

# Ripple Mill Machine Failure Analysis Using the Failure Mode and Effect Analysis (FMEA) Method at PT. Ujong Neubok Dalam

Jayarullah<sup>a,1,\*</sup>, Rita Hartati<sup>b,2</sup>

<sup>a,b</sup>Teuku Umar University, Alue Peunyareng streets, Ujong Tanah Darat, 23681, Indonesia  
<sup>1</sup>jayarullah1234@gmail.com\*; <sup>2</sup>ritahartati@utu.ac.id

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## ARTICLE INFO

## ABSTRACT

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Palm oil is a plantation crop of high economic value and is one of the crops producing vegetable oil and various other derivative products. Palm oil processing is one of the factors that determine the business productivity of a palm oil mill. The smoothness of the production process is greatly influenced by the reliability of the machines used. The Ripple Mill machine is a meisen that serves as a seed breaker to separate the shell from the palm kernel. The purpose of this study is to find out or identify the damage that occurs to the Ripple Mill machine. In this study, it uses the FMEA (Failure Mode and Effect Analysis) method, which is to find out whether the level of damage that occurs can be minimized so that the damage caused can be reduced. Based on the results of the study, there are 5 failure risks that occur in the Ripple Mill engine with the component that has the highest value is the V-Belt, which is 294 RPN, while the one with the lowest value is the Ripple Plate Pipe with a Risk Priority Number value of 60 RPN.

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## I. Introduction

Palm oil processing is one of the factors that determine the success of a business in a palm oil mill. Thus, causing palm oil to become one of the superior commodities and have large yield on the economy of the country with the majority of palm oil. Therefore, it is important for a factory to pay attention to the processing process because it is certain that the processed palm oil must be produced with good quality and quality [1].

The growth of oil palm agricultural land until 2017 was 234,479 ha, with a production productivity of 437,292 tons. So that the development of the palm oil industry is increasing. Oil palm plantations have become a major plantation crop in Indonesia. Indonesia is one of the largest palm oil producers in the world [2]. This is because oil palm is a plantation crop with high economic value and is one of the crops producing vegetable oil. In addition, various palm oil derivative products with various uses also support the development of oil palm plantations. Over time, efforts to utilize palm oil will continue to increase, and the number of palm oil companies in Indonesia will continue to grow [3].

The smoothness of the production process is greatly influenced by the reliability and availability of the machines used. A machine that breaks down suddenly can disrupt the established production plan. To overcome this, it is necessary to plan engine maintenance on a scheduled basis to reduce sudden engine damage. In connection with the development of palm oil agriculture, mills urgently need palm oil processing machines to get maximum results. One of them is the Palm Kernel Breaking Machine (Ripple Mill) [4].

The Ripple Mill machine is one of the must-have machines at a palm kernel processing station that serves as a palm kernel breaker to separate the shell from the palm kernel. On the Ripple Mill



machine, there is a rotor that rotates on the Ripple Plate at rest. Then the seeds will enter between the Rotor and the Ripple Plate until they intersect and the core splits from the shell [5].

PT. Ujong Neubok Dalam (UND) is a company engaged in the palm oil industry, one of these companies is located in Ujong Lamie Village, Nagan Raya Regency which manages palm oil into crude oil (CPO). In the palm oil processing process, UND has several processing stations, namely fresh fruit bunch stations, steralization stations, threshing stations, pressing stations, clarification stations and kernel stations. Ripple Mill is located at the kernel station. The function of this Ripple Mill is as a breaker or separator of the palm shell from the palm kernel by utilizing centrifugal force (away from the center of rotation) [6].

However, in carrying out the production process of PT. UND often runs the risk of failure on Ripple Mill engines. The risk of failure that occurs in Ripple Mill is caused by several factors, namely the type of thick-skinned palm fruit or dura palm type, as well as too much nut filling which results in damage to the 19x390 Rotor Bar component so that the Ripple Mill experiences downtime and another risk that occurs in the Ripple Mill machine is the fall down of objects, both iron and equipment. The number of times the number of downtime events on the Ripple Mill machine based on company data in 2022 is 32 times. This results in the Ripple Mill machine not functioning effectively and efficiently.

