Nusantara Journal of Multidisciplinary Science
Vol. 1, No. 12, July 2024
Hal 826-838
E-ISSN : 3024-8752
P-ISSN : 3024-8744
Site : https://jurnal.intekom.id/index.php/njms

Analysis of Maintenance Planning and Scheduling of Plastic Packaging Production Machine Spout Products with RCM, RAM, and Preventive Maintenance Methods at PT. X

Daniel Chrisnanda[1], Etik Puspitasari[2]
[1,2] Department of Mechanical Engineering, State Polytechnic of Malang, Malang, Indonesia

Article Info

Article history:

Received June 29, 2024
Revised June 29, 2024
Accepted July 25, 2024

Kata Kunci:

Mesin Produksi Plastik,
Preventive Maintenance,
RCM,
RAM,

Keywords:

Plastic Production Machine,
Preventive Maintenance,
RCM,
RAM

ABSTRACT

PT. X is a plastic packaging manufacturing company, based on machine comparison in 2023, the spout assembly machine is the most critical machine because of the high frequency of downtime, which is 106 times. With the RCM method and RAM determination of critical components determined by FMEA, the RPN value at the very high-risk level (> 200) is; line feeder (681), gear (608), electric sensor (440) and pneumatic (224). Reliability value electrical sensor component 0.5 at (t) = 96 operating hours, transmission (t) = 108 operating hours, line feeder (t) = 120 operating hours, and pneumatic (t) = 729 operating hours. Maintainability of line feeder components maximally maintained for 3 hours = 81.1%, transmission 5.5 hours = 82%, electrical sensor 1.5 hours = 84.6%, pneumatic 2.5 hours = 83%. The results of maintainability value have been included in the IVARA standard (80%). Inherent Availability (AI) and Operational Availability (AO). AI of line feeder = 98%, transmission = 98%, electric sensor = 99%, and pneumatic = 99%. While the AO value of the line feeder component = 94%, transmission = 92%, electric sensor = 94%, and pneumatic = 85%. AI percentage reached IVARA level, but AO percentage did not reach IVARA level (95%). Maintenance schedule planning is: line feeder repair = 15 days, replacement = 8 weeks, gear; repair = 8 days, replacement = 9 weeks, electric sensor; repair = 178 days, replacement = 50 weeks, pneumatic; repair = 118 days, replacement = 33 weeks. Through the predetermined maintenance cost savings for the company with the comparison results, the estimated savings is Rp83,881,208 or 51.9%.

Corresponding Author:

Etik Puspitasari
Department of Mechanical Engineering, State Polytechnic of Malang,
Malang, Indonesia
Email: etik.puspitasari@polinema.ac.id

1. INTRODUCTION

The use of plastic products in everyday needs is still very high, such as for food packaging, cosmetics, electronics, and various other needs. PT. X is one of the largest plastic packaging manufacturing companies in Indonesia with a very high demand for orders from customers. In manufacturing a spout product, PT. X uses two machines that are in one production line, namely an injection molding machine to print the body spout and cap spout product components, and an assembly machine to join the body and cap components. Until now, the plastic packaging production machine (spout) has not had a planned maintenance schedule and there is also no appropriate Standard Operating Procedure (SOP) for machine maintenance and repair actions, so currently maintenance actions are performed during breakdowns to replace damaged components. This is certainly a loss to the company as the machine loses production opportunities and the company loses profits. Without a proper maintenance system, the company will suffer huge losses, such as damaged machines, and cannot function again, the number of defective products increases, to material losses due to frequent replacement of components on the machine [1].

The above problems indicate the need to improve maintenance management. Machinery and equipment are a unit in production that cannot be separated from each other, so it needs the attention of the company. Maintenance is carried out to maintain quality, minimize activities that endanger operators, reduce downtime, and optimize production [2]. In this study, an approach with the RCM (Reliability Centered Maintenance) method was used to determine the maintenance activities carried out to ensure that each production machine can operate properly in accordance with Standard Operating Procedures [2], which aims to analyze RAM (Reliability, Availability, and Maintainability) on plastic packaging production machines. RAM aims to identify the critical items that have the greatest impact on RAM. Based on downtime data comparison for spout product production machines at PT. X, assembly machines have a higher percentage of downtime than injection molding machines.
On the basis of the RCM-RAM analysis, there is an expectation that the reliability value of a critical component is known. Reliability is the probability that a component, piece of equipment, machine or system will continue to operate properly according to its expected function for a specified time interval and under specified conditions [3].

