

Identification of Damage in Press Stations Using the Failure Mode and Effect Analysis (FMEA) Method at PT. Beurata Subur Persada

Abdiel Khaleil Akmal^{a,1,*}, Iing Pamungkas^{a,2}, Heri Tri Irawan^{a,3}

^aDepartment of Industrial Engineering, Faculty of Engineering, University of Teuku Umar, Aceh, Indonesia
¹Abdielkhaleilakmal@utu.c.id*; ²iingpamungkas@utu.ac.id; ³heritriirawan@utu.ac.id

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ABSTRACT

PT. Beurata Subur Persada (BSP) is a crude palm oil (CPO) producer based in Babah Dua Village, Tadu Raya District, Nagan Raya Regency, Aceh. PT BSP employs 103 people across various production stations, including presses, threshers, sterilizers, and trucks. The Failure Mode and Effect Analysis (FMEA) method is being used in this study to determine damage to PT. Beurata Subur Persada's press station. The FMEA approach is used to assess probable failures in the manufacturing process, determining their severity, frequency of occurrence, and detection capabilities. This study focuses on gathering machine damage data from November 6 to December 6 of 2023 and evaluating it to determine the Risk Priority Number (RPN) value, which will be used to indicate the priority repairs required. This research aims to make recommendations for future damage repair and prevention, as well as improve the company's reliability and efficiency in operations.

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I. Introduction

The manufacturing industry is currently developing at a tremendous pace. To compete in the era of globalization, every organization must make constant improvements (continuous improvement) in all departments, particularly in the manufacturing line. An extremely important line in a firm. Several items on the production line must always be raised in productivity, including equipment and machinery that assist the manufacturing process. Improvement efforts in the manufacturing environment, in terms of equipment and machinery, are aimed at making the best use of existing equipment. In the average industrial industry, existing equipment is utilized at half of its true machine capabilities [1]. Activities involve processing and production operations that result in crude palm oil PT. Beurata Subur Persada uses a variety of machines and workstations in its manufacturing process. Palm oil fruit is processed into crude palm oil, palm kernel oil, and shells through a series of steps, including weighing, boiling, threshing, pulverizing, pressing, refining, and kernel extraction. Press machines have the most significant impact on the crude palm oil (Crude Palm Oil) processing business. However, throughout production, PT BSP frequently encounters damage to machine parts at each station, including the press station. Damage may include obstructions and leaks from the press station, as well as damage to other components. Machines with good operational functions can press with hydraulic pressures ranging from 50 to 60 bar [2]. A good engine maintenance concept must be supported by a competent strategy for assessing the causes of poor engine performance. One of numerous approaches for reducing problems that arise throughout the manufacturing process is the Failure Mode and Effect Analysis (FMEA) method. Failure Mode and Effect Analysis (FMEA) is a methodology for assessing failures or damage in a system, design, process, or service. Failure identification is accomplished by assigning a score to each failure mode that occurs based on the frequency, severity, and detection [3].



II. The Proposed Method

This investigation was conducted from January to February 2024 at PT. Beurata Subur Persada (BSP)'s Palm Oil Factory in Babah Dua Village, Tadu Raya District, Nagan Raya Regency, Aceh. The research focused on identifying any damage at the palm oil mill press station at Pt. Beurata Subur Persada using the Failure Method Mode and Effect Analysis (FMEA), as well as the level of severity (Severity), the frequency of failure and damage (Occurrence), detection control (Detection), and determining the Risk Priority Number (RPN) value [5]. The author conducted direct observations and discussions with the press machine operator to determine the damage that occurred in the field. Once the damage is identified, it will be assessed using the FMEA approach to determine the most dominant or priority damage to the press machine [6].

III. Method

Failure Mode and Effect Analysis (FMEA) is typically classified into two types: design FMEA and process FMEA. Design FMEA concentrates observations on product design. Meanwhile, Process FMEA focuses on the manufacturing process [7]. FMEA study examines potential risks in maintenance operations and firm operational activities. In this situation, three factors help define the illness [8].

