Jurnal Inovasi Teknologi dan Rekayasa
Vol. 9, No. 1, January-June 2024, pp. 8-14

Ripple Mill Machine Damage Analysis Using the FMEA Method at the PT Argo Sinergi Nusantara Palm Oil Factory

Raven Zayyan Tsaqif [a,1], Sulaiman Ali [b,2] *, Mahmudin Marbun [c,3]

[a,b,c] *Department of Mechanical Engineering, Faculty of Engineering, University of Teuku Umar, Aceh, Indonesia*
[1] *ravenzayyantsaqif@gmail.com;* [2] *sulaimanali@utu.ac.id *;* [3] *mahmudin.marbun@utu.ac.id*
**Corresponding author*

ARTICLE INFO

Article history:
Accepted

Keywords:
Fishbone
FMEA
Factory
Machine
Ripple Mill

ABSTRACT

PT Agro Sinergi Nusantara (ASN), one of the industries engaged in the Palm Oil Mill (PKS) industry, is located in Teunom, Aceh Jaya Regency. The Ripple Mill machine is one of the important machines used in Palm Head Mills which functions as a separator or splitter of kernel kernels and palm shells by utilizing centrifugal force to produce Palm Kernel Oil. From the initial analysis, it is known that the use of Ripple Mill machines in the industry today often experiences downtime or damage. The purpose of this study is to analyze the damage of the Ripple Mill machine at PT ASN's Palm Oil Mill using the Failure Mode and Effects Analysis (FMEA) method and Fishbone diagram. The results of the study obtained damage to the Ripple Mill machine in the identification of 5 (five) malfunctions or failure modes that occurred. using the FMEA method, it is known that the most dominant Ripple Mill machine failure mode occurs is the fracture of rotor bar components due to the entry of hard objects with the Risk Priority Number (RPN) which is 384 and using the fishbone diagram method, it is known that there are (four) influencing factors, namely human, machine, environmental and method factors.

I. Introduction

The development of the industrial era that is so competitive makes the existence of every company to be able to produce quality products in the most efficient way possible and the quality of products produced efficiently will be achieved if a company is able to minimize failures of production machines that interfere with the production process [1]. The efficiency process of the smooth production process begins with preventing and repairing damage to production machines, this is because the damage that occurs can hamper the production flow so that it affects the company's efficiency to achieve the target [2], therefore every company is required to be able to analyze damage to each production machine for prevention and handling so that it can run well.

The palm oil processing industry is one of the industries that is experiencing rapid development and is one of the main pillars of the economy in Indonesia, this is due to the growth of the palm oil industry which has made a significant positive contribution to the Indonesian agro-industry sector as a whole [3]. In the processing process, every palm oil mill requires good raw material processing machines to achieve optimal results, one of which is a ripple mill machine [4] *a* ripple mill machine is a machine that functions as a separator or splitter of kernel kernels and palm shells by utilizing centrifugal force to produce Palm Kernel Oil [5]. Ripple Mill machine performance mechanism starts with collision between rotors that turn at high speed To break the palm nut so as to separate the nut fragments and the kernel from the shell [6] the production process that operates

DOI: 10.31572/inotera.Vol9.Iss1.2024.ID280 W : http://inotera.poltas.ac.id | E : inotera@poltas.ac.id

continuously also causes the ripple mill machine to be damaged, therefore every company must be able to analyze and evaluate the damage that occurs.

PT Agro Sinergi Nusantara, one of the companies engaged in the palm oil mill industry located in Teunom, Aceh Jaya Regency. In companies, the smooth running of the production process is highly dependent on the machines used [7] but the production process that runs continuously can cause damage and decreased machine performance in the production process. Based on preliminary analysis, it is known that the use of Ripple Mill machines in the company today often experiences downtime or damage, the type of damage that often occurs is caused by too many nut filling factors and coconuts that are too thick so that the serrated plate components and rotors on the machine experience difficulties so that the rotor bar and ripple plate components are bent, from this problem, the machine is not optimal in solving nuts.

The author aims to analyze the damage to the Ripple Mill machine at PT Agro Sinergi Nusantara's palm oil mill using the Failure Mode and Effects Analysis (FMEA) method and Fishbone diagram. The FMEA method is used to find the most dominant damage and to be resolved then the damage will be sought cause and effect to propose repair. The benefits of this research are to be able to assist companies in designing improvement strategies and can be applied in the company's Standard Operating Procedures (SOP) to increase production results more effectively and efficiently.