Previous research by Supoyo [7], Failure Mode and Effect Analysis (FMEA) is a method that identifies, analyzes, and sorts priorities for failures that occur so that the causes and impacts of each failure will be known. This method produces a Risk Priority Number (RPN) score value which starts from the results of a recapitulation between the Severity, Occurance and Detection rating values to show the priority level of the problem that occurs. Based on the RPN calculation carried out in this study, the highest RPN value occurred in the Defect Bubble type, which was 288. Ranked second is the Defect Scratch type with an RPN score value of 180. The third is the Press failure with an RPN score of 81 and the last is the Bending failure with an RPN score of 40. Rohmah [8], The use of the Failure Mode and Effect Analysis (FMEA) method to determine the level of risk priority that has been identified according to the Risk Priority Number (RPN) value. The identification results obtained a total of 12 risks in the supplier section, raw material storage, and production processes. The highest priority risk is in the Supplier section where there is a delay from the importer and loading Shearing experiences overload which is indicated by the RPN value of 90. In addition, inaccuracy in the Shearing process is the second highest priority risk with an RPN value of 50. So it is necessary to make improvements to the highest priority risks by evaluating supplier performance.

Based on the above problems, the authors aim to determine failure, risk level and handling of failure risk using failure mode and effect analysis (FMEA) that occurs in ripple mill machines.

## II. The Proposed Method

This research was conducted at PT. Ujong Neubok Dalam Nagan Raya which is engaged in the palm oil industry. The object of this study focuses on the Ripple Mill machine at PT. UND Nagan Raya. Data collection was carried out in two ways, namely literature studies and direct observation to the field through interviews with the Maintenance Supervisor and several PT workers. UND for 4 (four) months, namely July-November 2022.

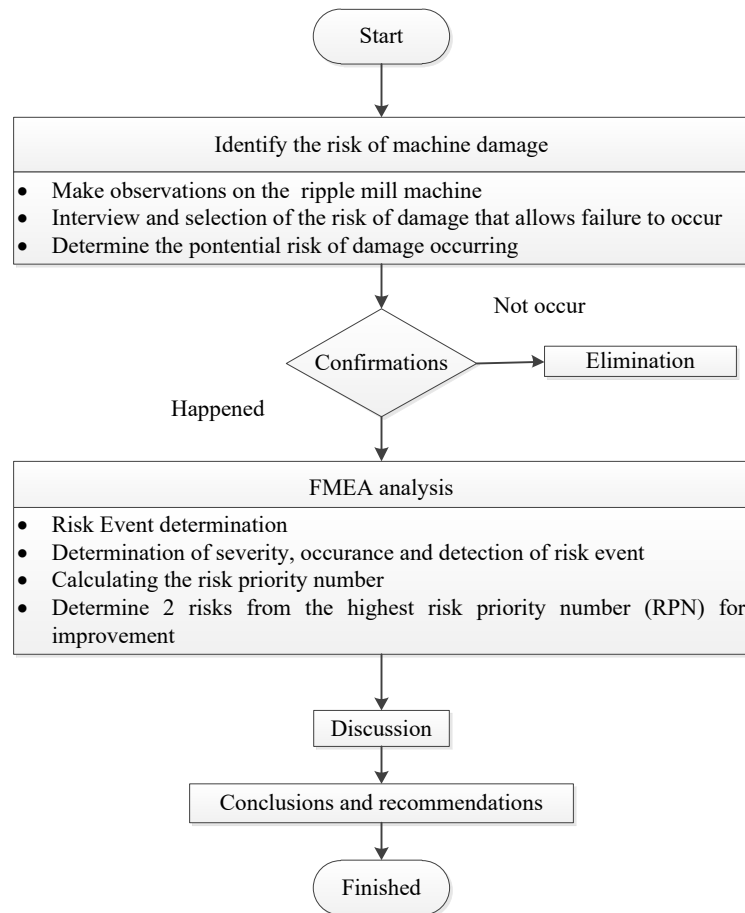


Fig. 1. Flowchart of Research Stages

Based on figure 1, the stages can be explained as follows:

1. The research started from identifying the damage (Downtime) experienced by the Ripple Mill machine. The identification was carried out by arranging the engine performance process as well as interviews with the Maintenance Supervisor and Ripple Mill machine operator to determine the problem with the machine. Then from the results of observations and interviews, it was determined the risk that might cause damage to the Ripple Mill machine.
2. Ripple Mill engine malfunction risk analysis is performed from determining the Risk Event. Risk Event The occurrence of an event that creates the potential for an event to occur that creates the potential for loss (bad results). In assessin risk, it is carried out based on severity, occurrence, and detection to obtain a Risk Priority Number (RPN) value at each risk.
3. Risk research based on the Risk Priority Number (RPN) is then ranked from highest to lowest. The highest RPN value is the value that is prioritized for repairs.