A. Stages in fmea (failure mode and effect analysis)

- Identifying the type of likely failure on the equipment
- Identifying the causes of any probable problems that occur
- Determining the implications of the failure
- Identify failure controls
- Severity (S), Occurrence (O), Detection (D)
- Identify the factors creating defective products with the highest Risk Priority Number (RPN) and prioritize improvement efforts

B. Determination of interference

- Level of Damage (Severity), When determining the amount of damage (severity), it is possible to determine how severe the damage is caused by process failures in terms of maintenance operations and corporate operational activities.
- Frequency (occurrence), This occurrence can be determined by calculating how many disturbances can cause failure in maintenance operations and manufacturing operational activities.
- Detection Level To define the level of detection, consider how failures can be recognized before they occur. The amount of controls that manage the process's flow can also have an impact on the detection level [9].

C. Stages of making an FMEA

- Identifying possible failure modes (types, effects, causes, and controls). The possible failure effect refers to the impact that a failure has on consumers.
- Determine the Severity (S) value, a severity rating reflects how bad the ramifications of a failure mode are. Table 1 shows criteria for establishing severity values [10].

Table 1. Calculation of savings value

Effect	Criteria	Rank
<i>Maximum Severity</i>	Any failure that occurs will definitely cause danger	10
<i>Exterm severity</i>	Failure that occurs may cause danger, work safety must be considered	9
<i>Very High Severity</i>	Downtime increases significantly and has an impact on finances, products cannot be used but are safe, consumers are very dissatisfied	8
<i>High Severity</i>	High Severity Downtime increases significantly, product performance greatly decreases, consumers are very dissatisfied	7
<i>Severe</i>	Severe Smooth production is disrupted, production is running but performance is decreasing, consumers are not satisfied	6
<i>Moderate</i>	The effect seen through the production process performance will slowly decrease - customers are slowly dissatisfied	5
<i>Minor</i>	Minor The possibility of smooth production being disrupted by consumers realizing the small impact on the product	4
<i>Slight</i>	Slight Users may be aware of the impact on production but the impact is very small (process and consumer)	3
<i>Very Slight</i>	Does not affect the smoothness of production. Does not have a significant effect on the product	2
<i>None</i>	Realized by operators, not realized by consumers	1

- Determining the Occurrence (O) value, Occurrence is the possibility that the cause will occur and result in some form of failure during machine use. Criteria for determining the Occurrence value.

Table 2. Calculation of occurrence

Occurence	Criteria	Rank
<i>Extremelyunlikely</i>	Failure is highly unlikely	1
<i>Remote Likeli hood</i>	The possibility of failure is rare	2
<i>Very low like lihood</i>	Very few failures are possible	3
<i>low likeli hood</i>	Few failures are possible	4
<i>Moderately low likeli hood</i>	Medium probability of failure	5
<i>Medium likeli hood</i>	The probability of failure is quite high	6
<i>Moderately High likeli hood</i>	High probability of failure rate	7
<i>High Likeli hood</i>	The possibility of failure is very high	8
<i>Very High likeli hood</i>	Kegagalan mungkin	9
<i>Extremelyunlikely</i>	Failure is almost certain	10

- Calculating the detection (D) value, determining the level of detection involves identifying the process controls that will clearly (particularly) detect the cause of failure or damage. Detection is an assessment of the ability to control or control potential problems.

Table 3. Determination of value *detection*

Detection	Criteria	Rank
<i>Extremely unlikely</i>	Controls required to recognize defects	1
<i>Very high likelihood</i>	Control is very necessary to detect failure	2
<i>High likelihood</i>	Controls have high effectiveness for detection	3
<i>Moderately high likelihood</i>	Controls have rather high effectiveness for detection	4
<i>Medium likelihood</i>	Controls have moderate effectiveness for detection	5
<i>Moderately low likelihood</i>	Controls have rather low effectiveness for detection	6
<i>Low likelihood</i>	The probability of detection is low	7
<i>Very low likelihood</i>	The probability of detection is very low	8
<i>Remote likelihood</i>	Controls have little influence on detecting defects	9
<i>Extremely unlikely</i>	Controls will not be able to detect defects	10

- Calculating the Risk Priority Number (RPN) value, a Risk Priority Number is a type of value that indicates the priority that must be given to improving a system in order to prevent failure. The RPN value is calculated using the formula below [11].

$$RPN = \text{Severity} \times \text{Occurrence} \times \text{Detection.}$$

Description:

Severity : Potential causes of failure derived from interview data

Occurrence : Effects of failure derived from interview data

Detection : Control of failure using interview data

IV. Results and Discussion

Data collecting techniques are implemented by:

- Observation is a method of data collection that involves doing field research (directly) and observing the thing under study to get pertinent data.
- Interviewing, or asking multiple questions of firm employees in order to gather more up-to-date and correct information.
- Literature review, which is looking for various supporting theories in books and journals/articles linked to the problem under consideration.
- Data damage and repair time

A. Data Damage And Repair Time

Damage to the press station and the time required to repair damaged components are shown in Table 4.

