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Proposed Maintenance Plan for Maker Machinery with Reliability Centered Maintenance (RCM) Method and Maintenance Value Stream Mapping (MVSM) at PT. XYZ

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A B S T R A C T

PT XYZ is a company engaged in cigarette production, where most of the production process uses automatic machines. The problem faced by the company is damage that occurs at any time before the scheduled maintenance interval causes overhaul and replacement or corrective maintenance activities which causes downtime and stops the production process on production machines that have a high average downtime compared to other machines. With these problems, calculations are carried out to obtain maintenance scheduling time intervals. The index of fit is used to measure how well the Weilbull distribution is based on the time to repair data. The fit index value (r) for the Hoper component downtime data is 0.92 or 92%, which means that the Hoper component downtime data can be completed using the Weilbull distribution. Calculation of the time to failure and time to repair parameters uses the Weilbull distribution by finding the intercept (a), gradient (b), shape parameter (α) and scale parameter (β). Calculation of the mean time to failure and mean time to repair using the results of parameter calculations using the Weilbull distribution based on the gamma table results in a mean time to failure of 1054.67 hours and a mean time to repair of 218.18 minutes. Calculation of the inspection time interval on the Hoper component for 250 hours or 10 days per month. Analysis of maintenance efficiency using the maintenance value stream mapping (MVSM) approach obtained a maintenance efficiency percentage of 77.5%. Activities that provide added value have a longer time, namely 218.18 minutes. While activities that do not have added value is 63.2 minutes.

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1. INTRODUCTION

In the era of competition in the industrial world, especially manufacturing, every company is required to continuously improve innovation in order to remain competitive with other companies. An important factor in increasing productivity is the level of reliability of the production system machines at the company. In measuring how well the integrity of a production machine is, an effective and efficient maintenance process is needed. The company's ability to create quality results cannot be separated from the importance of machines and other manufacturing equipment.

PT. XYZ, which is located in East Java, is one of the companies engaged in the cigarette industry. This is in accordance with the number of consumers at this time. Due to the large number of consumer requests that result in machines working continuously, PT. XYZ requires scheduling machine maintenance to reduce downtime. PT XYZ is a company engaged in the production of cigarettes, where most of the production process uses automatic machines. The problem faced by the company is damage that occurs at any time before the scheduled maintenance interval causes overhaul and replacement or corrective maintenance activities which causes downtime and stops the production process on maker machines which have a high average downtime compared to other machines. Based on the problems faced by PT. XYZ, with the approach of using RCM and MVSM is expected to be able to reduce the number of downtimes that occur on machines that play a role in production at PT. XYZ.

In this study, the appropriate method used to solve the above problems is Reliability Centered Maintenance (RCM) which is used to determine the activities carried out to ensure that each production machine can run properly in accordance with Standard Operating Procedures. Then proceed to the Maintenance Value Stream Map (MVSM) method for the repair process, increase maintenance, visualize the flow of the machine maintenance process, and this method is very effective if used to ensure that each facility operates according to its function to reduce waste

In the era of competition in the industrial world, especially manufacturing, every company is required to improve and continue to be innovative in order to remain competitive with other companies. An important factor in increasing productivity is the level of reliability of the production system machines in the company. In measuring how good the integrity of a production machine is, an effective and efficient maintenance process is needed. The company's ability to create quality results cannot be separated from the importance of machinery and other manufacturing devices.

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2. LITERATURE REVIEW

1. Maintenance

Maintenance is an activity that includes maintenance, repair, replacement, cleaning, adjustment, measurement, and inspection of the facility being treated (Felecia & Limantoro, 2013). Treatment begins with the human desire to obtain comfort and safety for the facilities owned so that they can meet human needs.

