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# Maintenance Analysis on Cap Roller Press Machine with FMEA Method and RCM

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**Abstract**

Maintenance is all the activities needed to maintain the quality of a production process. At PTPN VI Solok the problem that occurred was that there was damage to the Press Cap Roller machine which played a role in the tea pressing process. The purpose of this study is to determine the Maintenance of the Press Cap Roller Machine and provide maintenance suggestions for the Press Cap Roller machine in the rolling section using the Failure Mode And Effect Analysis (FMEA) and Reliability Centered Maintenance (RCM) methods. The use of the Failure Mode And Effects Analysis (FMEA) method is intended to examine and track all possible damage that may occur, while the Reliability Centered Maintenance (RCM) method is intended to select, develop, and create an effective maintenance strategy in the event of a breakdown. The data used are Press Cap Roller machine damage data, engine state data for September 2021, data on the causes of damage and production time data. The results of the Failure Mode And Effect Analysis (FMEA) analysis show that the most dominant cause of damage is the higher Risk Priority Number (RPN), namely the crankshaft = 120 and the analysis of the Reliability Centered Maintenance (RCM) results obtained that the average time of component damage is 1631, 1591, 1633, 1754.28 and 1639.

Keywords: Press Cap Roller Machine, Failure Mode and Effect Analysis , Reliability Centered Maintenance, Risk Priority Number, Machine Damage



## 1. Introduction

The main export industry of commodities has a big role in the world market is tea. In the tea processing process there are good processing activities to obtain quality tea. Quality tea can be obtained from fresh brewing, fragrant aroma, and thick brewing color. To obtain quality tea can be seen in the production process, there must be machine maintenance.

PT Perkebunan Nusantara Solok is a State-Owned Enterprise that produces and manages tea commodities in the Solok area. At PT Perkebunan Nusantara VI in tea processing there are a number of stages with machine rolling Which different like *Monorail* , *Withering Through WT* ***),*** *Double India Ball Breaker Net Sort* (DIBN), *Press Cup Roller* (PCR), *Retorven* (RV), *Two Stage Drier* (TSD), *Tea Cutter* , *Vibro* , *Cutting* . This company often experiences damage to the *Press machine Cup Roller* which causes the production process to not run optimally.

Machines are an aspect that greatly influences the continuity of a production activity [1]. For these production activities, maintenance is needed as an effort to reduce the number of machine failures or damage [2]. The benefits of maintenance are to maintain and preserve the quality of company assets so that they function properly [3]. There are several causes that can be factors in machine damage, one of which is due to the maintenance program being carried out less than optimally in terms of planning.

*Failure Mode and Effect Analysis (FMEA)* method can be used as a step to identify priority scale [4]. Through FMEA method, failure can be analyzed and processed so that maximum solution is obtained [5]. Then *Reliability Centered Maintenance* (RCM) method can be used in maintenance activities so that it is carried out optimally according to the existing damage [6]. Next is to provide recommendations for the initial cause to be carried out correctly and effectively [7], [8]. RCM method examines more about the criteria of severity, detection, and frequency of occurrence [9-11]. With the RCM method, the maintenance carried out can be carried out optimally according to the existing damage.

To overcome this problem, an analysis will be carried out for machine maintenance and efforts to make improvements to the PCR machine using the FMEA and RCM methods [12-14]. The purpose of this study is to determine Maintenance Machine *Press Cap Roller* and provide maintenance proposal For machine *Press Cap Roller* in partrolling with use method *Failure Mode And Effect Analysis* And *Reliability Centered Maintenance* . The contribution of this study is that there has been no study comparing the results of these two methods in the production area. The systematics of writing this study include part 2 explaining the theory, part 3 explaining the research method, part 4 explaining data processing,

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part 5 explaining the analysis and discussion, and the last part explaining the conclusion of this study.

