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Conference Paper

Machine Maintenance in the Sabroe Line Using Reliability Centered Maintenance (RCM) and Maintenance Value Stream Mapping (MVSM) Methods

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ABSTRACT

PT. XYZ is a company that operates in the frozen food industry in particular. The company is a producer of high-quality frozen food products for export, so, naturally, other stakeholders in each division of the company need to work together well. Machine maintenance is a key aspect in maintaining the performance and reliability of industrial equipment. To increase machine maintenance efficiency in this factory, a comprehensive and structured approach is needed. Therefore, this research will discuss the machine maintenance strategy implemented in the Sabroe production line. The two methods that will be the main focus of this research are Reliability Centered Maintenance (RCM) and Maintenance Value Stream Mapping (MVSM). The conclusion obtained by examining the highest Risk Priority Number (RPN) for each component in the blanching machine, it can be concluded that the gearbox component has the highest RPN, namely 216, which is the result of multiplying the Severity, Occurrence, and Detection values. During the period of breakdowns and repairs of the blanching machine, the Mean Time to Failure (MTTF) is found to be 242.2538 hours. Meanwhile, the Mean Time to Repair (MTTR) reaches 172.6 minutes or equivalent to 2.8 hours. The gearbox component requires a repair time of 2.8 hours. The inspection interval for the gearbox component is calculated for 302.01 hours, or every 12 days in a month. Efficiency analysis of maintenance using the Maintenance Value Stream Mapping approach indicates that the percentage of maintenance efficiency reaches 73.2%. Activities that add value require a longer time, around 172.6 minutes, while activities that do not add value require about 63.2 minutes.

Keywords: Reliability centered maintenance, RCM, maintenance value stream mapping, MVSM, risk priority number, failure mode and effect analysis

Introduction

Companies must continue to make continuous improvements, especially in their production lines, to remain competitive in an increasingly competitive manufacturing industry. Because the production line plays an important role in the process of making goods, it has a significant impact on the company's growth and development (Komar et al., 2022). Therefore, efforts are needed to increase productivity in all aspects that support the production process (Karningsih et al., 2023). Apart from that, companies must also try to reduce waste efficiently so that the production process runs well (Rochmoeljati et al., 2022).

PT. XYZ is a company that operates in the frozen food industry in particular. The company is a producer of high-quality frozen food products for export, so, naturally, other stakeholders in each division of the company need to work together well. In carrying out its production operations, PT. XYZ relies on complex production machines and requires proper maintenance to operate optimally. One of

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the divisions that participates in keeping the production process running well is the engineering or maintenance division which determines the success of maintaining production machines. However, as time went by the company experienced several obstacles in carrying out its production process, including frequent downtime or long machine downtime. This matter must be corrected by the company because if downtime occurs too often it will result in defective products in the production process and hamper the progress of the production system due to long machine downtime which can be detrimental to the company.

Machine maintenance is a key aspect of maintaining the performance and reliability of industrial equipment (En–Nhaili et al., 2015). Especially in the context of a complex environment like the Sabroe refrigeration plant, keeping the machines operating optimally is a must. The Sabroe refrigeration plant is known for its high-quality products used in a variety of refrigeration and heat-quenching applications.

To increase machine maintenance efficiency in this factory, a comprehensive and structured approach is needed (Saifuddin et al., 2021). Therefore, this research will discuss the machine maintenance strategy implemented in the Sabroe production line. The two methods that will be the main focus of this research are Reliability Centered Maintenance (RCM) and Maintenance Value Stream Mapping (MVSM).

The RCM method is a systematic approach that allows maintenance management based on risk analysis and prioritization of critical components (Mulya, 2023). This method aims to ensure that engine maintenance is carried out efficiently and effectively, focusing on components that have the most significant impact on overall performance (Putra & Nurhidayat, 2022).

Meanwhile, MVSM is an important tool in mapping and analyzing value streams in maintenance processes (Damanik et al., 2020). This method allows the identification of process improvements and the elimination of waste in machine maintenance, potentially increasing maintenance productivity and efficiency (Rofi & Achmadi, 2022).