Besides that, maintenance stems from the human desire to have a system that is more organized, neat, clean, and measurable. There is no similarity between the types of maintenance between one company and another. This is because each company has a different character and management pattern. However, in general, the grouping of maintenance activities can be divided into two groups, namely planned maintenance and unplanned maintenance. Types of treatment:

a. Corrective maintenance (corrective maintenance) is a maintenance activity carried out to repair and improve the condition of the facility/equipment until it reaches an acceptable condition. In repairs, improvements can be made in such a way as making changes or modifications to the design so that the equipment gets better.
b. Emergency maintenance is a repair activity that must be carried out immediately due to unexpected congestion or damage.
c. Running Maintenance where maintenance work is carried out when the facility or equipment is in operating condition. Ongoing maintenance is applied to equipment that must operate continuously in serving the production process. Some of the activities carried out such as cleaning, inspection, adjustment.
d. Shut Down Maintenance where maintenance work is carried out when the facility or equipment must be in a stopped state. Stop maintenance is planned maintenance activities. Several activities are carried out such as cleaning, inspection, overhaul.
e. Maintenance after damage occurs (Breakdown Maintenance) is maintenance work carried out after damage to the equipment occurs, and to repair it, spare parts, materials, tools and workforce must be prepared
f. Overall maintenance (Overhaul Maintenance) is a routine activity that includes disassembling, cleaning, checking, measuring repairs, assembling, and testing.(Ahmad & Arsyad, 2018)

2. FMEA (Failure Mode and Effect Analysis)

Failure Mode and Effect Analysis (FMEA) is the process of identifying the failure of a component that can cause a malfunction of the system. Analysis on the failure mode and effect analysis (FMEA) table consists of (Novianti & Rochmoeljati, 2023; Wahyudin et al., 2023) :

a. Function serves to describe the function of the component being analyzed.
b. Functional failure serves to determine failures that occur in components.
c. Failure modes function to identify the causes of failures that occur in the component being analyzed.
d. Failure effect serves to identify the impact caused by component failure.
e. Severity is used to determine the rating of the impact caused by the failure of the components being analyzed.
f. Occurrence is used to determine the frequency rating of the component being analyzed.
g. Detection is used to determine the probability rating of a component to detect a malfunction.
h. The risk priority number is used to determine the priority number for the risk of a malfunction which is obtained from the multiplication of severity, occurrence, and detection. (Dahniar, 2019)

3. Downtime

The term "downtime" refers to the period of time during which infrastructure and facilities remain unoccupied as a result of repair or maintenance procedures (Kulsum et al., 2018). Machine failure wastes time, prevents production processes from running normally, hinders the production of goods, and delays repairs. Crashes, setups, and adjustments are all part of downtime (Anardani et al., 2021)

4. RCM (Reliability Centered Maintenece)

One method of determining the maintenance requirements of any physical asset in the context of its operation is referred to as modified maintenance (RCM) (Setiawan et al., 2013). In essence, the RCM approach addresses several important issues that other methods of program maintenance lack. Process or facility safety is more important than any physical equipment. Different equipment will be more likely to fail due to different degradation mechanisms than other equipment due to differences in design and operation. entertainment, RCM is a methodical approach to evaluating facility and equipment resources to achieve pairing, cooling, and cost efficiency at the best facilities.(Raharja et al., 2021).

5. MVSM (Maintenance Value Stream Mapping)

The process of viewing and presenting the flow of information and materials from the start of the manufacturing process to the final product is known as Maintenance Value Stream Mapping (MVSM). A technique called Maintenance Value Stream Mapping is used to describe and simulate system maintenance activities to evaluate the efficiency of the maintenance function in terms of value added activities and non-value added activities. There are two activities in Maintenance Value Stream Mapping:

1. Value Added is a maintenance activity that can provide added value or benefits to the equipment.
   a) Mean Time To Repair (MTTR): Activities used to repair engine components that have failed (Fatma et al., 2020).
2. Non Value Added is an activity that cannot provide added value or benefits to the equipment.
   a) Mean Time To Organize (MTTO): Activities used to organize.
   b) Mean Time To Yield (MTTY): Check whether the machine is functioning as it should. (Ade et al., 2022)

Mean Time To Failure (MTTF) is the average value of the failure time that will come from a system (component). For a system that can be repaired, the MTTF is the service life of a component when it is first used or turned on until the unit is damaged again or needs to be checked again. Mean Time To Repair (MTTR) is the average time for checking or repairing when the component or unit is inspected until the component or unit is used or restarted.