## 2. Methodology

The type of examination used in this study is a quantitative research type. This kind of quantitative examination is one type of research whose details are precise, structured and clearly organized from the beginning to the making of the design. research [15]. Where the examination requires the use of numbers, starting from the collection of data, data translation, and the existence of results. Research Methods and Time The method used is *Failure Mode And Effect Analysis* And *Reliability Centered Maintenance* . Research location implemented in PTPN VI Solok. The data collection period was conducted from 5 - 17 January 2022. The data used were data on damage to the *Press Cap Roller machine* , data on the condition of the machine in September 2021, data on the causes of damage and data on production time.

## 3. Results and Discussion

### 3.1 Data Processing Analysis Using FMEA and RCM Methods

#### 3.1.1 Data Processing Analysis Using FMEA Method

In filling the FMEA table, filling in the component function, failure method, damage effect, cause of damage and actions taken are obtained from direct interviews with the company and the criteria for filling in *severity* , *occurrence, detection,* and RPN values. From the results of multiplying *Severity, Occurrence* , and *Detection* are obtained.

Table 1. Cumulative RPN of PCR Machines

| No | Component | Total RPN Percentage (%) | Cumulative RPN Percentage (%) |
|---|---|---|---|
| 1 | Worm Well | 4.55 | 4.55 |
| 2 | Bearing | 7.97 | 12.52 |
| 3 | Electric motor | 8.96 | 21.48 |
| 4 | Gearbox | 15.93 | 37.41 |
| 5 | Drive Shaft | 11.38 | 48.79 |
| 6 | Grinding Table | 14.94 | 63.73 |
| 7 | Crankshaft | 17.07 | 80.8 |
| 8 | V-belt | 4.27 | 85.06 |
| 9 | Winding Cylinder | 2.99 | 88.05 |
| 10 | Grinding Base | 11.95 | 100 |

*Fishbone* diagrams help companies find out the root cause of a conflict. Here is a cause and effect analysis of PCR machine failure:

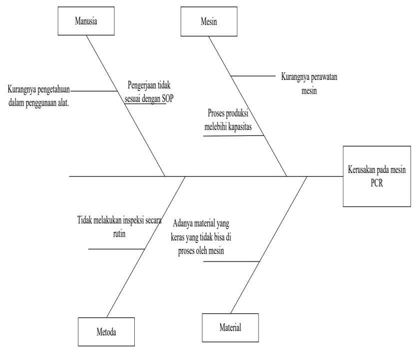


Figure 1. *Fishbone* Diagram of PCR Machine Damage

#### 3.1.2 Data Processing Using RCM Data

The data processing carried out is to identify critical components of the PCR machine.

1. *Reliability Centered Maintenance* (RCM) *Decision Worksheet* Analysis

*Reliability Centered Maintenance* (RCM *) Decision Worksheet* is used to find the right type of maintenance task that has the potential to overcome each *failure . mode* with the following *worksheet information:*

*Worksheet* Information

| No | Function | | Function Failure | | Failure Mode |
|---|---|---|---|---|---|
| 1 | Tea Press Worm | A | Broken worm | 1 | Overload |
| | | | | 2 | Improper Care |
| 2 | As a support for the work of the shaft | A | vibration occurs in the bearing | 1 | Unstable rotation |
| | | | | 2 | Lubrication error |
| 3 | PCR machine driver for pressing | A | Electric motor failure | 1 | high temperature |
| | | | | 2 | over current |
| 4 | Driving force in PCR machine | A | Worn on the gearbox | 1 | continuous loading |
| 5 | Transferring rotational power to the PCR machine | A | The drive shaft part is cracked at the joint. | 1 | Overload |
| 6 | A rotating base that holds the tea leaves | A | Broken grinding table | 1 | Too much tea was added |

| | | | | | |
|---|---|---|---|---|---|
| 7 | Changing the forward and backward movement on the PCR machine | A | Crankshaft | 1 | Overload |
| 8 | Transmitting power from the electric motor to the gearbox | A | V belt broken | 1 | continuous loading |
| 9 | A container for wilted tea leaves | A | Damaged roller cylinder | 1 | Too much tea was added |
| 10 | Ground for ground tea | A | Broken grinding base | 1 | continuous loading |

2. *Logic Tree Analysis*

*Logic Tree Analysis* (LTA) is a qualitative measurement to classify failure modes. If the answer to the question leads to a failure mode in category D, then the analysis is continued to determine whether the item falls into category D/A, D/B or D/C.

