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JOINTING MACHINE MAINTENANCE ANALYSIS USING RELIABILITY CENTERED MAINTENANCE (RCM) METHOD

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Abstract

Maintenance activities must be carried out appropriately based on the type of machine and machine components. A machine consists of vital components, so that if the components of a machine are continuously subject to fatal damage, it can result in losses for the company. Proper maintenance activities can extend the service life of the machine and can minimize costs for maintenance of damaged machines. PT. Bakrie Pipe Industries is a company that produces steel pipes of various diameters. In producing steel pipes, PT. Bakrie Pipe Industries uses several machines. In 2019, there were several machines with the most frequent problems at Plant KT 24. The machine with the highest downtime of 2660 minutes was the Jointing Machine. In this study, a maintenance analysis was carried out using the Reliability Centered Maintenance (RCM) method on the Jointing Machine at Plant KT 24 PT. Bakrie Pipe Industries. In the results of selecting the maintenance task for the Jointing Machine critical components, it can be concluded that the Roller Blade component with the Potential Cause of Failure is broken Guide Wheel Bearing, the maintenance task is selected, namely Condition-Directed Task, Indexing Clamp component is Condition-Directed Task, Torch component is Condition-Directed Task, Nozzle component is Condition-Directed Task, Roller Blade component with the Potential Cause of Failure is Leaky Cylinder is Failure Finding Task, Bushing Torch component is Condition-Directed Task, and Cooler Torch Hose component is Failure Finding Task.

Keyword: downtime; jointing; maintenance; RCM

INTRODUCTION

The rapid development of the industry has the impact of increasing competition that is getting tougher, so that companies need to compete to increase the quantity and quality of the products produced (Kurniawan & Mujayin, 2015). One way that can be done to be able to compete is by increasing productivity, which can be done by maintaining the continuity of the production process. The continuity of the production process is influenced by several things, including human resources who have an important role in the production process as well as the conditions for production facilities such as production machines and other supporting equipment (Susanto & Azwir, 2018) The company must be able to maintain the continuity of the production process. One of the efforts that must be made is to extend the operation of the company's facilities in the form of machines and minimize company expenses caused by the damage to these facilities (Kurniawan & Mujayin, 2015).

The machine is one of the important facilities for carrying out the production process in a company. A suddenly broken machine can cause the production process stopped and the predetermined production plan will be disrupted. The role of the machine is very important in the entire production process. Therefore, the machine condition must always be in optimal condition. A machine with high productivity can operate optimally in a production process in the company (Kurniawan & Mujayin, 2015). Production machines must always be in good condition. So that the condition of the machine is always in good condition, maintenance activities are needed with the aim of optimizing the reliability of the production machine components (Susanto & Azwir, 2018). Maintenance activities must be carried out appropriately based on the type of machine and machine components. A machine consists of vital components, so that if the components of a machine experience fatal damage continuously, it can result in losses for the company (Zein et al., 2019). Proper maintenance activities can extend the service life of the machine and can minimize costs for maintenance of damaged machines (Camerling et al., 2020).

PT. Bakrie Pipe Industries is a company that produces steel pipes of various diameters. In producing steel pipes, PT. Bakrie Pipe Industries uses several machines. In 2019, there were several machines with the most frequent problems at Plant KT 24 PT. Bakrie Pipe Industries. The machine with the highest downtime of 2660 minutes is the Jointing Machine. Based on the problems experienced by PT. Bakrie Pipe Industries, this study will analyze machine

maintenance using the Reliability Centered Maintenance (RCM) method with the aim of determining the proper maintenance task for the Jointing Machine at Plant KT 24 PT. Bakrie Pipe Industries.

LITERATURE REVIEW

Maintenance Management

(Kurniawan, 2013) states that maintenance is an activity for repair, maintenance, adjustment, replacement, inspection, and cleaning of the object being treated. The concept of treatment begins with the human desire to get safety and comfort for an object, so that the object can function properly and can last the desired time period. Maintenance also begins with the human desire to create a system that is more orderly, functional, clean and neat. The main function of maintenance is to control the condition of machine and equipment.

