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Damage Analysis of Grinding Machine Using FMEA and LTA Method at PT. X

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ABSTRACT

PT. X is a company in Banyuwangi, East Java, that produces shrimp feed. PT. X which is engaged in the shrimp feed production process has its production machine that supports the shrimp feed production process. PT. X can carry out the production process from raw materials to finished materials, namely various shrimp feeds. One of the production machines at PT. X is a vertical pulverizer grinding machine branded Yeong-ming. The objectives of this study are a. Analyze the breakdown of grinding machines using FMEA. b. Determine and categorize damage priorities using LTA. The method used in this study is the FMEA Method is carried out to identify grinding machine spare parts that are often damaged or aim to find critical spare parts, with the FMEA table producing RPN values to rank the level of damage to grinding machine spare parts. There are 11 failures or failure modes obtained from grinding machine spare parts. Based on FMEA calculations, there is the highest RPN with a value of 108 resulting from the types of spare parts block C6 and block C7 with a failure caused by surface wear. These problems include failures in the operating process, where spare parts block C6 and block C7 function to smooth raw materials, where spare parts rub all the time with raw materials. Analysis using the LTA method on 11 causes of damage, there are 6 that are included in the category of outage problems (B), there are 4 that are included in the category of hidden failure (D) and outage problems (B) and there are 1 that are included in the category of safety problems (A) and outage problems (B).

Keywords: Engine malfunctions, Failures mode and effects analysis, logic tree analysis

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1. Introduction

PT. X is a company in Banyuwangi, East Java, which produces shrimp feed. PT. X, which is engaged in the shrimp feed production process, has its production machine that supports the shrimp feed production process. PT. X is capable of carrying out the production process from raw materials to finished materials, namely various shrimp feeds. One of the production machines at PT. X is a vertical pulverizer grinding machine with the Yeong-ming brand. The grinding process also known as the sanding process is a step that should be carried out before carrying out the test because many of the specimens to be tested have corroded, have an uneven surface, or some even have lines on the surface [1].

A grinding machine is a machine that functions to refine raw materials according to the specified formula, this grinding machine also has an after-grinding standard of > 90% x 80, if it does not reach the after-grinding standard then the raw material will continue to be refined to achieve after grinding standards. Yeong-ming vertical pulverizer grinding machine at PT. X works 24 hours throughout the year and the machine is supervised by technicians based on the shifts in force at the company, the grinding machine has a production capacity of 4,000 kg or 4 tons per hour.

Maintenance is an activity to maintain factory facilities/equipment and stage repair, adjustment, and replacement which are needed so that there are circumstances of operational production that satisfy what which planned. System treatment can be viewed as a shadow of system production, meaning that if the production system operates at a very high capacity tall so maintenance will be more intensive [2].

The amount of damage that occurs on the grinding machine compared to the existing production machines at PT. X is the reason this research will focus on the causes of damage to the grinding machine and the risks caused by the occurrence of damage using the FMEA and LTA methods.

Failure Mode and Effects Analysis (FMEA) is a systematic approachthat applies something such as failure, reason failure, and effect from failureThis is to help the thought process used by engineers toidentify potential failure modes and effects. FMEA is a technique that evaluates the level of reliability of a system to determine the effect of failure from the system [3]. The Failure Mode and Effect Analysis (FMEA) method can identify each process step that can cause failure or defects in a production process [4]. The Failure Mode and Effect Analysis (FMEA) method is a technique used to identify in prevent failure or defects of a product so that the product produced can meet the standards desired by the company [5].

According to [6], FMEA or Failure Mode and Effects Analysis is a method which done determination ratings severity, incidents as well and ratings detection. Calculation RPN is a calculation based on 3 matters, ie as follows:

1. Impact Damage (severity)
   Level severity danger Which showed severity (S) is how danger whenthe system works.
2. Possibility of appearance damage(occurrence)
   Frequency Happen Which is shown by occurrence (O) is how much Lotsof incident disturbance on the component that causes system failure or can exist opportunities for disturbances to occur.
3. Level detection (detection)
   The detection level shown in detection (D) is how failure can identified before/just before the incident occurred. Evaluation is very subjective and depends on experience from the source person field [7].