3. *Task Selection*

*Task Selection* Action selection is the final stage of the RCM process. From each failure mode, a list of effective actions to be carried out next is made. In the implementation of action selection, *Time-Directed* (TD), *Condition-Directed* (CD), *Failure-Finding* (FF), *Run-to-Failure* (RTF) are carried out.

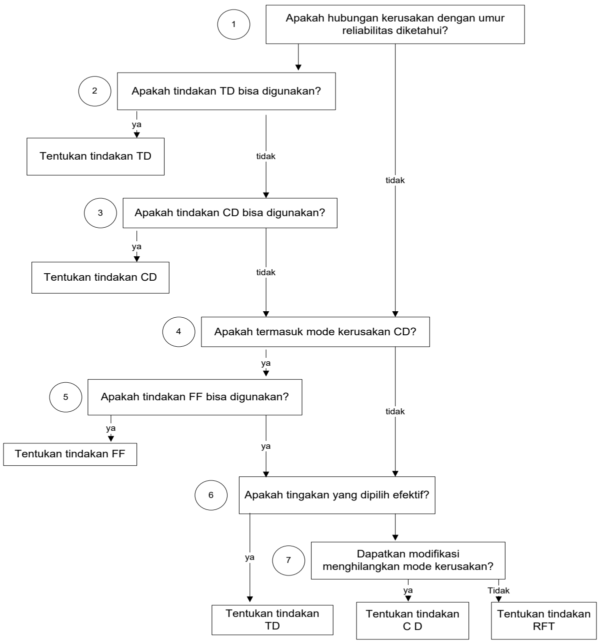

Figure 2. *Task Selection*

4. Time to Failure Calculation (TTF) and Time to Failure Calculation (TTR)

To determine the damage, *the Time to Repair* (TTR) and *Time to Failure* (TTF) calculations are carried out for each component.

Table 3. Recapitulation of *Worm Wheel* Component TTF Time

| PCR Machine No. | Working days | Total Operating Hours | TTR (Hours) | TTF (Hours) | PCR Machine No. | Working days |
|---|---|---|---|---|---|---|
| 1 | 152 | 1,824 | 3 | 1827 | 1 | 152 |
| | 154 | 1830 | 3 | 1833 | | 154 |
| 2 | 130 | 1542 | 3 | 1545 | 2 | 130 |
| 3 | 130 | 1542 | 3 | 1545 | 3 | 130 |
| 4 | 152 | 1806 | 3 | 1809 | 4 | 152 |
| 5 | 129 | 1530 | 3 | 1533 | 5 | 129 |

Table 4. Recapitulation of TTF Time of Bearing Components

| PCR Machine No. | Working days | Total Operating Hours | TTR (Hours) | TTF (Hours) |
|---|---|---|---|---|
| 1 | 130 | 1560 | 6 | 1566 |
| | 154 | 1830 | 6 | 1836 |
| 2 | 129 | 1548 | 6 | 1554 |
| | 108 | 1278 | 6 | |
| 3 | 109 | 1308 | 6 | 1314 |
| | 107 | 1266 | 6 | 1272 |

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| | | | | |
|---|---|---|---|---|
| | 109 | 1308 | 6 | 1314 |
| 4 | 152 | 1806 | 6 | 1812 |
| 5 | 152 | 1824 | 6 | 1830 |
| | 131 | 1830 | 6 | 1836 |