Reliability Centered Maintenance (RCM)

According to Moubray, Reliability Centered Maintenance (RCM) is a process that aims to determine what must be done so that each physical asset can continue to operate according to what its users want in its operational context (Ahmadi & Hidayah, 2017). Reliability Centered Maintenance (RCM) is a method that aims to determine maintenance tasks that will guarantee a system of reliability. RCM has a function to overcome the most dominant cause of failure by selecting the proper maintenance task decisions aimed at preventing the occurrence of types of failures that often occur.(Palit & Sutanto, 2012)

Fault Tree Analysis (FTA)

According to Bayu (in Rachman & Septianto, 2015) Fault Tree Analysis (FTA) is a technique to reduce certain fault events which then builds a logical diagram of all events that can lead to the fault event. The function of the FTA method is to identify faults in a branched way, both from a physical and human perspective. FTA is a multi-component system that has the function of examining the possible mechanisms that will occur from a failure.

Failure Mode and Effect Analysis (FMEA)

According to Stamatis (in Anthony, 2016) FMEA is a methodology that aims to evaluate failures that occur in a system, process, design or service. Identification of potential failures is done by giving a score for each failure mode based on severity, occurrence, and detection. The Risk Priority Number (RPN) is the product of the multiplication of severity, occurrence and detection. RPN is used to determine the priority of failures.

Logic Tree Analysis

According to Pranoto et al. (2013) Logic Tree Analysis (LTA) aims to determine priorities for each failure mode. LTA also aims to review functions and malfunctions. The priority of a failure mode can be determined by answering the questions that have been designed in the LTA. Critical analysis places each failure mode into one of four categories as follows:

1. Category A (Safety problem)
2. Category B (Outage problem)
3. Category C (Economic problem)
4. Category D (Hidden failure)

METHODS

This study was conducted at Plant KT 24 PT. Bakrie Pipe Industries. Starting from problem identification, literature study, data collection, analysis and discussion, and drawing conclusions. Primary data collection was carried out by interviewing related parties who understood the problems to be analyzed, namely the Maintenance Foreman Mechanical Plant KT 24, Maintenance Foreman Electrical Plant KT 24, and Maintenance Planner Plant KT 24. In addition, secondary data was obtained from company documents and literature related to the problem.

In this study, an analysis of machine maintenance was carried out using the Reliability Centered Maintenance (RCM) method. The steps for implementing the Reliability Centered Maintenance (RCM) according to Moubray (in Palit & Sutanto, 2012) are as follows:

1. Determine the cause of failure using a Fault Tree Analysis (FTA). FTA aims to determine critical components that are prone to failure.
2. Perform analysis with Failure Mode and Effect Analysis (FMEA) to determine the priority of the components that need maintenance.
3. Classify the level of consequences of failure with Logic Tree Analysis (LTA).
4. Selecting RCM decisions by classifying the type of maintenance task required.

RESULT AND DISCUSSION

Tube Mill KT 24 Downtime in 2019

At the KT 24 Tube Mill in 2019, the Jointing Machine has the highest downtime, which is 2660 minutes. Therefore, the analysis will be carried out on the Jointing Machine.