Logic Tree Analysis

According to [8] preparation logic tree Analysis (LTA)has a goal to give priority to each mode damage and do review And function so that status mode damage is not the same. Priority of a mode damage can be known by answering the questions that have been provided in LTA. Analysis criticality puts every mode of damage into one of the four categories. Four matters which are important in criticality analysis viz as following.

a. Evident, that is is operator knowing under normal conditions, has been happen disturbance?
b. Safety, i.e. what is this crash mode causing problem safety?
c. The outage, that is mode damage resulted whole or part machine being stopped?
d. Categories, that is categorization obtained after answering questionsquestions asked. In the section, These components fall into 4 categories, ie :
   1. Category A (Safety problem). If failure mode has consequences safety of personnel or environment.
   2. Category B (Outage problem). If failure mode has operational consequences plant (influence quality or quality output) it can cause a loss of economy significantly.
   3. Category C (Economic Problems). If failure mode has no impact on safety as well operational plant and only causes economic lossretrain small Forrepair.
   4. Category D (Hidden failed). If the failure mode belongs to hidden failure, it is then classified Again into category D/A, category D/B, and category D/C.

The purpose of the study these are to analyze damage on grinding machine by using FMEA, determining and categorizing priority damage use LTA.

2. Methodology of Research

FMEA is not always the same for every company because every company has different organizational interests and problems. According to [9] the steps in compiling FMEA consist of several parts.

1. Process reviews
2. Brainstorming to find out the potential damage

3. Determines the severity ranking
4. Determine the ranking of occurrences
5. Define ranking detection
6. Calculating WPN with the equation:
   WPN = Severity (S) x Occurrence (O) x Detection (D)
7. Determine the priority of damage that should be addressed immediately
8. Follow up to reduce damage.

In order to obtain results desired in this research, the following are the steps for obtaining results.

1. Identifying the problem on the grinding machine for no reason from several problems that occur in grinding machine in PT. X
2. Conducting field studies during work hours to find out the conditions grinding machine directly at PT. X.
3. Studying references to get the basic theory in this study, and conducting a literature review to obtain information and theories from earlier studies. For the made amplifier in the study, the theory that is obtained is the method of failure mode and effect analysis and logic tree analysis.
4. Taking data is done to get the data to be processed into theory Which has got, taking data This is data maintenance from the technician and an interview made directly with the technician Which responsible answer on grinding machine the.
5. Processing data using the method FMEA, use method FMEA performed to identify spare part machine girding which often experiences damage or aim to know the spare part that critical, with the FMEA table generating values RPN For done ranking level damage spare part grinding machine.
6. After processing FMEA And getting spare parts which often damaged or critical so step is to compile table LTA, the objective of drafting table LTA is to group spare part grinding machine into the appropriate category with level damaged spare parts the flow chart of this research can be seen in Figure 1.