Table 5. Recapitulation of TTF Time of Electric Motor Components

| PCR Machine No. | Working days | Total Operating Hours | TTR (Hours) | TTF (Hours) |
|---|---|---|---|---|
| 2 | 152 | 1806 | 5 | 1811 |

Table 6. Recapitulation of Gearbox Component TTF Time

| PCR Machine No. | Working days | Total Operating Hours | TTR (Hours) | TTF (Hours) |
|---|---|---|---|---|
| 1 | 129 | 1530 | 3 | 1533 |
| 2 | 129 | 1548 | 3 | 1551 |
| | 152 | 1806 | 3 | 1809 |
| 3 | 130 | 1560 | 3 | 1563 |
| 4 | 130 | 1542 | 3 | 1545 |
| 5 | 130 | 1542 | 3 | 1545 |

Table 7. Recapitulation of TTF Time of Drive Shaft Components

| PCR Machine No. | Working days | Total Operating Hours | TTR (Hours) | TTF (Hours) |
|---|---|---|---|---|
| 1 | 152 | 1824 | 3 | 1827 |
| 2 | 129 | 1530 | 3 | 1533 |
| 3 | 130 | 1560 | 3 | 1563 |
| | 132 | 1566 | 3 | 1569 |
| 4 | 152 | 1806 | 3 | 1809 |
| 5 | 129 | 1530 | 3 | 1533 |

Table 8. Summary of TTF Time of Grinding Table Components

| PCR Machine No. | Working days | Total Operating Hours | TTR (Hours) | TTF (Hours) |
|---|---|---|---|---|
| 1 | 129 | 1530 | 7 | 1537 |
| 2 | 152 | 1806 | 7 | 1813 |
| 4 | 130 | 1542 | 7 | 1549 |

Table 9. Recapitulation of TTF Time of Crankshaft Components

| PCR Machine No. | Working days | Total Operating Hours | TTR (Hours) | TTF (Hours) |
|---|---|---|---|---|
| 1 | 152 | 1824 | 5 | 1829 |
| 2 | 130 | 1560 | 5 | 1565 |
| | 132 | 1566 | 5 | 1571 |
| 3 | 152 | 1806 | 5 | 1811 |
| 4 | 129 | 1530 | 5 | 1535 |
| 5 | 130 | 1542 | 5 | 1547 |
| | 131 | 1554 | 5 | 1559 |

Table 10. Recapitulation of TTF Time of V-Belt Components

| PCR Machine No. | Working days | Total Operating Hours | TTR (Hours) | TTF (Hours) |
|---|---|---|---|---|
| 1 | 129 | 1530 | 3 | 1533 |
| 2 | 130 | 1542 | 3 | 1545 |
| | 131 | 1554 | 3 | 1557 |
| 3 | 152 | 1824 | 3 | 1827 |
| 4 | 109 | 1308 | 3 | 1311 |
| | 107 | 1266 | 3 | 1269 |
| | 109 | 1308 | 3 | 1311 |
| 5 | 152 | 1542 | 3 | 1545 |

Table 11. Recapitulation of TTF Time for Rolling Cylinder Components

| PCR Machine No. | Working days | Total Operating Hours | TTR (Hours) | TTF (Hours) |
|---|---|---|---|---|
| 1 | 130 | 1542 | 10 | 1552 |
| | 131 | 1554 | 10 | 1564 |
| 2 | 152 | 1806 | 10 | 1816 |
| 3 | 107 | 1266 | 10 | 1276 |
| | 109 | 1308 | 10 | 1318 |
| 4 | 152 | 1806 | 10 | 1816 |
| 5 | 130 | 1560 | 10 | 1570 |
| | 132 | 1566 | 10 | 1576 |

Table 12. Recapitulation of TTF Time of Milling Base Components

| PCR Machine No. | Working days | Total Operating Hours | TTR (Hours) | TTF (Hours) |
|---|---|---|---|---|
| 1 | 130 | 1560 | 10 | 1570 |
| | 154 | 1830 | 10 | 1840 |
| 2 | 152 | 1806 | 10 | 1816 |
| 3 | 154 | 1830 | 10 | 1840 |
| 4 | 152 | 1824 | 10 | 1834 |
| | 154 | 1830 | 10 | 1840 |
| 5 | 129 | 1530 | 10 | 1540 |

5. Machine Failure *Downtime* Calculation

Based on the results of the machine breakdown time calculation, the total downtime of each component from September 2020 to September 2021 for each PCR machine component can be determined.