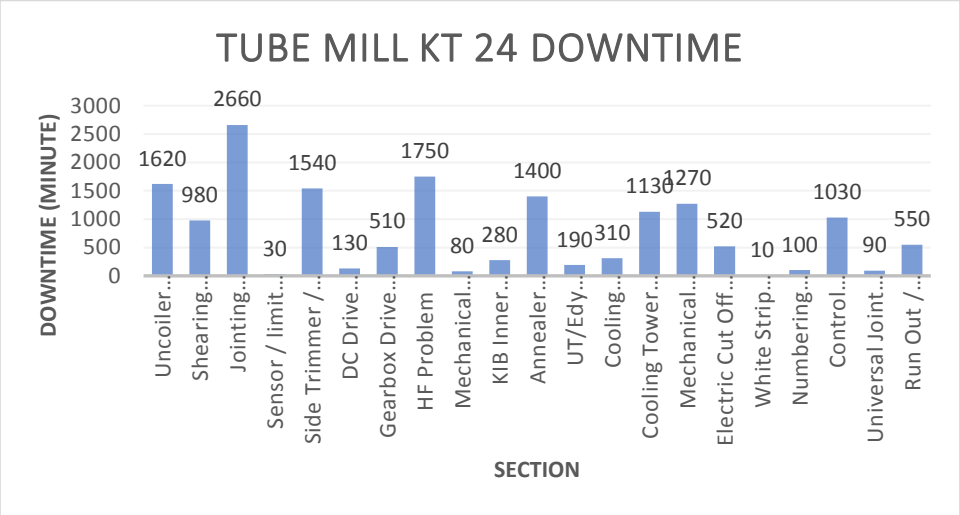

Figure 1. Tube Mill KT 24 Downtime

Fault Tree Analysis (FTA)

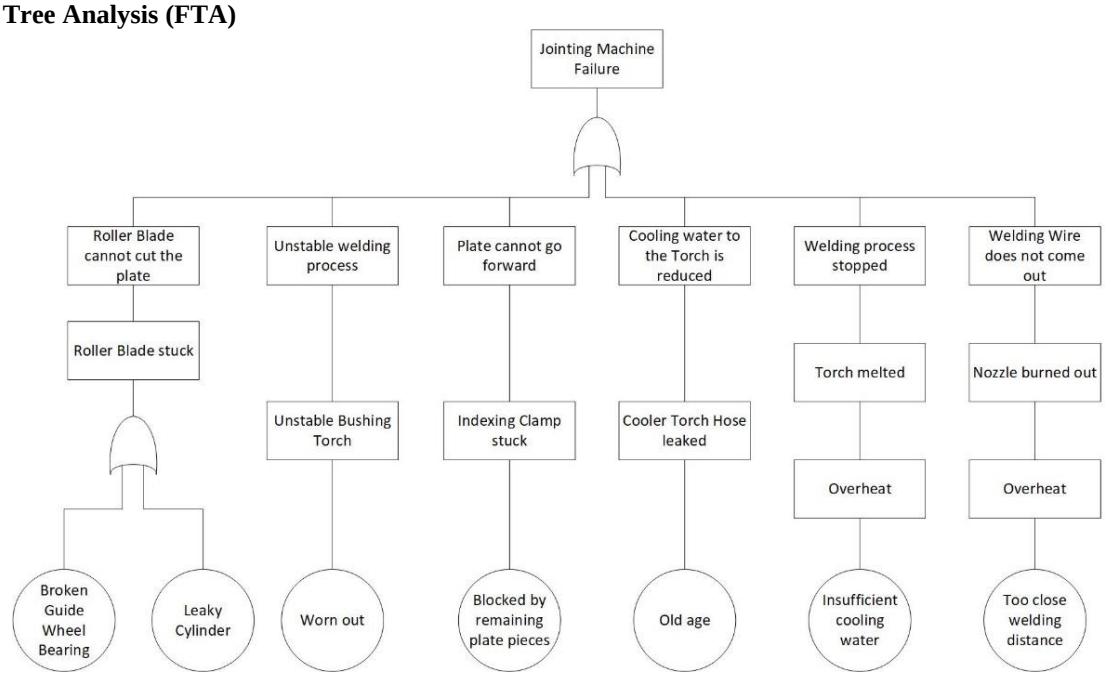

Figure 2. FTA Jointing Machine

In the FTA diagram in Figure 1, it can be seen that there are some of the most basic causes of failure of the Jointing Machine, namely broken guide wheel bearing, leaky cylinders, worn out, blocked by remaining plate pieces, old age, insufficient cooling water, and too close welding distance.