By integrating these two methods, this research aims to develop a better and structured machine maintenance strategy on the Sabroe production line. It is hoped that the results of this research will make a positive contribution in improving maintenance performance, increasing equipment service life, and reducing unexpected operational disruptions (Mukhtar, 2022).

Material and Methods

Variable identification

This research was conducted at PT. XYZ located in Jember Regency, East Java, in February 2023 until the required data were obtained. Data collection was carried out through direct observation of the edamame production machines during operation and maintenance to collect data related to downtime, repair time, and other maintenance activities. Observation was also conducted to observe the edamame production process and understand how the machines contribute to this process. Data were collected through interviews with edamame production machine operators and maintenance staff to understand how the machines are operated, the types of maintenance performed, and the common issues with these machines.

Data Processing Methods:

1. Reliability Centered Maintenance (RCM).
   The RCM method is a systematic approach used to improve machine maintenance performance by considering the reliability and associated risks of the machines (Kurnianto et al., 2017). This method involves reliability analysis, functional analysis, and the determination of the appropriate maintenance strategies for each machine component (Lelu & Setiafindari, 2023).

2. Maintenance Value Stream Mapping (MVSM).
3. The MVSM method is an optimization approach to maintenance processes that focus on waste elimination and cost reduction by identifying and eliminating non-value-added activities in the maintenance process (Fitri & Farid, 2023). This method involves mapping the value stream from start to finish and identifying and eliminating non-essential or replaceable activities with more effective methods (Sembiring et al., 2018).

Results and Discussion

Data Collection

The machine that will undergo damage identification is the machine on the Sabroe line. The following is the downtime data for the machine on the Sabroe line:

Table 1. Downtime data for the machine on the Sabroe line

No	Machine	Downtime (Minutes)
1	Washing Sabroe	783
2	Feeder Sabroe	532
3	Blanching Sabroe	3606
4	Cooling 1 Sabro	783
5	Cooling 2 Sabroe	881

Based on Table 1, the Sabroe blanching machine has the highest machine downtime value, which is 3606 minutes. Therefore, this study focuses on the Sabroe blanching machine. Below are the downtime values for the components of the Sabroe blanching machine:

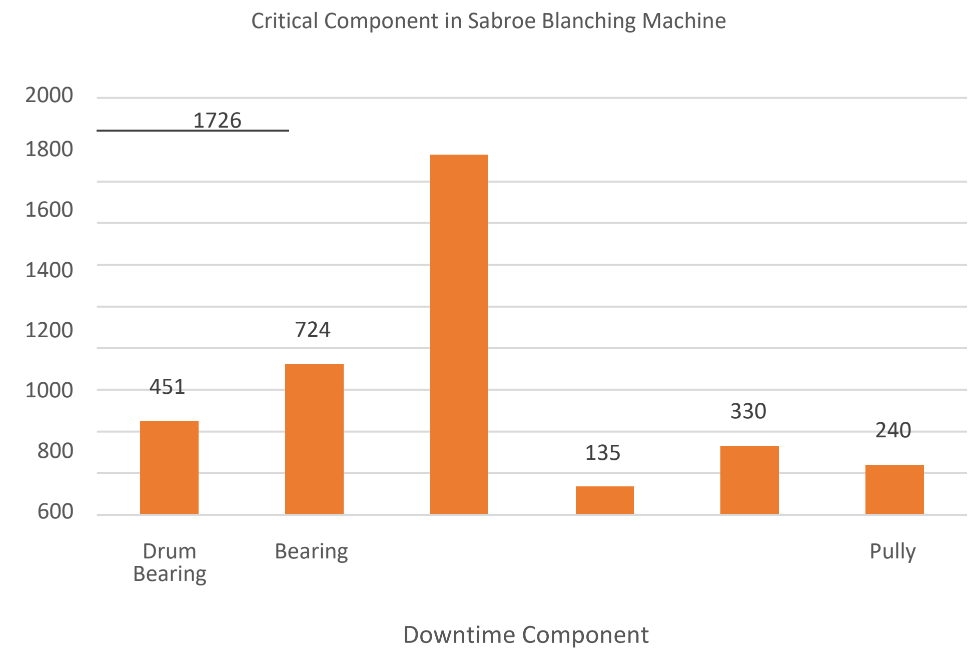

Figure 1. Critical component in sabroe blanching machine

In critical assessment, indicating the level of significance of a component considered to have the highest risk, special attention is required for repair. Based on the critical component diagram of the Sabroe blanching machine, it can be concluded that the gearbox component is the most critical.