Based on the reliability value, the preventive maintenance schedule of the critical component can be determined. The existence of a structured maintenance schedule is expected to be a guideline for operators and maintenance teams to carry out maintenance actions and to reduce the risk of losses caused by the stoppage of production machinery due to damage to components or machines. Preventive maintenance is maintenance that is carried out on a scheduled basis, usually periodically, where a set of maintenance tasks such as inspection and repair, replacement, cleaning, lubrication, adjustment and replacement of components [4] The results of this study will determine a preventive maintenance schedule plan with an overhaul-to-overhaul period.

Maintenance cost estimation is also a parameter that must be considered in maintenance planning. If the effect of the damage will increase the production costs, it will be a good tone if the action to make repairs is carried out as soon as possible [5]. Maintenance cost estimate is a total estimate of the costs that must be incurred by the company in carrying out maintenance actions. maintenance cost estimate is expected to open up opportunities for savings and profits for the company. The maintenance cost estimate is also influenced by the need for tools and other support to perform maintenance activities. The difficulty usually encountered is determining the correct preventive maintenance schedule. This requires accurate data on component damage patterns along with repair costs, preventive maintenance, and lost production time. [5].

2. METHOD

In the process of research, a flow chart is needed to make it easier for researchers to determine the sequence of the research process from start to finish:

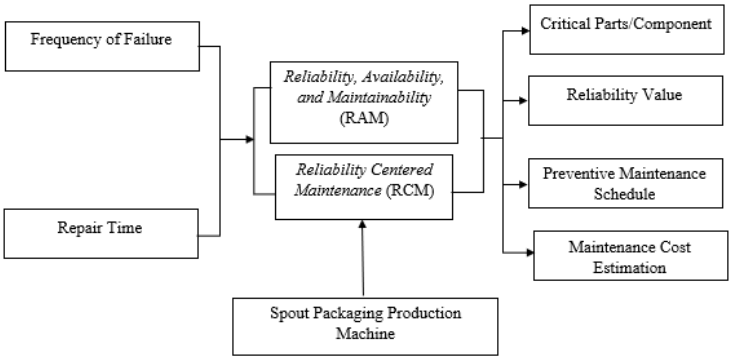

Figure 1. Research Framework

This research has been carried out in several stages, which are;

1. Problem Identification: Problem identification is the first step that is carried out when research takes place so that it can raise clear and focused problems.
2. Problem Formulation: Problem formulation restates the core of the identified problem and then places it within a specific problem scope.
3. Research Objective: Problem formulation restates the core of the identified problem and then places it within a specific problem scope.
4. Data Collection: The data collected in this study consisted of quantitative data and qualitative data, both in the form of primary data and secondary data.
   a. Primary Data: In this research, the author will collect data directly from the original source by means of observation or direct observation and interviews.
      - Interview: The process of collecting data by means of Q&A (questions and answers) sessions either directly or indirectly.
      - Observation: One method of approach to collect data by directly observing the object of data.

Secondary Data: This research is obtained indirectly, meaning that research can be obtained through literature references sources such as journals, books, theses, and the internet. Based on literature references, the author can listen to and study information through literature related to the problems discussed in the study.

3. RESULT AND DISCUSSION

3.1 Downtime Data Collect

Spout assembly machine component downtime data is historical data recorded in the operator's daily report and company's monthly report for January-December 2023. The data includes the parts or components that are damaged and the total downtime of the machine until the damage is repaired.

3.2 Failure Mode and Effect Analysis (FMEA)

Failure Mode and Effect Analysis FMEA is used to identify the functions and failures of components and their impact on system reliability. The FMEA method provides a method of calculating risk by creating a risk prioritization value and Risk Priority Number (RPN) based on severity, occurrence and detection values. The following is the determination of the risk level based on the RPN value [8]. FMEA data is completed based on input from business managers, machine operators, and the maintenance team.