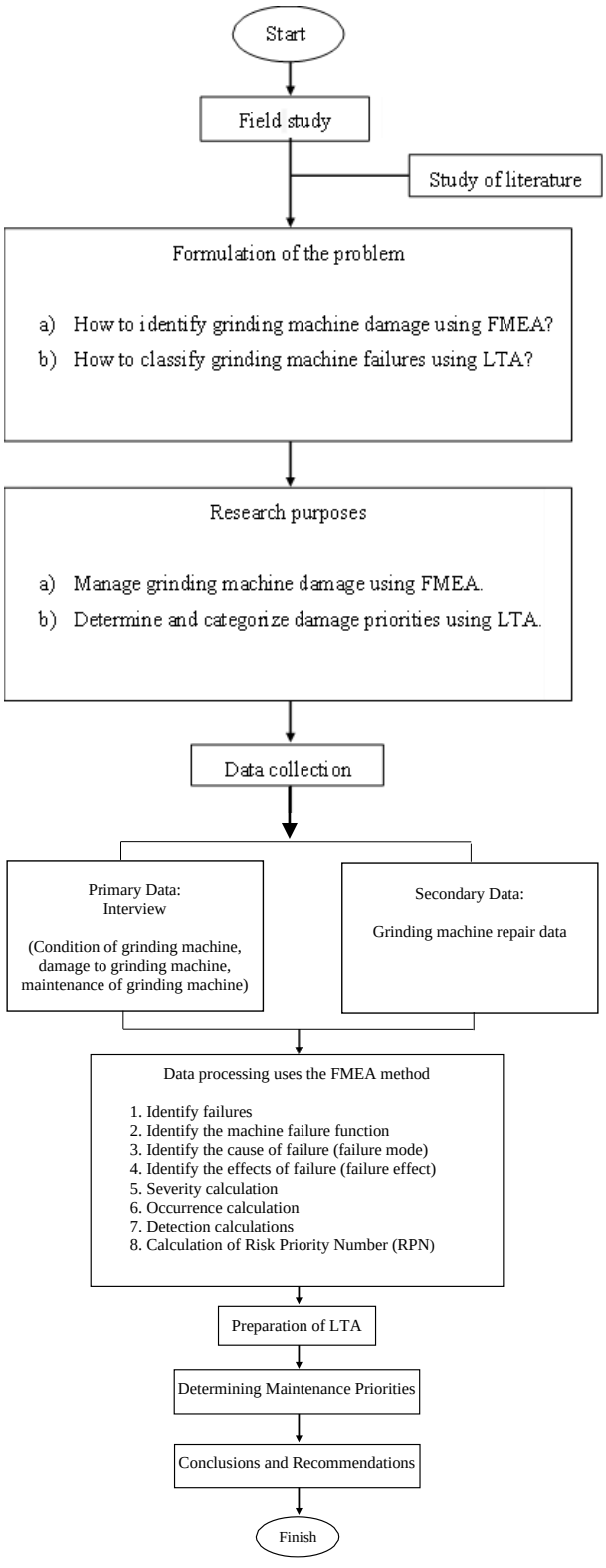

Figure 1. Research Flowchart

3. Result and Discussion

Based on previous research conducted by [8] entitled Analysis of the Causes of Damage to the Sizing Baba Sangyo Kikai Machine Using the Fmea and Lta Methods (Case Study at PT. Primatexco Indonesia). The results of the analysis using Logic Tree Analysis (LTA) can show that the pulley bracket

bearings have collapsed, the bearings are worn, the bottom roll has collapsed (bearings and seals), Shaft pulley motors, Bearings, and worn v-belts are included in category B which has consequences for plant operations (affecting the quantity and quality of output) which can cause significant economic losses. Proposed improvements that need to be carried out by the company are: It is better if in carrying out the work, the operator has carried out the SOP properly and correctly, Scheduled replacement of all components, especially components that are often worn out, Should carry out routine maintenance every week or once every 1 month, Provision spare parts/components that are often replaced, it is better if the operator is also given instructions on how to use the machine so it doesn't get damaged quickly, Prioritizing component repair/replacement work in the event of damage according to the highest rating of the Risk Priority Number (RPN).

This study identifies damaged grinding machine using data grinding machine repair at PT. X in the year 2022. The next stage is to analyze FMEA to get the RPN value, value RPN Alone obtained from Severity (S), Occurance (O), and Detection (D), RPN values obtained from S x O x D = RPN. Mark RPN is a mark that aims to know the spare part Which most often damaged or critical. Results processing damage using the FMEA method can seen in Table 2.

3.1 Logic tree analysis

Preparation logic tree Analysis (LTA) with method analysis criticality put every mode damage into one of four categories, categories it is evident t, safety and outage. Thus classifying failure machines into several categories, then determining level priority handling each based on category. Compilation results LTA can seen in Figure 2. below.

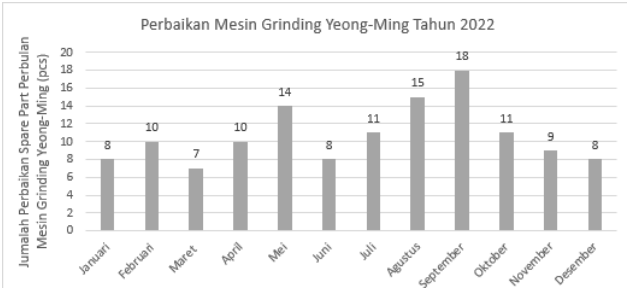

Figure 2. Repair grinding machine year 2022

Figure 2, shows that the number of repairs for Yeong-Ming grinding machine spare parts each month varies. Number of repair spare parts January 8 times, February 10 times, March 7 times, April 10 times, May 14 times, June 8 times, July 11 times, August 15 times, September 18 times times, October 11 times, November 9 times, December 8 times. The least number of spare part repairs is in March 2022, namely 7 times. Meanwhile, the most repaired spare parts are in September 2022 which is as much 18 times.

3.2 Type engine failure grinding

Based on the observation done following This is failure spare part Which experienced by a grinding machine.