II. The Proposed Method

This research was conducted at the PT Agro Sinergi Nusantara Palm Oil Mill located in Teunom, Aceh Jaya Regency, the research was carried out from January to May 2023. The focus of the research object leads to the analysis of ripple mill machine damage in the palm kernel oil (PKO) production process. In identifying damage to the ripple mill machine, the author makes direct observations and discusses with the ripple mill machine operator to find out the damage that occurs in the field, after the damage is known, the damage will be analyzed using the FMEA method, so that the most dominant damage or priority damage to the ripple mill machine is obtained so that repairs are proposed as soon as possible, while the results of priority damage will be found root cause and effect with Implementation of the fishbone diagram method to determine the causative factors of the damage.

III. Method

A. Metode Failure Mode and Effects Analysis (FMEA)

Failure Mode and Effects Analysis (FMEA) is a systematic method used to identify, prioritize, and address potential failures in machinery, equipment, or systems [5]. The main objective of FMEA is to prevent or mitigate the impact of damage that could arise due to such failures [7]. Here are the components of the stages of the FMEA method:

a. Identifying Failure Modes and Consequences:
  - The initial step is to identify various potential modes of failure in the system or equipment. Failure mode is the way a system or equipment can fail.
  - Then, for each identified failure mode, its effect or impact on the system or process is determined, including its impact on performance, security, environment, and more.

b. Determining Priorities:
  - Once the failure mode and its aftermath are identified, the FMEA method uses a priority score to determine the urgency in addressing each problem. Priority scores are usually obtained by combining three main factors: occurrence, severity, and detection.

c. Calculating RPN (Risk Priority Number):

- RPN is a number used to measure the potential risk of a particular failure mode. RPN is calculated by multiplying the probability rate, consequence rate, and detectability rate. The formula is usually RPN = Occurrence × Severity × Detection.
- The higher the RPN value, the greater the potential risk of such failure modes.

d. Take corrective action:
- After calculating the RPN, priority is given to the failure mode that has the highest RPN. Corrective actions are then taken to reduce the risk of such failures.
- Corrective actions may be design changes, changes to operational procedures, maintenance improvements, or other actions necessary to reduce risk and prevent future failures [8].

B. Method Diagram Fishbone

Fishbone diagrams or Ishikawa diagrams are visual tools used to analyze the cause of problems. In this diagram, the aftermath of the problem is placed in the center, while the branches describe categories of causes such as people, processes, equipment, materials, environment, and measurement [9]. The steps of its creation involve identifying the problem, determining the category of causes, identifying potential causes, and connecting them to the main line. This helps the team to analyze the cause of the problem and determine the appropriate corrective action. Fishbone diagrams are used in various sectors as a problem-solving and process improvement tool [10]. In general, the damage analyzed can be affected by a variety of factors, including labor, materials or raw materials, equipment or machinery, procedures or methods, and environmental conditions [6].

IV. Results and Discussion

A. Ripple Mill Machine Malfunction Identification

In this study, the identification of damage was carried out through direct observation in the ripple mill machine area and discussions with machine operators in order to obtain concrete and accurate data. From the results of observations and discussions, it revealed several ripple mill machine malfunctions that occurred at PT Agro Sinergi Nusantara as in table 1.

Table 1. Ripple Mill Machine Malfunction Identification

NO	***Failure***
1	Damaged or broken V-Belt pulley Components
2	Breakage of rotor bar components due to ingress of hard objects.
3	Wear on rubbing rotor bar pipe components
4	Wear on the ripple plate component wall
5	High vibration is not balanced so that bolts and nuts are damaged on the rotor bar.

Source: Research Results at PT Agro Sinergi Nusantara, 2023

Based on the results of the identification above, the author obtained 5 (five) damages that often occur in PT Agro Sinergi Nusantara's Ripple Mill Machine and then analyzed using the *Failure Mode and Effects Analysis* (FMEA) method.

B. *FMEA methods*

The identification results found several ripple mill machine damages, then an analysis of the FMEA method will be carried out at PT Agro Sinergi Nusantara. The initial stage of analysis is to determine *the level of occurrence*, level of consequence (severity) and level of detection (detection) of a damage, determination of *severity*, *occurrence* and *detection* values *in order to calculate Risk* Priority Number (RPN). Obtain value obtained based on direct observation and interviews with Ripple Mill Machine operators. The following are the results of obtaining *severity*, *occurrence* and *detection values as* well as RPN calculations.