Table 4. Damage and repair time at press stations

No	Damaged Components	Damage	Repair Time	Information
1	<i>Screw press</i>	worn out	4 hour	Replaced with a new unit
2	<i>Chain bucket elevator</i>	broken off	1 hour	Replaced with a new unit
3	<i>Chain thereser drum</i>	broken off	1 hour	Replaced with a new unit
4	Hidrolik press	Less pressure	3 hour	Repaired/not immediately replaced
5	Gearbox press	congested	3 hour	Repaired/not immediately replaced
6	<i>konveyor</i>	broken off	4 hour	Replaced with a new unit
7	Engine motor press	Rough voice	2 hour	Repaired/not immediately replaced
8	System Kontrol	Congested	1 hour	Repaired/not immediately replaced
9	Wall press machine	leak	2 hour	Repaired/not immediately replaced
10	Pipes and Connections	leak	2 hour	Repaired/not immediately replaced

B. Data damage on stage press

Damage to Press Station components occurred from 06 February 2024 to 06 December 2024. So the damage that occurred to the press machine components is shown in Table 5.

Table 5. Component data and damage to press station components

No	Press Machine Parts Components	Damage
1	<i>Screw press</i>	worn out
2	<i>Chain Bucket elevator</i>	broken off
3	<i>Chain Thereser drum</i>	broken off
4	Hidrolik press	Less pressure
5	Gearbox press	congested
6	<i>Konveyor</i>	broken off
7	Press machine motor	Rough voice
8	System Kontrol	Congested
9	Wall press machine	leak
10	Pipes and Connections	leak

C. Calculation of risk priority numbers (RPN)

The Risk Priority Number is a value that represents the severity of the repercussions of failure (Severity), the frequency (Occurrence), and the level of detection (Detection) based on interviews and brainstorming. One example of the calculation is for screw press components [12].

Known:

$$\begin{aligned} S &= 6 \\ O &= 2 \\ D &= 3 \end{aligned}$$

Solution:

$$\begin{aligned} \text{RPN} &= S \times O \times D \\ &= 6 \times 2 \times 3 = 36 \end{aligned}$$

So, the RPN value for the screw press component is 36. Risk Priority Number values for damage to press station components in Table 6

Table 6. Calculation of Risk Priority Number (RPN)

No	Components/Parts of press machines	S	O	D	RPN
1	<i>Screw press</i>	6	2	3	36
2	<i>Chain Bucket elevator</i>	9	4	2	72
3	<i>Chain Thereser drum</i>	9	4	2	72
4	Hidrolik press	6	2	3	36
5	Gearbox press	6	5	2	60
6	<i>Konveyor</i>	2	2	3	12
7	Press machine motor	5	5	3	75
8	System Kontrol	1	4	2	8
9	Wall press machine	10	6	3	180
10	Pipes and Connections	10	6	3	180

Table 7. Recapitulation Results of Failure Mode and Effect Analysis (FMEA) Assessment

No	Press Station Components	Potential Failure Types	Potential Causes of Failure	Determining the Effects Caused by Failure	Identify Control Failures	S	O	D	RPN
1	<i>Screw press</i>	worn out	Lifetime	Disturbances in the Processing Process	Carry out regular machine maintenance and check the screw press	6	2	3	36
2	<i>Chain Bucket elevator</i>	broken off	The material is damaged	Disturbances in the Processing Process	Carry out regular machine maintenance and check the elevator bucket chain	9	4	2	72