Table 1 Spare Failure Type Machine Parts Grinding

Failure Mode	
Name Spare Part	**Fail mode**
Motorcycle	Lost Power
Bearings	Wrong One bearings broke or cracked
Vanbelt	Rubber van belt slack
Disc plates C2	Part lower worn plates
Disc plates C3	Part of the plate wears out
Liners	The eye knife wears out
Beaters	wear out caught friction material
Blocks C6	Surface wear out
Blocks C7	Surface wear out
Separator	Bearings director shiver
Grinding Chamber	Overloaded

Table 1 shows the types of failure of grinding machine spare parts at PT X, including motor, bearing, van belt, disc plates C2, disc plates C3, liner, beater, block C6, blocks C7, separator, grinding, and chamber.

3.3 Failure effect of grinding machine

With the failure experienced by grinding machine spare parts Certain will There is an effect caused by failure the, following this is an effect grinding machine spare parts

Table 2. Failure effect of spare part grinding machine

Failure Effect Mode		
Spare Part	**Fail mode**	**Effect from Failure Mode**
Motor	Lost Power	Machine stop operate
Bearings	Wrong One bearings broken or cracked	Influential on rotation grinding machine
Vanbelt	Rubber van belt slack	Grinding machine will stop operate
Disc plates C2	Part lower worn plates	Surface wear causes quality production

Disc plates C3	Part of the plate wears out	Surface wear causes quality production
Liners	The eye knife wears out	Material which mashed not by standard production
Beaters	Wear out caught friction material	Process refinement No by standard production
Blocks C6	Surface wear out	The smoothing process does not work with Good cause production the long
Blocks C7	Surface wear out	Process refinement No walk with good cause production the more long
Separator	Bearings director shiver	Material Which fine No sucked with Good
Grinding Chamber	Overloaded	Speed machine will slow down and refinement will slow down.

Table 2 shows the failure effect of grinding machine spare parts in PT. X. The effects include: Machine will direct stop operating, Influential on rotation grinding machine And impact on process production, Machinery grinding will stop operating Because There isn't any liaison energy of motors, Surface wear out cause on quality production, Materials Which mashed no by standard production, Process refinement No in accordance standard production, the refining process does not run with Good cause production the longer, Materials Which fine No sucked with good and Speed machine will slow down And refinement will slow down.

3.4 Reason for failure of grinding machine spare parts

Following This is the reason for the failure of the spare part which was experienced bygrinding machine. Table 3 cause of failure grinding machine spare parts.

Table 3 Modes engine damage grinding

	Failure Cause	
Spare Part	**Failure Mode**	**Failure Cause**
Motorcycle	Lost power	Blackout electricity
Bearings	One of the bearings is broken orcracked	Already reach lifetime
Vanbelt	Rubber van belt slack	Already reach lifetime
Disc plates C2	Part lower plate worn out	the top wear caused usage process production
Disc plates C3	the part on the plate wears out	the top wear caused usage process production
Liners	eye worn blade	happen friction with object hard moment smoothing process
Beaters	wear out caught friction material	component material caught object-object hard foreigner
blocks C6	surface wear out	surface wear caused use of process production
blocks C7	surface wear out	surface wear caused use of process production
Separator	bearings director shiver	not enough done checking And settings in a manner periodically
grinding Chumber	overload	happen problem on a spare part otherso that causes overload

Based on Table 3, the damage mode of the grinding machine is divided by the type of spare part. Each spare part has a failure mode and cause of damage. There are 11 types of spare parts whose damage is observed based on the mode of damage and the cause.

3.5 FMAE analysis

According to [10] a failure mode is a condition that can cause functional failure. Based on the Failure Mode and Effect Analysis analysis on the Nissan Serena C24 automatic transmission component, the RPN (Risk Priority Number) value for each component can be obtained so that more attention can be given to the component that has the highest RPN value [11] by implementing appropriate actions. RPN is the result of calculating the seriousness of the effect (severity), the possibility of failure (occurrence), and the ability to detect failure before it occurs (detection) [12].

After all aspects are known, that aspect is a failure mode. effect of failure mode and failure cause then the next step is to determine The RPN of the failure, below is the result of the FMEA calculation obtained. Based on Table 2, the numbers are obtained based on the severity, occurrence, and detection scales. How to get the value RPN is by way of S x O x D = RPN. RPN on motor spare parts is 4 x 3 x 3 = 36,then the RPN value for engine spare parts is 36 The results of calculating the Risk Priority Number (RPN) values for several parts can be seen in Table 4.