Table 2. Ripple Mill Machine Malfunction Identification

NO	*Failure*	S	O	D	RPN
1	Damaged or broken V-Belt pulley Components	7	7	6	294
2	Broken rotor bar components due to the ingress of hard objects.	8	8	7	448
3	Wear on rubbing rotor bar pipe components	7	7	8	392
4	Wear on the walls of ripple plate components	6	6	7	252
5	High vibration is not balanced so that bolts and nuts are damaged on the rotor bar.	7	8	7	392

Source: Research Results 2023

From the provision of *severity,* occurrence *and* detection *values as well as the calculation of RPN above, damage to the Ripple mill machine, the classification of the highest to lowest RPN can be taken as follows.*

Table 3. RPN Results of Ripple Mill Machine Malfunction

NO	Failure	RPN
1	Broken rotor bar components due to the ingress of hard objects.	384
2	Wear on rubbing rotor bar pipe components	336
3	Wear on the ripple plate component wall	343
4	High vibration is not balanced so that bolts and nuts are damaged on the rotor bar.	294
5	Damaged or broken V-Belt pulley Components	252

Source: Research Results 2023

The results of the FMEA method are known that damage / failure to the ripple mill machine that can be prioritized to be handled or repaired is damage due to fracture of rotor bar components due to the entry of hard objects. This is because the damage obtained the highest Risk Priority Number (RPN) value of 384, so it can be ascertained that the damage can be handled as soon as possible.

C. *Cause and Effect Analysis (Fishbone diagram) Fracture of Rotor Bar Components Due to the Entry of Hard Objects*

The FMEA method is known that the most dominant ripple mill machine damage is influenced by the fracture of rotor bar components due to the entry of hard objects, the root cause of the damage is influenced by human factors, methods, environment and machines, so it is necessary to use the fishbone diagram method. The results of interviews and field reviews, the cause-and-effect diagram of the ripple mill machine damage is predominantly influenced by the fracture of the rotor bar component due to the entry of hard objects, as for the ripple mill machine at the palm oil mill at the charnel station as shown in figure 1.

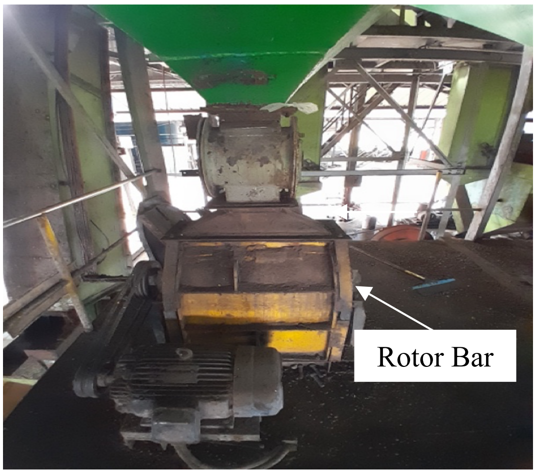

Fig. 1. Ripple Mill Machine

From Figure 1, Ripple mill machine at palm oil mill charnel station to separate the shell from the kernel of the palm kernel.

The causal factors due to the fracture of rotor bar components due to the ingress of hard objects can be described as follows,

a. Human Factor
- Lack of Training: operators or personnel who do not receive adequate training may not understand properly how to properly operate or maintain rotor bar components.
- Operator Error: human error such as negligence, confusion, or improper action can cause rotor bar components to break.
- Weak Safety Policy: if a company does not have a strong safety policy or does not follow existing safety procedures, the risk of rotor bar component fracture increases.
- Lack of Safety Awareness: Low safety awareness among personnel can lead to risky behaviors, such as not avoiding hard objects that enter the rotor.
- Non-compliance with the Procedure: if the personnel do not comply with the existing procedures for the operation, maintenance, or supervision of the machine, then the risk of failure increases.

b. Engine Factor
- Inadequate maintenance: machines that do not undergo regular and adequate maintenance may experience wear or damage that contributes to fractured rotor bar components.
- Engine wear and damage: engines that experience significant wear or internal damage can potentially cause rotor bar damage.
- Poor component quality: if rotor bar components or related parts are of poor quality, they may be more susceptible to damage by hard objects.
- Surveillance system failure: machine surveillance systems that are ineffective or unable to detect the ingress of hard objects quickly can allow rotor bar damage to develop without prevention.

c. Environmental Factors
- Extreme Environmental Conditions: Extreme environments such as extreme temperatures or adverse weather conditions can affect machine performance and allow hard objects to enter.
- Exposure to dust or foreign matter: dust or foreign matter accumulating around the machine can cause contamination and fracture of rotor bar components.
- Electrical or vibrational disturbances: Uncontrolled electrical disturbances or vibrations can contribute to rotor bar damage.