3	Chain Thresher drum	broken off	The material is damaged	Disturbances in the Processing Process	Carry out regular machine maintenance and check the drum thresher chain	9	4	2	72
4	Hidrolik press	Less pressure	The material is damaged	Disturbances in the Processing Process	Carry out regular engine maintenance and check the hydraulic oil	6	2	3	36
5	Gearbox press	congested	Lifetime	Disturbances in the Processing Process	Carry out regular machine maintenance and check its lubrication	6	5	2	60
6	Konveyor	broken off	The material is damaged	Disturbances in the Processing Process	Carry out regular machine maintenance and check conveyor parts for cracks	2	2	3	12
7	Press machine motor	Rough voice	The material is damaged	Disturbances in the Processing Process	Carry out regular machine maintenance and check the press machine motor	5	5	3	5
8	System Kontrol	Congested	The material is damaged	Disturbances in the Processing Process	Carry out regular machine maintenance and check the press machine control system	1	4	2	8
9	Wall press machine	leak	Lifetime	Oil leak on floor	Carry out regular station maintenance and check the floor and machine walls	10	6	3	180
10	Pipes and Connections	leak	The material is damaged	Gas leak	Carry out regular machine maintenance and check pipes and connections when the machine is operating	10	6	3	180

V. Conclusion

Based on the research aim, identify any damage at the palm oil mill press station and determine the level of severity (Severity), the frequency of failure and damage (Occurrence), detection control (Detection), and the Risk Priority Number (RPN) value. Using the Failure Mode And Effect Analysis (FMEA) method at PT. Beurata Subur Persada, it can be concluded that: 1) There were ten types of damage during this research, which took place from February 6 to March 6, 2024 the damage that occurred at the press station was screw press, bucket elevator chain, thresher drum chain, hydraulic press, gearbox press, conveyor, press machine motor, control system, press machine walls, and pipes/connections. 2) Using the FMEA method, several potential damages were detected at the press station. This demonstrates the importance of risk analysis in order to maintain the performance and dependability of manufacturing equipment.

Severity Level: The Severity analysis reveals that various potential flaws have a considerable impact on press station performance and product quality. This demonstrates the need of concentrating

prevention and remediation efforts in areas of high severity. Occurrence Frequency Rate: Occurrence Evaluation identifies locations that are prone to repeated failures and damage. With this insight, businesses may focus their prevention efforts to lower the frequency of events. Detection Controller: Detection Evaluation offers information on the system's ability to identify harm before it causes substantial damage. Risk Priority Number (RPN): Using RPN to identify action priorities takes into account the severity, frequency of failure, and efficacy of detection controls. The areas with the highest RPN scores require further attention to implement corrective actions.

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References

- [1] R. Santoso, dkk., 2021. Optimalisasi Perawatan Mesin Press Dengan Metode Failure Mode Effect Analysis (FMEA).
- [2] Jambura Industrial Review. Volume 1, Nomor 1, hal. 1-6
- [3] T. A. Sandhy, (2018). Evaluasi Performa Unit Desalinasi 24 tingkat kapasitas 90 Ton/Jam (Doctoral dissertation, Sepuluh Nopember Institute of Technology).
- [4] Stamatis, D. H., 1995. Failure Mode and Effect Analysis FMEA from Theory to Execution. Wisconsin: ASQC Quality Press.
- [5] N., A. Puspitasari, dan A., Martanto. 2014. Penggunaan Fmea Dalam Mengidentifikasi Resiko Kegagalan Proses Produksi Sarung ATM (Alat Tenun Mesin) (Studi Kasus PT. Asaputex Jaya Tegal). *J@TI Undip*. Vol IX, No. 2, hal. 93-98.
- [6] 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.
- [7] Jayarullah and Rita Hartati, "Ripple 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.
- [8] Crosby, Philip B. 1979. Quality Is Free. New York: New American Library.
- [9] Deming, W. Edwards. 1982. Guide to Quality Control. Cambirdge: Massachussetts Institute Of Technology
- [10] Gaspersz, Vincent. 2001. Metode Analisis Untuk Peningkatan Kualitas. Cetakan Pertama, Jakarta: PT. Gramedia Pustaka Utama
- [11] Gaspersz, Vincent. 2008. Total Quality Control. Jakarta: PT. Gramedia Pustaka Utama.
- [12] Imai, Maasaki. Kaizen, 2008. Kunci Sukses Jepang Dalam Persaingan. Penerbit PPM. Jakarta