Table 1. Failure Mode and Effect Analysis

Part	*Function*	*Potential Function Failure*	*Potential Effects of Failure*	*Severity (S)*	*Potential Cause of Failure*	*Occurrence (O)*	*Action*	*Detection (D)*	*RPN*
Transmision	Drive System / Power source engine	The rotation of the rotary plate is not maximized or slowed down	products that will be in assembling not exactly position between body spout with cap spout	8	Locking Bolt sprocket loose position on the sprocket gear experiencing shift Sprocket Mount not suitable Loose rotary chain	6	Tightening the bolt locking stationary sprocket re-positioning sprocket gear sprocket mount modification Retighten the rotary chain	8	384
		broken van belt electric motor	machine stop production	8	condition of the van belt worn out belt size that does not match the drive pulley	7	replacing with a new v-belt parts order V-belt with the size that matches the motor pulley	4	224
electrical sensor	as a motion detector, meter, and processor on machines	spout products does not enter the rotary area	machine stop production	8	damage to feeding sensor that that reads the motion of the shaft	5	replaced the new photoelectric sensor feeding part	5	200
		Sensor tidak membaca kondisi produk	“Not Ok” product enter into the product output “OK”	8	Sensor support loose and causing thethe sensor does not fit	10	re-positioning the sensor support / mount, tightening the sensor locking bolt	3	240
Line feeder	entry line products that will be assembled into the rotary section	Vibrator on Line Feeder is not working	Product does not move towards rotary	9	Mica Buffer Broken Vibrator	7	Replaced the mica part vibrator support with PCB Mica	7	441
		line feeder position tilted	product stuck stopper/inverted causing defects and jamst	8	line feeder position shifted due to vibration	6	repositioning the Line Feeder	5	240

E-ISSN : 3024-8752
P-ISSN : 3024-8744

Part	*Function*	*Potential Function Failure*	*Potential Effects of Failure*	*Severity (S)*	*Potential Cause of Failure*	*Occurrence (O)*	*Action*	*Detection (D)*	*RPN*
bowl vibrator	a place to to hold the product before it enters the feeder line	bowl slide	products get stuck and do not enter the feeder line	7	bowl shifts due to vibration	6	repositioning the vibrator bowl	3	126
		vibrator does not works	bowl does not vibrate and the product does not move/movement product slows down	2	failure of vibrator cable Disfunctional Frequency Control unit Vibrator	3	perform replacement vibrator control unit cable restart Frequency control unit vibrator	4	24
Pneumatic	control device movement mechanism machine system	vacuum cap is not stable	vacuum cap suction power is reduced, the cap cannot be vacuum suctioned to the rotary	8	solenoid valve vacuum filter clogged/dirty Exhaust Filter silencer leaking	4	Cleaning the solenoid vacuum valve replace with a new part	7	224
conveyor	a tool to accommodate and distribute product before entering the vibrator bowl	conveyor isn't moving	bowl not filled	4	dislocation belt conveyor Product stuck on conveyor liner	5	re-aligning the position of the conveyor belt regulates the number of products that enter the conveyor so as not to overload	2	40
capping	To close and lock the cap on the body spout	capping is not working properly	the presence of defects caused by unstable torque and capping speed	7	belt on the capper Loose	6	resetting and tightening the capper belt	2	84
Rotary	placeholder for products to be assembled	rotary limiter Loose	causing defects defects in products	7	locking bolt on rotary limiter is loose/detached	5	tightening the bolt rotary limitery	2	70

Table 2. RPN Risk Parameter

RISK LEVEL	RPN VALUE
VERY LOW	x < 20
LOW	20 ≤ x ≤ 80
MEDIUM	80 ≤ x ≤ 120
HIGH	120 ≤ x ≤ 200
VERY HIGH	x > 200

With the RPN category, it can be seen that the risk of high RPN values is included in the Very High parameter, so that it can be prioritized in determining anticipation, mitigation and strategy actions for risks that have the highest level [8] From Table 3, it can be seen that the risk of components with the highest RPN value is very high. In this case, the FMEA table shows that there are 4 components that fall into the Very High-Risk category with a total RPN value greater than 200, there is the line feeder (681), electric sensor (440), transmission (608) and pneumatic (224).

3.3 MTBF and MTTR

In order to determine the MTBF and MTTR values on critical components of the spout assembly machine, data processing is carried out based on data from each critical component that has been obtained as follows

Table 3. Downtime Data of Critical Parts of Spout Assembly Machine During 2023

No	Parts	Optimal Time (∑T uptime)	Failure Frequency (n)	Total Downtime (∑T)
1	Line feeder	2.789 Hours	28	53 Hours
2	Transmission	2.789 Hours	9	54,5 Hours
3	Electrical Sensor	2.789 Hours	18	14,5 Hours
4	Pneumatic	2.789 Hours	6	8,5 Hours

Based on the values of Optimal Time, Frequency of Damage, and downtime, the MTBF and MTTR values of each critical component can be determined, using the equations below. Asked MTBF and MTTR?