Failure Mode and Effect Analysis (FMEA)

In the FMEA analysis, the OCC value, SEV value, and DET value were obtained from interviews with the Foreman Maintenance Plant KT 24 by looking at the predetermined criteria and scale.

Table 1. FMEA Jointing Machine

Component	Function	Potential Failure Mode	Potential Cause of Failure	Potential Effect of Failure	OCC	SEV	DET	RPN	*Rank*
Roller Blade	Cut the tip of the tongue 2 plates	Roller Blade stuck	Broken Guide Wheel Bearing	Roller Blade cannot cut the plate	4	7	6	168	1
			Leaky Cylinder	Roller Blade cannot cut the plate	4	7	4	112	5
Bushing Torch	As a Motor Torch holder	Unstable Bushing Torch	Worn out	Unstable welding	3	5	7	105	6
Indexing Clamp	Deliver the plate to be jointed to the previous plate	Indexing Clamp stuck	Blocked by remaining plate pieces	Plate cannot go forward	5	7	4	140	2
Cooler Torch Hose	Deliver cooling water to the Torch	Cooler Torch hose leaked	Old age	Cooling water to the Torch is reduced	4	6	4	96	7
Torch	To perform welding	Torch melted	Insufficient cooling water	Welding process stopped	4	8	4	128	3
Nozzle	To control the direction of the welding wire	Nozzle burned out	Too close welding distance	Welding wire does not come out	6	7	3	126	4

In Table 1, the FMEA Jointing Machine can be seen that the Roller Blade component with the potential failure mode is Roller Blade is stuck, the potential cause of failure is broken Guide Wheel Bearing, and the potential effect of failure is Roller Blade cannot cut the plate, has the highest RPN value, which is 168, then the potential failure mode will be the first priority for maintenance. Meanwhile, the component Cooler Torch Hose with the potential failure mode is Cooler Torch Hose is leaking, the potential cause of failure is old age, and potential effect of failure is cooling water to the Torch is reduced, has the lowest RPN value, which is 96.

Logic Tree Analysis (LTA)

Logic Tree Analysis (LTA) was conducted by interviewing the KT 24 Maintenance Foreman Plant which was based on the provisions of the LTA method.

Table 2. LTA Jointing Machine

Component	Potential Failure Mode	Potential Cause of Failure	Evident	Safety	Outage	Category
Roller Blade	Roller Blade stuck	Broken Guide Wheel Bearing Leaky Cylinder	Y	N	Y	B

Bushing Torch	Unstable Bushing Torch	Worn out	N	N	Y	D
Indexing Clamp	Indexing Clamp stuck	Blocked by remaining plate pieces	Y	N	Y	B
Cooler Torch Hose	Cooler Torch hose leaked	Old age	N	N	N	D
Torch	Torch melted	Insufficient cooling water	Y	N	Y	B
Nozzle	Nozzle burned out	Too close welding distance	Y	N	Y	B

In Table 2, LTA for the Jointing Machine, it can be seen that the potential failure mode is Roller Blade is stuck in category B, Unstable Bushing Torch in category D, Indexing Clamp is stuck in category B, Leaky Cooler Torch Hose in category D, Torch melted in category B, and Nozzle burned out in category B.