In the formulation of calculations for downtime, namely:

$$t_{downtime} = t_{finished} - t_{start} \quad (1)$$

MTTF parameter calculation as follows:

$$b = \frac{\sum_{i=1}^{N} Ti.Yi - \frac{\sum_{i=1}^{N} Ti\,.\sum_{i=1}^{N} Yi}{N}}{\sum_{i=1}^{N} Ti^2 - \frac{(\sum_{i=1}^{N} Ti)^2}{N}}$$

$$\alpha = \frac{\sum_{i=1}^{N} Yi}{N} - b\frac{\sum_{i=1}^{N} Ti}{N}$$

$$\sigma = \frac{1}{b} \quad (2)$$

$$MTTF = \mu = -\alpha \times \sigma \quad (3)$$

Whereas in the calculation of the Mean Time To Repair (MTTR), namely the average time needed to repair a critical component if the component can still be repaired, using the formula:

$$MTTR = \frac{\text{total repair time}}{\text{repair amount}} \quad (4)$$

(Sukopriyatno et al., 2019)

6. Reliability

Reliability is defined as the probability of an item performing its function satisfactorily over a period of time and being used or operated under proper conditions. If the condition of the machine is unreliable or bad, then of course it can affect the smooth production of the company, one of which can cause defects in the products that are produced. But preferably, if the condition of the machine is in good condition, then of course the production results can be maximized. Therefore, good and reliable engine conditions are needed by the company. one way to keep the machine in good condition and reliable is to carry out routine maintenance. The function of maintenance is to be able to extend the economic life of existing production machines or equipment and to make sure that these production machines and equipment are always in optimal condition and ready to use for the implementation of the production process. The cause of the high downtime frequency, of course, does not necessarily come from the high utility level of the machine, but it can come from the machine itself whose reliability is starting to decrease. The reduced reliability of the engine is also caused by the reduced reliability of the engine components. In other words, one of the causes of high frequency of downtime that occurs suddenly, causing a discrepancy between production volumes and company production targets is low component reliability affecting machine reliability. It can be ascertained by having low component reliability, the machine will experience downtime. To minimize this, of course the company must have a good machine maintenance system so that it can increase the reliability of machines and components so as to reduce the frequency of downtime that occurs suddenly (Sulistyarini et al., 2019).

3. RESEARCH METHOD

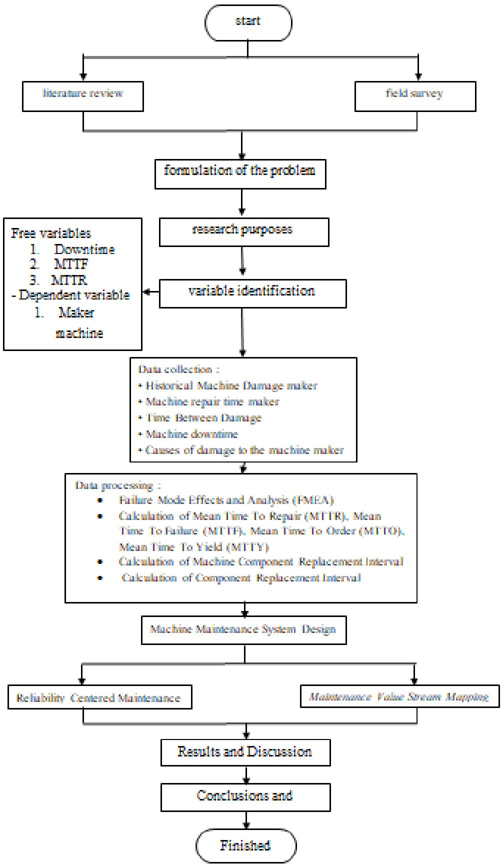

Fig. 1. Problem solving steps

To determine the optimal maintenance scheduling time interval so that the machine runs well according to its performance standards, it uses the one starting with FMEA to get the most critical components in the next damage with the approach Reliability Centered Maintenance (RCM) dan Maintenance Value Stream Mapping (MVSM). Failure Mode and Effect Analysis (FMEA) is the process of identifying the failure of a component that can cause a malfunction of the system. Reliability Centered Maintenance is a process that is carried out to determine what must be done in order to prevent failures from occurring to ensure that a tool or machine can work optimally when needed. Where the main goal of RCM is to maintain the function of identifying failure modes and prioritizing the importance of failure modes. Then, the selection of effective and applicable preventive maintenance measures is carried out. RCM can be defined as the process used to determine what must be done to ensure that some physical assets can function normally and perform the functions they are intended to use in the present operating context.