A. Mean Time Between Failure (MTBF)

$$\text{MTBF} = \frac{\sum \mathbf{T\ uptime}}{\mathbf{n}}$$

B. Mean Time to Repair (MTTR)

$$\text{MTTR} = \frac{\sum \mathbf{T}}{\mathbf{n}}$$

Based on the equations, the MTBF and MTTR values of each critical component are obtained as follows:

Table 4. MTBF and MTTR Value of Critical Parts

No	Parts	MTBF (Hours)	MTTR (Hours)
1	Line feeder	99,6	1,8
2	Transmission	164	3,2
3	Electrical Sensor	154,9	0,8
4	Pneumatic	464,8	1,4

3.3 Distribution Test Results

The distribution test results using Minitab 21 software are as follows:

Table 5. Distribution Test Results for Critical Parts

No	Parts	Remarks	Anderson-Darling (Adj)			
			Weibull	Lognormal	Normal	Exponential
1.	Line feeder	TTF (Time to Failure)	0,752	1,336	2,176	0,979
2.	Transmission		1,621	1,931	1,750	1,480
3.	Electrical Sensor		0,924	0,908	1,567	0,798
4.	Pneumatic		2,402	2,470	2,353	2,524

According to the results in the table, the distribution used is the one with the smallest Goodness-of-Fit. Determination of this distribution is based on the Anderson Darling value, the largest Correlation, and the smallest P-value. [9]. then it can be determined for line feeder using the

Weibull distribution, pneumatic using the normal distribution, transmission and electrical sensors using the exponential distribution.

3.4 Reliability

For the reliability calculation of each component based on the corresponding distribution results.

1. Line Feeder
   (η) Scale parameter = 203,814
   (β) Shape parameter or slope= 0,724702
   (t) time interval = 12 – 168 Hours
   Reliability value of line feeder?
   R(t) $= e^{-\left(\frac{t}{\eta}\right)^{\beta}}$
   R(t) $= e^{-\left(\frac{12}{203,814}\right)^{0,724702}} = 0,87$
   = 0,87 x 100%
   = 87%

2. Transmision
   MTBF =164 hours
   (t) time interval = 12 – 168 hours
   Reliability value of transmission?
   R(t) $= e^{\left(-\frac{t}{MTBF}\right)=e^{-}\lambda(ty)}$
   R(t) $= 2,7182^{\left(-\frac{12}{164}\right)=0,92}$
   = 0,92 x 100%
   = 92%

3. Electrical Sensor
   MTBF = 154,9 hours
   (t) time interval = 12 – 168 hour
   Reliability value of electrical sensor?
   R(t) $= e^{\left(-\frac{t}{MTBF}\right)=e^{-}\lambda(ty)}$
   R(t) $= 2,7182^{\left(-\frac{12}{154,9}\right)=0,92}$
   = 0,92 x 100%
   = 92%

4. Pneumatic
   (μ) Mean = 809,9
   (σ) Standart deviaation = 674,464
   (t) time interval = 72 – 864 hours
   (ϕ) Z Value = based on z score table
   Reliability value of pneumatic?
   R(t) $= 1 - \phi\ (\frac{t-\mu}{\sigma})$
   R(t) $= (\frac{72-809,9}{674,464}) = -1,094 \quad \phi = -1,094 \rightarrow 0,1379$

Based on the results of the calculation of the reliability value of each component, a graph is made to determine the reliability value of the component at a predetermined hourly interval.