Failure mode effect analyze

Failure Mode and Effect Analysis (FMEA) is used to assess the failure modes and the effects of failures of each component in a system, as well as to analyze their impact on the system's reliability. In this calculation, rating values are utilized to reflect the level of damage that occurs in the machine during the production process. These rating values include Severity, Occurrence, and Detection, and are employed to calculate the Total Risk Priority Number (RPN).

Part / Process	*Function*	*Potential Failure Mode*	*Potential Effect Of Failure*	*Sev*	*Potential Cause Of Failure*	*Occ*	*Current Control*	*Det*	RPN
Drum Bearings	Supports and supports *blanching* drums used for cooking	Tear and Wear	Engine performance slows down	5	Lack of lubricant	3	Regular lubrication checks	2	30
		crack		6	Contaminated by dust particles	3	Regular checks	2	36
		Ball bearing wear	Making noise on the machine	3	Too heavy a load	2	Perform a load test to ensure the drum bearing can withstand the required load with good periodically	2	12
TOTAL RPN									78
Gear box	Decrease the speed of the power generated	Voice and Violent vibration	Performance Lame Transmission	6	The gears damaged or dirty	5	Regular *gearbox* checking	2	60
		Shaft Wear Out	Production process *of blanching* machine Stalled	8	Replacement of non-compliant parts Service life	6	Regular *shaft* checks	2	96
		Gear Wear Out	If the edamame has entered the drum, *blanching* can cause the edamame to overcook, causing Product defects	6	insufficient quantity of oil	5	*Regular gear* checks	2	60
TOTAL RPN									216
Steam Tap	Delivering hot steam to the *blanching* drum	Leaky Faucet	Lack of hot steam in *the blanching* drum	3	Replacement of non-compliant parts Service life	4	Regular checking of steam faucets	3	36
		Faucet lever does not work	Hot steam does not enter the *blanching* drum	3	The time of application of lubricant is not On schedule	2	Regular lever lubrication check	3	18
		broken steam pipe	steam leakage before entering	5	Too steam capacity tall	2	Periodic pipe checking	3	30
			into the drum blanching						
TOTAL RPN									84
Bearing	Rotating system drive	*Bearing* Loose	Production process *of blanching* machine be slow	3	Too heavy a load	5	Checking crack marks on *bearing surfaces*	2	30
			The *process of cooking* edamame does not work with good	3	Lack of lubricant	4	Regular lubrication checks	2	36
		Bearing Bad	*Cooking* process Edamame is not up to standard	3	Installation improper	4	Noise checking on *bearings* When the machine is operating	3	36
TOTAL RPN									102
Pulley	Moving other parts of the engine and accelerating and /or slowing down the rotational speed and transmitting power from one part of the engine to another	Belt ripped	Disruptions in engine performance	5	Inappropriate *belt* tension	3		3	45
		Contamination or Corrosion of *pulleys*	Engine rotation speed may change or not orderly	6	Long pulley life	2	Periodic maintenance includes cleaning, lubrication and regular *pulley* condition checks	2	36
			Friction on v*belt*	5	Poor quality *pulley*	3	Selection of the right *pulley* that has the right size and type for *Sabroe Blanching* Machine	2	30
TOTAL RPN									111

Table 2. Failure mode and effect analysis

From the data in the Failure Mode Effect Analysis (FMEA) table, it can be observed that the component with the highest total Risk Priority Number (RPN) is the Gearbox, with an RPN value of 216, followed by the bearing with an RPN of 102, and the Pulley with an RPN of 111. The results of this FMEA calculation will guide the subsequent maintenance steps using the RCM II method.