### III. FMEA Method Data Analysis

FMEA is a method used to determine or observe whether a failure rate can be analyzed or measured so that a failure can be anticipated and minimized so that the negative effects of the failure can be controlled [9]. FMEA provides three criteria for each problem that occurs, namely the Severity, Occurance, and Detection criteria, these three criteria then form a priority number (RPN), namely with the formulation  $S \times O \times D = RPN$ , where the higher the RPN, the higher the impact of the problem on the quality of the product or process so that the handler must be moved [10]. According to ref [11] in research ref [12], the definition and scale of Severity, Occurance, and Detection can be explained as follows:

#### 1. Severity

Severity is a rating or level that refers to the seriousness of the impact of a potential Failure Mode

Table 1. Severity Scale

<i>Rating</i>	<i>Effect</i>	<i>Severity Effect</i>
10	<i>Hazardous without warning</i>	Very high severity when a potential failure mode affects system safety without warning.
9	<i>Hazardous with warning</i>	Severity is very high when a potential failure mode affects system safety by lightning.
8	<i>Very high</i>	The system cannot operate with failure causing damage without jeopardizing safety.
7	<i>Excessive</i>	System inoperable with equipment failure.
6	<i>Moderate</i>	The system is inoperable with minor failures.
5	<i>Low (L)</i>	The system cannot operate without failure.
4	<i>Very Low</i>	The smooth running of production is likely to be disrupted costumers are aware of the small influence on the product.
3	<i>Minor</i>	User may be aware of the influence on the product but the effect is small.
2	<i>Very Minor</i>	The occurrence of slight interference with the operating system.
1	<i>None</i>	No effect.

2. Occurrence

Occurrence is a rating that refers to some frequency of occurrence of defects or failures. The failure frequency value indicates the frequency of a problem that occurs due to potential causes.

Table 2. Occurrence Scale

<i>Rating</i>	<i>Probability of Occurrence</i>	<i>Failure probability</i>
10	<i>Very High (VH): failure is almost inevitable</i>	>1 in 2
9	<i>High (H):</i>	1 in 3
8	<i>Failure</i>	1 in 8
7	<i>Recurring</i>	1 in 20
6	<i>Moderate (M):</i>	1 in 80
5	<i>Occasional</i>	1 in 400
4	<i>Failure</i>	1 in 2000
3	<i>Low (L): relative</i>	1 in 15000
2	<i>Little</i>	1 in 150000
1	<i>Failure</i>	< 1 in

3. Detection

Detection is a process control that will detect the specific root cause of the failure. Detection is a measurement to control failures that can occur.

Table 3. Scale Detection

<i>Rating</i>	<i>Detection</i>	<i>Possible Detection by Controlling Device</i>
10	<i>Absolute Uncertainty</i>	No controlling toll is capable of detecting the cause of the malfunction and the subsequent mode f damage.
9	<i>Very Remote</i>	Very little ability of the detecting controller tool to determine the cause of the failure and subsequent mode of failure
8	<i>Remote</i>	The probability of detecting failure of damage is very low
7	<i>Very Low</i>	The probability of the ability to detect is very low.
6	<i>Low</i>	The controller has a slightly low effectiveness for detecting.
5	<i>Moderate</i>	The ability of the controller toll is detect the cause of the failure and the subsequent mode of failure
4	<i>Moderately High</i>	Control has a rather high effectiveness for detecting failures and damage
3	<i>High</i>	Dicks have activity to detect
2	<i>Very High</i>	Control is indispensable to detect failure and malfunctions.
1	<i>Almost Certain</i>	Control is needed to be aware of detects.