- Quality of covering material: the quality of the shield or shield protecting the rotor bar may be inadequate, so hard objects can easily enter.

d. Method Factors
- Lack of maintenance procedures: if machine maintenance procedures are absent or incomplete, the machine may be poorly maintained and more prone to damage
- Lack of surveillance procedures: the absence of effective surveillance procedures can make it difficult to detect the ingress of hard objects and take precautions
- Inadequate production methods: if the production method or assembly of rotor bar components is inadequate, this may increase the risk of structural defects
- Tool and Equipment Incompatibility: use of non-compliant or non-compliant tools or equipment may cause rotor bar damage
- Untested design changes: Changes to the design of rotor bars or related components.

V. Conclusion

The results and discussion of this study can be concluded that the damage to the ripple mill machine at PT Agro Sinergi Nusantara's palm oil mill was identified as having 5 (five) failures or failure modes that occurred, using the *Failure Mode and Effects Analysis* (FMEA) method, it is known that the most dominant ripple mill machine failure mode occurs is the fracture of the Rotor Bar component due to the entry of hard objects with Risk The highest Priority Number (RPN) is 384. From the results of finding root cause and effect using the fishbone diagram method, it is known that there are 4 factors that influence it, namely human, machine, environmental and method factors.

Acknowledgment

The author would like to thank PT Agro Sinergi Nusantara as the industry where the author of the independent learning program is an independent campus intern and to the Mill Manager, Assistant Minister of Enece Mr. Mursid Makaminan, Employee of PT Agro Sinergi Nusantara, Field Supervisor Mr. Mahmudin Marbun, S.T., M.Sc and Article Supervisor Mr. Ir. Sulaiman Ali, S.T., M.T.

References

[1] R. T. S. Nandiroh, Hartanto, and H. Munawir, "Perencanaan Pemeliharaan Mesin Pompa Gilingan Saus dengan Metode Markov Chain Untuk Minimasi Biaya Pemeliharaan," Universitas Muhammadiyah Surakarta, 2014.

[2] B. A. Zardi and Renilaili, "Analisis keselamatan kerja menggunakan metode hazard and operability," *Bina Darma Conf. Eng. Sci.*, pp. 155–162, 2022.

[3] D. M. Putro and Q. Sholihah, "Analisis Keandalan (Reliability) Pada Mesin Digester (Studi Kasus : Pt. Smart Tbk Batu Ampar Mill Kotabaru)," *Sci. J. Mech. Eng. Kinemat.*, vol. 4, no. 1, pp. 67–76, 2019, doi: 10.20527/sjmekinematika.v4i1.53.

[4] O. Hikmawan, M. Naufa, and B. M. Indriani, "Pengaruh Jarak Rotor Terhadap Efisiensi Pemecahan Biji pada Stasiun Ripple Mill Di Pabrik Kelapa Sawit," no. ripple mill, pp. 14–21, 2014.

[5] Jayarullah and Rita Hartati, "Riplle Mill Machine Failure Analysis Using the Failure Mode and Effect Analysis (FMEA) Method at PT. Ujong Neubok In," *J. Inotera*, vol. 8, no. 1, pp. 92–98, 2023, doi: 10.31572/inotera.vol8.iss1.2023.id219.

[6] K. Siregar and D. H. Rizkiansyah, "Analisis Efektivitas Mesin Ripple Mill Menggunakan Metode Overall Equipment Effectiveness (OEE)," *Talent. Conf. Ser. Energy Eng.*, vol. 5,

no. 2, pp. 0–7, 2022, doi: 10.32734/ee.v5i2.1556.

[7] A. Saputra *et al.*, “Analisis Risiko Kerusakan Mesin (Downtime) Ripple Mill Stasiun Kernel (Studi Kasus PT. Ujong Neubok Dalam),” *SITEKIN J. Sains, Teknol. dan Ind.*, vol. 19, no. 2, pp. 241–247, 2022.

[8] E. Krisnaningsih, P. Gautama, and M. F. K. Syams, “Usulan Perbaikan Kualitas Dengan Menggunakan Metode Fta Dan Fmea,” *J. InTent*, vol. 4, no. 1, pp. 41–54, 2021.

[9] A. Pratama, “Analisis Produk Cacat Brake Wheel (PT. Panasonic) dengan Menggunakan Metode Seventools di CV. Sumber Baja Perkasa,” *Integr. Lab J.*, vol. 5, no. 2, 2017.

[10] Meutia, B. S., and D. Dirahayu, “Analisis Pengendalian Mutu Produk Koran Dalam Upaya mengendalikan Tingkat Kerusakan Produk,” *Ind. Eng. J.*, vol. 2, no. 1, 2018.