Based on the evaluation using the RCM II Decision Worksheet above, for the maintenance of the Sabroe blanching machine, regarding the gearbox component, when there is damage involving loud noises and harsh vibrations, the corrective action involves inspection to restore the component's condition. For worn shaft damage, the corrective action involves inspection with component replacement, while for worn gear damage, inspection with component replacement is required. For the bearing component, when there is loose bearing damage, the corrective action involves inspection with component replacement, whereas for seized bearing damage, inspection with the recovery of component conditions is needed. Meanwhile, for the pulley component, in the case of torn belt damage, the corrective action involves inspection with component replacement, and for damage due to contamination on the pulley, inspection with the recovery of component conditions is required. The results from the RCM II Decision Worksheet indicate the necessary actions for each component that frequently experiences damage, and the details can be seen in Table 3.

<table>
<tr><td rowspan="3">Bearing</td><td rowspan="3">Rotating System Drive</td><td rowspan="2">Loose Bearings</td><td>Blanching Machine Production Process Becomes Slow</td><td>Too heavy a load</td><td>Decrease in Machine Productivity</td><td>Examination and Detection of Potential Failure</td><td>Component Replacement</td></tr>
<tr><td>The cooking process of edamame did not go well</td><td>Lack of lubricants</td><td>Decrease in Machine Productivity</td><td>Examination and Detection of Potential Failure</td><td>Component Replacement</td></tr>
<tr><td>Bearing Jams</td><td>The process of cooking edamame is not up to standard</td><td>Improper installation</td><td>Decrease in Machine Productivity</td><td>Examination and Detection of Potential Failure</td><td>Component Condition Recovery</td></tr>
</table>

Table 3. The results from the RCM II Decision Worksheet

The Index of Fit is used to measure the extent to which the Weibull distribution fits the failure time data. From the above calculations, the Index of Fit (r) for the downtime interval of the gearbox component is 0.981 or 98.1%, indicating that the downtime data for the gearbox component can be well explained using the Weibull distribution. The Index of Fit is also used to assess the quality of the Weibull distribution based on repair time data. The calculation results show that the Index of Fit (r) for the downtime data of the gearbox component is 0.983 or 98.3%, indicating that the downtime data for the gearbox component can be well explained using the Weibull distribution.

Parameters for failure time and repair time are calculated using the Weibull distribution by finding the intercept (a), slope (b), shape parameter (α), and scale parameter (β). Mean time to failure and mean time to repair are calculated based on these parameters. From the gamma table, the mean time to failure is determined to be 242.2538 hours, and the mean time to repair is 172.6 minutes.

The calculation for the inspection time interval for the gearbox component is 302.01 hours, equivalent to an inspection every 12 days in a month. Maintenance efficiency analysis using the Maintenance Value Stream Mapping approach indicates that the percentage of maintenance efficiency is 73.2%. Activities that add value require a longer time, around 172.6 minutes, while activities that do not add value require about 63.2 minutes.

Conclusion

Based on the results of the data analysis conducted, the following conclusions can be drawn:

1. Critical components in the blanching machine can be identified through Failure Mode and Effect Analysis (FMEA). By examining the highest Risk Priority Number (RPN) for each component in the blanching machine, it can be concluded that the gearbox component has the highest RPN, namely 216, which is the result of multiplying the Severity, Occurrence, and Detection values.
2. During the period of breakdowns and repairs of the blanching machine, the Mean Time To Failure (MTTF) is found to be 242.2538 hours. Meanwhile, the Mean Time To Repair (MTTR) reaches 172.6 minutes or equivalent to 2.8 hours. The gearbox component requires a repair time of 2.8 hours. The inspection interval for the gearbox component is calculated for 302.01 hours, or every 12 days in a month.
3. Efficiency analysis of maintenance using the Maintenance Value Stream Mapping approach indicates that the percentage of maintenance efficiency reaches 73.2%. Activities that add value require a longer time, around 172.6 minutes, while activities that do not add value require about 63.2 minutes.

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