According to the process of viewing and presenting the flow of information and materials from the beginning of the manufacturing process to the final product is known as Maintenance Value Stream Mapping (MVSM). A technique called Maintenance Value Stream Mapping is used to describe and simulate system maintenance activities to evaluate the efficiency of the maintenance function in terms of value added activities and non-value added activities. The relationship between Reliability Centered Maintenance and Maintenance Value Stream Mapping, namely the two methods have a close relationship in maintaining the reliability and availability of machines and systems that are operated in manufacturing or other industrial environments.

The Reliability Centered Maintenance (RCM) method is a systematic approach to ensure the reliability and availability of machines and systems by conducting risk analysis and identifying appropriate maintenance actions to reduce the risk of failure and extend the service life of machines and systems. RCM usually involves a multidisciplinary team consisting of mechanics, electricians, production experts, and others. Meanwhile, the Maintenance Value Stream Mapping (MVSM) method is a method for identifying and mapping the value streams that occur in machine and system maintenance systems. MVSM helps identify activities that are not added value, eliminate waste, and improve operational efficiency. In the context of machine and system maintenance, MVSM can be used to identify potential waste (waste or waste that must be disposed of or must be eliminated) in the maintenance system and reduce unnecessary downtime. Thus MVSM can be used together with RCM to increase the effectiveness and efficiency of overall maintenance time. In conclusion, RCM and MVSM are two methods that complement each other in increasing the reliability and availability of machines and systems through risk identification and elimination of waste in maintenance systems.

4. RESULT AND DISCUSSION

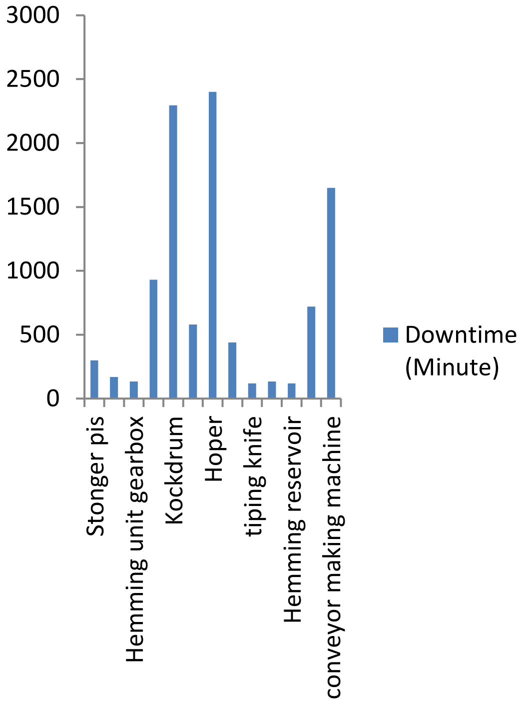

Fig. 2. Data of downtime maker machine components

Explains the study period, component data, maker machine damage data, calculation of component damage using Failure Mode Effect Analyze (FMEA), calculation of MTTF and MMTR values, and determination of component maintenance time intervals. The total downtime data for Maker machine components is taken in January 2022–December 2022 as follows:

Table 1. Downtime on maker machine components

Component	Downtime (Minute)
Stonger pis	300
Cuttop	170
Hemming unit gearbox	135
Cigarette knife	930
Kockdrum	2,295
Glueroll	580
Hoper	2,400
Gearbox tiping unit	440
Tiping knife	120
Fanbelt	135
Hemming reservoir	120
AS tiping unit	720
Conveyor making machine	1,650

(Source: company history)

Based on the analysis through FMEA, the Risk Priority Number (RPN) value for each component is obtained from determining the severity rating, occurrence and detection values. The following is an example of the results of calculating the RPN value taken from the Hoper component on the maker machine.

Where : RPN = S x O x D = (8 x 5 x 2) + (7 x 5 x 3) = 195

In critical determination which shows the level of importance of a component that is considered to have the highest level of risk so that it requires special treatment by making improvements. Based on the graph of critical components on the maker machine, it is found that the Hoper component is the most critical component.