#### IV. Results and Discussion

The risk identification of the Ripple Mill machine is determined from the results of interviews with maintenance supervisors and the results of field observations, so a Risk Event is obtained that affects the production process. Below are the results of the Risk Event on the Ripple Mill machine.

Table 4. Risk Event on Ripple Mill engine

<i>No</i>	<i>Defective Components</i>	<i>Damage</i>	<i>Repair Time</i>
1	<i>As Rotor</i>	Wear	6 Months
2	<i>Pipa Ripple Plate</i>	Broken	6 Months
3	<i>Bearing</i>	Broken	3 Months
4	<i>V-Belt</i>	Break	6 Months
5	<i>As Ripple Plate</i>	Broken	6 Months

Based on the results of the identification carried out, 5 types of damage risks were obtained on the Ripple Mill machine.

##### A. Risk of Damage

###### 1. As Rotor

The destruction of the Rotor Axle is due to the presence of hard materials that are too heavy such as stone and iron which makes the rotor rotation heavy so that it experiences wear on the Rotor Ace and must be repaired once every 6 months.

###### 2. Pipa Ripple Mill and As Ripple Plate

The damage to the two components is caused by the blunt jagged state of the plate, causing ineffective breakdown. The effect caused is not too heavy and the engine can still run and must also be repaired once every 6 months.

###### 3. Bearing

Damage to bearing components is caused by rotor rotation that cannot work normally or is unbalanced. The effect caused is quite heavy because it interferes with engine performance and must be repaired within 3 months.

###### 4. V-Belat

Damage to V-Belt components is caused by engine heat and oil or dust that causes friction too quickly and makes the V-Belt hot and easy to break. The effect caused is quite heavy and makes the engine performance stop and must be changed spart parts once every 6 months.

##### B. Risk Priority Calculation

Risk calculation is done to find the largest Risk Priority Number (RPN) value of a risk. So before looking for RPN, first determine the value of severity, occurrence and detection. The following are the results of the RPN calculation based on data that has been determined with the Maintenance Supervisor.

Table 5. The results of the calculation of the FMEA Method RPN

<i>No</i>	<i>Risk</i>	<i>S</i>	<i>O</i>	<i>D</i>	<i>RPN</i>
1	<i>As Rotor</i>	4	5	5	100
2	<i>Pipa Ripple Plate</i>	3	5	4	60
3	<i>Bearing</i>	6	6	4	144
4	<i>V-Belt</i>	7	7	6	294
5	<i>As Ripple Plate</i>	3	5	6	90

Results of data processing using the FMEA method

The graph of the Risk Priority Number (RPN) assessment results on the damage to Ripple Mill engine components is shown in Figure 1.

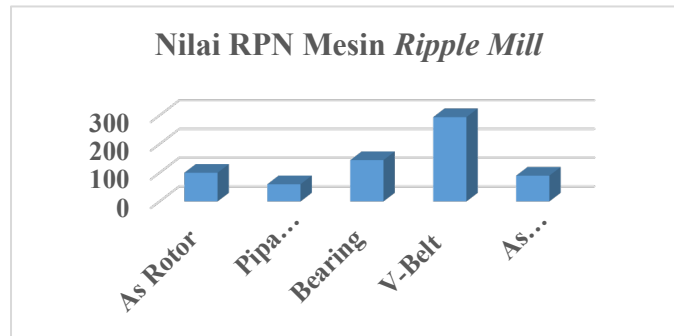


Fig. 2. Ripple Mill Engine Components RPN Value

Based on Figure 1, it can be explained that the highest RPN value occurs in the V-Belt component of 294, while the lowest RPN value occurs in the Ripple Plate Pipe component, amounting to 60. It can be interpreted that the greatest value is the top priority for improvement.

## V. Conclusion

The risk of failure on the Ripple Mill engine is obtained 5 risks that occur based on the results of the Risk Event. The Risk Priority Number from the calculation of Severity, Occurrence, and Detection obtained the highest value on the V-Belt component with a value of 294 RPN, while the lowest Risk Priority Number value was found in the Ripple Plate Pipe component with a value of 60 RPN. It can be interpreted that the greatest value is the top priority for improvement.

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