Table 4. Processing FMEA damage on grinding machine

No	Spare Parts Machine	Fail mode	Severity	Occurrence	Detection	RPN	Rank
1	Motorcycle	Power loss	4	3	3	36	5
2	Bearings	One of broken or cracked bearings	8	3	2	48	4
3	Vanbelt	Rubber van belt slack	6	3	2	36	5
4	Disc Plate C2	Low part worn plates	6	3	4	72	3
5	Disc Plate C3	The top of the plate wear out	6	4	3	72	3
6	Liners	The blade is worn out	6	5	3	90	2
7	Beaters	Aus hit material friction	6	5	3	90	2
8	Block C6	wear surface	6	6	3	108	1
9	Block C7	wear surface	6	6	3	108	1
10	Separator	Guide bearings shiver	7	5	1	35	6
11	grinding Chumber	Overloaded	4	2	4	32	7

Table 5. Preparation damage using LTA

NO	Functional Failure	Failure Mode	Evident	Safety	Outage	Categories
1	Motorcycle	Power loss	No	No	Yes	B
2	Bearings	One of the bearings is broken or cracked	Yes	No	Yes	B
3	Vanbelt	The vanbelt rubber is loose	Yes	No	Yes	B
4	Disc Plate C2	The bottom plate is worn	Yes	No	Yes	B
5	Disc Plate C3	The top of the plate is worn	Yes	No	Yes	B
6	Liners	The blade is worn out	No	No	Yes	D&B
7	Beaters	Wear exposed to friction of the material	No	No	Yes	D&B
8	Block C6	wear surface	No	No	Yes	D&B
9	Block C7	wear surface	No	No	Yes	D&B
10	Separator	The directional bearing vibrates	Yes	No	Yes	B
11	Grinding Chamber	Overloaded	Yes	Yes	Yes	A & B

Table 6. Treatment performed on grinding machine spare parts

Failure Mode	LTA category	Spare Part Treatment
Power loss	B	Carry out periodic checks on the motor and check the electrical voltage that enters the motor.
One of the bearings is broken or cracked	B	Carry out maintenance by replacing the cracked bearings with new ones as much as one set of these bearings.
The van belt rubber is loose	B	Periodic maintenance is carried out to monitor the age of the van belt rubber

The bottom plate is worn	B	Check first because only one part of the plate is worn out, if the bottom part is worn out, the top part is still good, you can do a plate reversal, if both parts are worn out, replace a new spare part.
The top of the plate is worn	B	Check it first because only one part of the plate is worn out, if the top part is worn out, the bottom part is still good, you can do a plate reversal, if both parts are worn out, replace a new spare part.
Blade wear	D and B	perform maintenance by replacing worn blades with new blades.
Wear exposed material	D and B	Maintenance is carried out by replacing spare parts with new ones.
wear surface	D and B	Treatment by reviewing the block first, if the surface of the other side is not worn out then it is not replaced with a new one, and a surface reversal will be carried out that is still good or not worn.
The directional bearing vibrates	B	Maintenance is carried out strictly and often settings are made to the separator.
Overloaded	A and B	Regular maintenance is carried out to monitor the chamber so that it is always ready for use.

Based on Table 4 it is known that the RPN value for Motor spare parts is 36, Bearing 48, Vanbelt 36, Disk Plate C2 72, Disk Plate C3 72, Linner 90, Beater 90, Block C6 108, Block C7 108, Separator 35, Grinding Chumber 4. The lowest RPN value occurs in the grinding chumber spare part with an RPN value of 32. Meanwhile, the highest RPN value occurs in the Block spare part C7 and Blocks C7 is equal to 108. After calculating the RPN value for each machine spare part, the highest rank is determined from the highest RPN value. It can be seen that the highest rank value occurs in Block Spare Parts C7 and Block C7 is rank 1.

4 Conclusions

According to the study results conducted, several conclusions such as there are 11 failure or failure modes Which got from spare part grinding machine. Based on the calculation of FMEA it is RPN highest with a mark of 108 resulting from the type spare part blocks C6 and C7 with failure cause surface wear out M problem the is including failure in the operation process, where spare part blocks C6 And blocks C7 function For smoothing material raw, Where spare part the rub throughout time with material raw. Based on analysis using the method LTA to 11 causes of damage then there are 6 are included in the category outage problem (B), is 4 a.m. included in the category hidden failure (D) and outage problem (B) and there is 1 included in safety problem category (A) and outage problem (B).

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