Table 2. Time lapse of hope component damage

No	Component	Start *Downtime*	Finish *Downtime*	Ti (Minute)
1	Hoper	22/01/2022 16:00	22/01/2022 20:00	0
2	Hoper	07/02/2022 15:30	07/02/2022 19:30	22,770
3	Hoper	07/03/2022 15:30	07/03/2022 17:30	40,080
4	Hoper	12/04/2022 15:00	12/04/2022 20:00	51,690
5	Hoper	11/05/2022 14:30	11/05/2022 17:30	41,430
6	hoper	14/06/2022 14:30	14/06/2022 18:30	48,780
7	Hoper	21/06/2022 14:30	21/06/2022 18:30	9,840
8	Hoper	21/07/2022 14:30	21/07/2022 17:30	43,380
9	Hoper	26/08/2022 16:30	26/08/2022 22:30	51,780
10	Hoper	17/09/2022 19:00	17/09/2022 21:00	31,470
11	Hoper	02/10/2022 20:00	02/10/2022 23:00	21,540

(Source: Data PT. XYZ)

Calculation of the distribution of time to failure, by using calculations

Ti = Start of downtime – end of downtime = 22/01/2022 20:00 – 07/02/2022 15:30 = 22,770 minutes. Then do the calculation of the index of fit of the Hoper component. Identification uses the wilbul distribution. Calculation of index of fit.

xi = ln ti
= ln (9840) = 9,19

xi^2 = $9{,}19^2$
= 84,5

F (ti) = $\frac{i-0{,}3}{n+0{,}4}$
= $\frac{1-0{,}3}{10+0{,}4}$ = 0,067

Yi = $\ln|\ln[\frac{1}{(1-f(ti))}]$
= $\ln|\ln[\frac{1}{(1-0{,}067)}]$ = -2,66

Yi^2 = $-2{,}66^2$
= 7,09

Xi.Yi = 9,19 x -2,66

Table 3. Data of repair time

No.	Compo-nent	Start Downtime	Finish Downtime	Ti (Minute)
1	Hoper	22/01/2022 16:00	22/01/2022 20:00	240
2	Hoper	07/02/2022 15:30	07/02/2022 19:30	240
3	Hoper	07/03/2022 15:30	07/03/2022 17:30	120
4	Hoper	12/04/2022 15:00	12/04/2022 20:00	300
5	Hoper	11/05/2022 14:30	11/05/2022 17:30	180
6	hoper	14/06/2022 14:30	14/06/2022 18:30	240
7	Hoper	21/06/2022 14:30	21/06/2022 18:30	240
8	Hoper	21/07/2022 14:30	21/07/2022 17:30	180
9	Hoper	26/08/2022 16:30	26/08/2022 22:30	360
10	Hoper	17/09/2022 19:00	17/09/2022 21:00	180
11	Hoper	02/10/2022 20:00	02/10/2022 23:00	120

(Source: processed data)

Calculating the index of fit of the Hoper component. Identification using the weilbull distribution

xi = ln ti
= ln (240) = 5,480638923

xi^2 = $5{,}480638923^2$
= 30,03740301

F (ti) = $\frac{i-0{,}3}{n+0{,}4}$
= $\frac{1-0{,}3}{11+0{,}4}$ = 0,083333

Yi = $\ln|\ln[\frac{1}{(1-f(ti))}]$

= -24,49

r *weilbull* = $\frac{[n\sum_{i=1}^{n} xiyi]-[(\sum_{i=1}^{n} xi)(\sum_{i=1}^{n} yi)]}{\sqrt{[n\sum_{i=1}^{n} xi^2-(\sum_{i=1}^{n} xi)^2][n\sum_{i=1}^{n} yi^2-(\sum_{i=1}^{n} yi)^2]}}$

r *weilbull* = $\frac{10(-49{,}2942)-(103{,}9728687)(-5{,}23113)}{\sqrt{((10\ x1083{,}54)-10810{,}35)}\ ((10\ x\ 13{,}9262)-(27{,}3647))}$

= $\frac{50{,}95}{52{,}94}$ = 0,96

From the calculation above, the index of fit (r) value for the Hoper component's downtime interval data is 0.96 or 96%, which means that the Hoper component's downtime interval data can be completed using the Weilbull distribution.

= $\ln|\ln[\frac{1}{(1-0{,}0614)}]$ = -2,75877

Yi^2 = $-2{,}75877^2$

= 7,61082

Xi.Yi = 5,480638923 x -2,75877
= -15,1198

r *weilbull* = $\frac{[n\sum_{i=1}^{n} xiyi]-[(\sum_{i=1}^{n} xi)(\sum_{i=1}^{n} yi)]}{\sqrt{[n\sum_{i=1}^{n} xi^2-(\sum_{i=1}^{n} xi)^2][n\sum_{i=1}^{n} yi^2-(\sum_{i=1}^{n} yi)^2]}}$

r *weilbull* = $\frac{11(-38{,}172)-(58{,}66629624)(-5{,}79289)}{\sqrt{((11x314{,}0695242)-3441{,}73)}\ ((11\ x\ 15{,}6845)-(33{,}5576))}$

= $\frac{4{,}8627169553}{5{,}2413413}$ = 0,92

From the calculation above, the index of fit (r) value for the downtime data of the Hoper component is 0.92 or 92%, which means that the downtime data for the Hoper component can be completed using the Weilbull distribution..