Classification of the Consequences of Failure

Table 3. Classification of the Consequences of Failure

Component	Potential Failure Mode	Potential Cause of Failure	Category	Consequences Category of Failure
Roller Blade	Roller Blade stuck	Broken Guide Wheel Bearing Leaky Cylinder	B	Outage Problem
Bushing Torch	Unstable Bushing Torch	Worn out	D	Hidden Failure
Indexing Clamp	Indexing Clamp stuck	Blocked by remaining plate pieces	B	Outage Problem
Cooler Torch Hose	Cooler Torch hose leaked	Old age	D	Hidden Failure
Torch	Torch melted	Insufficient cooling water	B	Outage Problem
Nozzle	Nozzle burned out	Too close welding distance	B	Outage Problem

In Table 3, the Classification of the Consequences of Jointing Machine Failure, it can be seen that the potential failure mode is roller blade is stuck has a consequence of failure of outage problem, Unstable Bushing Torch is hidden failure, Indexing Clamp stuck is outage problem, Leaky Cooler Torch Hose is hidden failure, Torch melted is outage problem, and Nozzle burned out is outage problem.

Maintenance Task Selection

In the maintenance task selection, an interview was conducted with the Maintenance Foreman Plant KT 24 with the aim of obtaining the proper type of maintenance task based on RCM method for critical components of the Jointing Machine.

Table 4. Maintenance Task Selection

Component	Potential Failure Mode	Potential Cause of Failure	Consequences Category of Failure	Maintenance Task
Roller Blade	Roller Blade stuck	Broken Guide Wheel Bearing	Outage Problem	Condition-Directed Task

		Leaky Cylinder		Failure Finding Task
Bushing Torch	Unstable Bushing Torch	Worn out	Hidden Failure	Condition-Directed Task
Indexing Clamp	Indexing Clamp stuck	Blocked by remaining plate pieces	Outage Problem	Condition-Directed Task
Cooler Torch Hose	Cooler Torch hose leaked	Old age	Hidden Failure	Failure Finding Task
Torch	Torch melted	Insufficient cooling water	Outage Problem	Condition-Directed Task
Nozzle	Nozzle burned out	Too close welding distance	Outage Problem	Condition-Directed Task

In selecting maintenance tasks, there are several maintenance tasks, namely Condition-Directed Task which aims to detect failures by checking equipment periodically. If any signs of equipment failure are detected, it is followed by repair or replacement of components. Failure Finding Task, which is an assignment that aims to find equipment failures hidden from operators by periodic inspection of equipment or components. In selecting the maintenance task for the Jointing Machine, it can be seen that Roller Blade component with the Potential Cause of Failure Guide Bearing Wheel is broken, a maintenance task is selected, namely Condition-Directed Task, Roller Blade Component with Potential Cause of Failure Leaky Cylinder, a maintenance task is selected, namely Failure Finding Task, Bushing Torch component is Condition-Directed Task, Indexing Clamp component is Condition-Directed Task, Cooler Torch Hose component is Failure Finding Task, Torch component is Condition-Directed Task and Nozzle component is Condition-Directed Task.

Maintenance Task Decisions

In the selection of maintenance decisions, an interview was conducted with the Maintenance Foreman Plant KT 24 with the aim of obtaining proper tasks for critical components of the Jointing Machine based on the predetermined types of maintenance tasks.

Table 5. Maintenance Task Decisions

Component	Potential Failure Mode	Potential Cause of Failure	RPN	Rank	Maintenance Task	Task
Roller Blade	Roller Blade stuck	Broken Guide Wheel Bearing	168	1	Condition-Directed Task	Check the Roller Blade periodically and if there are symptoms of noise, replace the Guide Wheel Bearings
Indexing Clamp	Indexing Clamp stuck	Blocked by remaining plate pieces	140	2	Condition-Directed Task	Check the Indexing Clamp and if there are signs of slow and unstable movement of the Indexing Clamp, clean the remaining pieces of the plate periodically.
Torch	Torch melted	Insufficient cooling water	128	3	Condition-Directed Task	Check the Torch and the Torch cooling water flow periodically and if there is a symptom of the welding filler metal output that is starting to become unstable, then replace the Torch

