O × D = RPN), so that 9 × 3 × 5 = 135 RPN are obtained. In the third month of failure and damage occurred due to the chain experiencing wear with values of Severity 5, Occurrence 4, and Detection 2, so that 5 × 4 × 2 = 40 RPN, In the fourth month the scrapper conveyor drive bearing broke with values of Severity 7, Occurrence 2, and Detection 4, so that 7 × 2 × 4 = 56 RPN were obtained.

Based on the level of risk of failure and damage to the scrapper conveyor, the connector of the detached conveyor chain has the highest risk of failure with an RPN value of 135, while wear on the chain has the lowest risk of failure with an RPN value of 40, and the bearing rupture with an RPN value of 56. The higher the RPN value, the higher the risk of failure or damage occurring. Therefore, the component with the highest RPN value must be a top priority for repair. In this case, the loose conveyor chain connector has the highest RPN value, so repairs to this component must be a top priority to prevent damage that can harm the company.

C. Determination of treatment measures

Based on the analysis of the FMEA method, it can be concluded that failure and damage with the highest risk is the release of the connecting chain. This is due to the lack of maintenance and inspection of the scrapper conveyor machine. Therefore, it is recommended to increase maintenance measures and carefully inspect every component of the machine that is prone to failure and damage.

In order to prevent failure and damage, it is necessary to carry out regular checks and maintenance, at least once a week, to reduce the risk of failure and damage.

IV. Conclusion and Advice

A. Conclusion

The conclusions that can be drawn from the discussion above are as follows:

a. There are three types of failures and potential damage to the scrapper conveyor, namely detachment of the scrapper conveyor chain connector, wear on the scrapper conveyor chain, and bearing rupture. The detachment of the scrapper conveyor chain connector is caused by rust on the connecting pins and overcapacity, wear on the conveyor occurs due to the input load of Fresh Fruit Bunches (FFB) that exceeds the conveyor capacity, and the bearing breaks due to lubrication errors.
b. The RPN values for each failure type are as follows: scrapper conveyor chain connecting detachment has an RPN value of 135, conveyor chain wear has an RPN value of 40, and bearing rupture has an RPN value of 56. In this case, the type of failure with the highest RPN is the detachment of the scrapper conveyor chain connecting with a value of 135, which indicates that this type of failure should be the top priority.
c. In order to prevent failures and damages, it is necessary to improve better and more thorough maintenance measures against every part of the machine that is prone to failure and damage. As a preventive measure, it is recommended to carry out checks and maintenance once every week to reduce the risk of failure and damage. In order to prevent failures and damages, it is necessary to improve better and more thorough maintenance measures against every part of the machine that is prone to failure and damage. As a preventive measure, it is recommended to carry out checks and maintenance once every week to reduce the risk of failure and damage.

B. Advice

Some important things that must be considered by PT. Socfindo Kebun Seunagan on the Conveyor Scrapper machine so that the machine is not easy to fail and damage includes the following:

a. Operators are expected to be more thorough in checking the scrapper conveyor and unloading cooked fruit (Sterilizer) on the scrapper conveyor in accordance with the predetermined capacity.
b. Regular monitoring, repair, and immediate replacement of failed components are required.

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