Calculation of TTF (Time To Failure) and TTR (Time To Repair)

Calculation of parameters for time to failure using the Weilbull distribution. The calculation of the intercept (a), gradient (b), shape parameter (α) and scale parameter (β) uses the following formula:

b = $\frac{n\sum_{i=1}^{n} xiyi-(\sum_{i=1}^{n} xi)(\sum_{i=1}^{n} yi)}{n\sum_{i=1}^{n} xi^2-(\sum_{i=1}^{n} xi)^2}$
= $\frac{10(-49{,}2942)-(103{,}9728687)(-5{,}23113)}{10(1083{,}542804)-10810{,}4}$
= $\frac{50{,}9536}{25{,}028}$
= 2,03

β = b
= 2,03

a = $\bar{y}$ - b$\bar{x}$ = -0,52 – (2,03)(10,4)
= 21,632
α = $e^{\frac{\alpha}{b}}$
= $e^{-(\frac{21,632}{2,03})}$
= $2.718^{10,656}$
= 42399,64 minute / 706,6 hour

The next calculation is the calculation of the Hoper component parameters. Calculation of parameters for time to repair using the Weilbull distribution. The calculation of the intercept (a), gradient (b), shape parameter (α) and scale parameter (β) uses the following formula

b = $\frac{n\sum_{i=1}^{n}xiyi-(\sum_{i=1}^{n}xi)(\sum_{i=1}^{n}yi)}{n\sum_{i=1}^{n}xi^2-(\sum_{i=1}^{n}xi)^2}$
= $\frac{11(-38,172)-(58,66629624)(-5,79289)}{11(314,0695242)-2441,73}$
= $\frac{-80,0445}{85,5694}$
= - 0,93
β = b
= -0,93
a = $\bar{y}$ - b$\bar{x}$ = -0,52 – (-0,93)(5,3)
= -4,409
α = $e^{-\frac{\alpha}{b}}$
= $e^{-(\frac{4,409}{-0,93})}$
= $2.718^{2,1}$
= 114,47 menit / 1,9 hour

Calculation of Mean time to failure (MTTF) and Mean time to failure (MTTR)

The next stage is calculating the Mean time to failure (MTTF) and calculating the Mean time to repair (MTTR) on the Hoper component according to the Weilbull distribution using the following formula:

1. *Mean time to failure* (MTTF)
MTTF = $\alpha r(1+\frac{1}{\beta})$
= 706,6r(1+ $\frac{1}{2,03}$) →
Berdasarkan Tabel *Gamma*
= 706,6(1,492)
= 1054,67 Hour
2. *Mean time to repair* (MTTR)
MTTR = $\frac{Total\ Repair}{Frekuensi}$
= $\frac{2400}{11}$
= 218,18 menit

Calculation of Component Reliability

Reliability calculations are carried out to determine the probability of the performance of machine components to fulfill the expected function, the following is the calculation of component reliability:
is known :
e = 2,718
t = 1054,67
β = 2,03
α = 706,6
R (t) = $e^{-(\frac{t}{a})^{\beta}}$
= $2,718^{-(\frac{1054,67}{706,6})^{2,03}}$
= 0,1049

It is known that the reliability of the Hoper component with t = 1054,67 is 0,1049 or 10,49%.