Nozzle	Nozzle burned out	Too close welding distance	126	4	Condition-Directed Task	Check the nozzle and the distance of the welding media periodically and if there is a symptom that the welding filler metal output is starting to become unstable, then replace the nozzle
Roller Blade	Roller Blade stuck	Leaky Cylinder	112	5	Failure Finding Task	Check the Roller Blade periodically and search for leaks in the cylinder and repair the cylinder
Bushing Torch	Unstable Bushing Torch	Worn out	105	6	Condition-Directed Task	Check the Bushing Torch periodically and if the welding movement shows unstable symptoms, then replace the Bushing Torch
Cooler Torch Hose	Cooler Torch hose leaked	Old age	96	7	Failure Finding Task	Check the Cooler Torch Hose periodically and search for leaks in the Cooler Torch Hose and welding the leaking Cooler Torch Hose.

In the Jointing Machine Maintenance Task Decision, it can be seen that the Roller Blade Component with the Potential Failure Mode is the Roller Blade is stuck, the Potential Cause of Failure is broken Guide Wheel Bearing, becoming rank 1 with RPN value is 168. The maintenance task is selected, namely Condition-Directed Task with the task, check the Roller Blade periodically and if there are symptoms of noise, replace the Guide Wheel Bearing.

In the Indexing Clamp component with the Potential Failure Mode is the Indexing Clamp is stuck, the Potential Cause of Failure is blocked by the remaining pieces of the plate, becoming rank 2 with RPN value is 140. The maintenance task is selected, namely Condition-Directed Task with the task, check the Indexing Clamp and if there are signs of slow and unstable movement of the Indexing Clamp, clean the remaining pieces of the plate periodically.

In the Torch component with the Potential Failure Mode is Torch melts, the Potential Cause of Failure is Insufficient cooling water, becoming rank 3 with RPN value is 128. A maintenance task is selected, namely Condition-Directed Task with a task, check the Torch and the Torch cooling water flow periodically and if there is a symptom of the welding filler metal output that is starting to become unstable, then replace the Torch.

In the Nozzle component with the Potential Failure Mode is Nozzle burns, the Potential Cause of Failure is distance of the welding media is too close, becoming rank 4 with an RPN value of 126.The maintenance task is selected, namely Condition-Directed Task with the task, check the nozzle and the distance of the welding media periodically and if there is a symptom that the welding filler metal output is starting to become unstable, then replace the nozzle.

In the Roller Blade component with the Potential Failure Mode is the Roller Blade is stuck, the Potential Cause of Failure is Leaky Cylinder, becoming rank 5 with an RPN value of 112. The maintenance task is selected, namely Failure Finding Task with the task, check the Roller Blade periodically and search for leaks in the cylinder and repair the cylinder.

In the Bushing Torch component with Potential Failure Mode is unstable Bushing Torch, the Potential Cause of Failure is worn out, becoming rank 6 with an RPN value of 105.The maintenance task is selected, namely Condition-Directed Task with the task, check the Bushing Torch periodically and if the welding movement shows unstable symptoms, then replace the Bushing Torch.

In the Cooler Torch Hose component with Potential Failure Mode is the Cooler Torch Hose is leaking, the Potential Cause of Failure is old age, becoming rank 7 with an RPN value of 96.The maintenance task is selected, namely Failure Finding Task with the task, check the Cooler Torch Hose periodically and search for leaks in the Cooler Torch Hose and welding the leaking Cooler Torch Hose.

CONCLUSION

Based on the results of the analysis on the Jointing Machine using the Reliability Centered Maintenance method and the results of selecting the maintenance task for the Jointing Machine critical components, it can be concluded that the Roller Blade component with the Potential Cause of Failure is broken Guide Wheel Bearing, the maintenance task is selected, namely Condition-Directed Task, Indexing Clamp component is Condition-Directed Task, Torch component is Condition-Directed Task, Nozzle component is Condition-Directed Task, Roller Blade component with

the Potential Cause of Failure is Leaky Cylinder is Failure Finding Task, Bushing Torch component is Condition-Directed Task, and Cooler Torch Hose component is Failure Finding Task.

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