Table 13. *Downtime* Summary

| No | Component | Repair time duration (Hours) |
|---|---|---|
| 1 | Worm Well | 3 |
| 2 | Bearing | 9 |
| 3 | Electric motor | 5 |
| 4 | Gearbox | 3 |
| 5 | Drive Shaft | 3 |
| 6 | Grinding Table | 7 |
| 7 | Crankshaft | 5 |
| 8 | V Belt | 3 |
| 9 | Winding Cylinder | 10 |
| 10 | Grinding Base | 10 |

6. *to* Failure (TFT ) and *Mean Time to Repair* (MTTR)

The following is a summary table of the time of damage and repair of PCR machines:

Table 14. Recapitulation of MTTF and MTTR

| No | Component | MTTF | MTTR |
|---|---|---|---|
| 1 | Worm Well | 1682 | 3 |
| 2 | Bearing | 1433.4 | 6 |
| 3 | Electric motor | 1811 | 5 |
| 4 | Gearbox | 1591 | 3 |
| 5 | Drive Shaft | 1639 | 3 |
| 6 | Grinding Table | 1633 | 7 |
| 7 | Crankshaft | 1631 | 5 |
| 8 | V Belt | 1487.25 | 3 |
| 9 | Winding Cylinder | 1561 | 10 |
| 10 | Grinding Base | 1754.2 8 | 10 |

### 3.2 Recommendations for Improvement / Quality Improvement Proposals

Recommendations made to improve the quality of PCR machine performance can be seen as follows :

1. It is advisable to check the rotation of the crankshaft component so that it continues to rotate regularly and carry out maintenance according to the scheduled time.
2. It is advisable to routinely check the gearbox components such as *checking* the condition of the gearbox oil level, *checking* the condition of the oil circulation flow, *checking for* gearbox area leaks, inspecting the condition of the gearbox oil, and replacing the gearbox according to the age of the components so that the gearbox can be maintained and operate optimally.
3. It is advisable to check the workload on the grinding table components, check for damage to the grinding table that causes the grinding process to be imperfect and carry out maintenance according to the scheduled time.
4. It is advisable to replace and check the grinding base components regularly and carry out component maintenance according to the scheduled schedule.
5. It is advisable to check the working load on the drive shaft components and ensure good bearings to prevent greater damage and carry out maintenance according to the scheduled time.

## 4. Conclusion

From the results of the multiplication of Severity, Occurrence, and *Detection, the highest RPN Percentage* is obtained , namely the crankshaft 17.07 in the FMEA method. Based on the results of the RCM analysis, the reliability calculation is carried out on the components included in the selection of *Time Directed* (TD) actions. These components include: *Gearbox crankshaft, grinding table, grinding base, grinding base, drive shaft* and *Condition-Directed* (CD) is a treatment directed at detecting failure or symptoms of damage. The main *electric motor component* is included in the selection of *Condition Directed* (CD) actions. The actions taken are aimed at detecting damage by means of *visual inspection* , checking tools, and monitoring a number of existing data. If there is a detection of symptoms of equipment damage, it is continued with repair or replacement of components.

The proposed maintenance of PCR machines carried out to reduce damage to PCR machines includes direct prevention of the source of damage and proper maintenance, regular replacement and checking of bearings according to schedule and not exceeding the life of the components, routinely checking current and temperature and carrying out maintenance according to schedule.

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