Calculation of Inspection Time Interval

The following is the calculation of the inspection time interval on the Hoper component :

- The time needed by the company for Hopper inspection is 1 hour
- Number of inspections (k)
  a. 1 month = 25 working days; 1 day 18 hours of work
  b. T = 25 days x 18 hours of work = 450 hours/month
  c. The number of component failures for 1 year = 11 times
  d. K = $\frac{11}{12\ bulan}$
  = 0,91
- Average time required for repairs
  a. MTTR = 3,63 hour
  b. T = 450 hour
  c. $\frac{1}{\mu}$ = $\frac{MTTR}{T}$
  $\frac{1}{\mu}$ = $\frac{3,63}{450}$
  $\frac{1}{\mu}$ = 0,008
  μ = $\frac{1}{0,008}$
  μ = 125
- Average time to carry out inspections
  a. Time to check (ti)= 1 hour
  b. T = 450 hour / month
  c. $\frac{1}{i}$ = $\frac{ti}{t}$
  = $\frac{1}{450}$
  = 0,002
- Calculation of inspection frequency
  N = $\sqrt{\frac{k.i}{\mu}}$

$= \sqrt{\frac{0{,}91 \; x \; 450}{125}}$

$= 1{,}80$

- Checking time intervals

$\frac{T}{N} = \frac{450}{1{,}80}$

= 250 hour = 10 day / month

Formula description:
T = Average working hours per month
μ = average time needed for repairs
i = average time to conduct inspections
ti = time to perform the inspection:

Maintenance Effectiveness Analysis Using Maintenance Value Stream Mapping (MVSM) Approach

Table 4. Hoper replacement time category

No	Activity Sequence	Time (Minute)	Time Category	Activity Category
1	The hopper is broken	-	-	-
2	Communicate the problem to the head of the maintenance division	6,2	MTTO	NVA
3	Delay determines and prepares repair workers	5	MTTO	NVA
4	Identify the source of the problem	20	MTTO	NVA
5	Identify required equipment resources and components	7	MTTO	NVA
6	Prepare work orders	15	MTTO	NVA
7	Perform machine repairs	218,18	MTTR	VA
8	Running Machine and Inspection After Repair	10	MTTY	NVA
	MLLT		**281,32**	
	MTTO		**53,2**	
	MTTR		**218,18**	
	MTTY		**10**	

Value added time = 218,18 Menit
Non value added time = 63,2 Menit
Maintenance Efficiency Percentage
= MTTR/MMLT x 100
= 218.18/281.32 x 100
= 0.775 / 77.5%

From the results of the calculation above, it was found that the percentage of maintenance efficiency values was 77.5%. Activities that provide added value have a longer time of 218.18 minutes. While activities that do not have added value are 63.2 minutes.

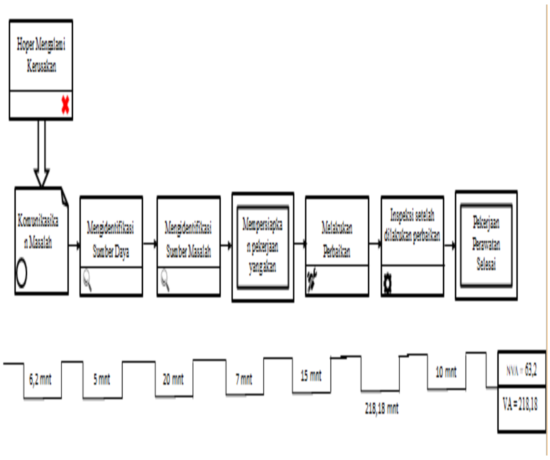

Fig. 3. Maintenance value stream mapping of hoper component

5. CONCLUSION

The index of fit is used to measure how good the Weilbull distribution is based on the time to failure data. From the calculation above, the index of fit (r) value for the Hoper component's downtime interval data is 0.96 or 96%, which means that the Hoper component's downtime interval data can be completed using the Weilbull distribution. The index of fit is used to measure how good the Weilbull distribution is based on the time to repair data. From the calculation above, the index of fit (r) value for the downtime data for the Hoper component is 0.92 or 92%, which means that the downtime data for the Hoper component can be completed using the Weilbull distribution. Calculation of parameters for time to failure and time to repair uses the Weilbull distribution by finding the intercept (a), gradient (b), shape parameter (α) and scale parameter (β). Calculation of the mean time to failure and mean time to repair using the results of parameter calculations using the Weilbull distribution based on the gamma table results in a mean time to failure of 1054,67 Hours and a mean time to repair of 218,18 minutes. Calculation of inspection time intervals on the Hoper component for 250 hours or 10 days per month. Analysis of maintenance efficiency using the maintenance value stream mapping approach found that the percentage of maintenance efficiency values was 77,5%. Activities that provide added value have a longer time of 218,18 minutes. While activities that do not have added value are 63.2 minutes.

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