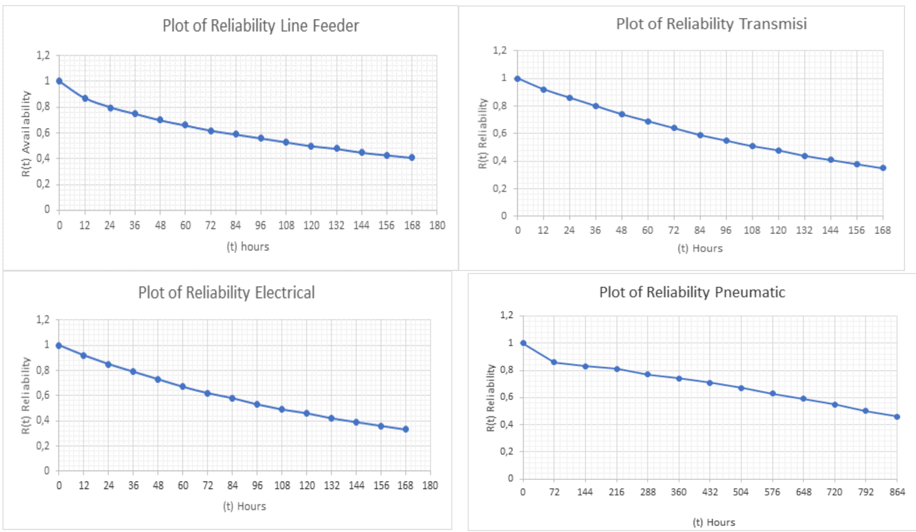

Figure 2. Assembly Spout Critical Parts Reliability Graph

E-ISSN : 3024-8752
P-ISSN : 3024-8744

In the graph above, the x-axis shows reliability R(t) and the y-axis shows engine time (t) hours. Based on the graph above, the reliability value of each component will decrease as the engine operating hours increase. To maintain the reliability value, maintenance must be performed on the part when the reliability value reaches or approaches 0.5.

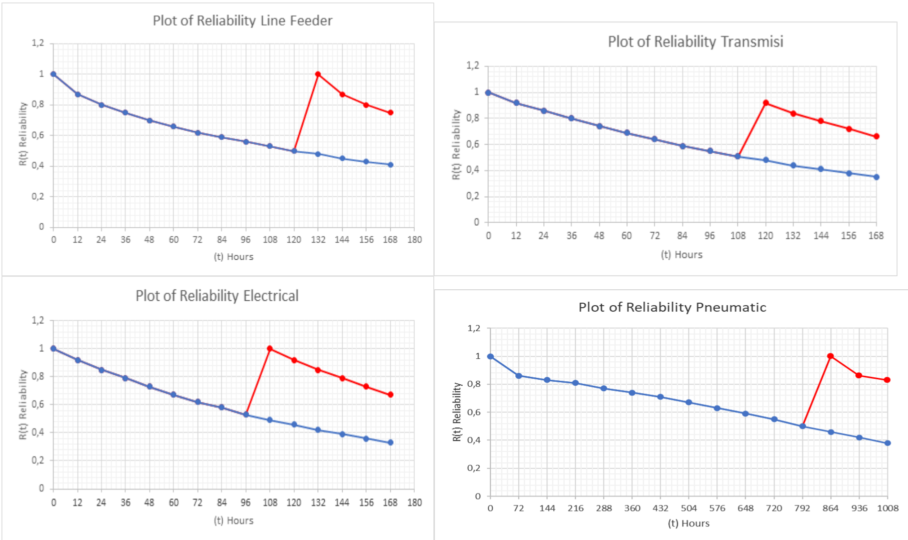

Figure 3. Assembly Spout Critical Parts Reliability Graph after implanting maintenance

The figure in the graph above shows an increase in the reliability value of the critical components of the spout assembly machine, the increase in reliability value occurs when the reliability value approaches R(t) = 0.5 back to R(t) = 1. This shows the increasing reliability of the machine after inspection and maintenance at certain time intervals to increase the reliability of a component.

3.5 Maintainability

Calculating maintainability is used to determine how long each component will take to maintain in order to maximize equipment availability. The maintainability equation is as follows:

$$M(t) = 1 - exp^{-\left(\frac{t}{MTTR}\right)}$$

The following is a summary of the maintainability value of each critical component after analysing the calculation, using the above equation to determine the maintainability value based on the repair time interval:

Table 6. Maintainability Value of Critical Parts

No	Parts	MTTR (Hours)	Repair Time Interval (Hours)	Maintainability M(t)
1	Line feeder	1,8	3	81%
2	Transmission	3,2	5,5	82%
3	Electrical Sensor	0,8	1,5	84,60%
4	Pneumatic	1,4	2,5	83%

The maintainability value will reach the IVARA standard (Maintenance Key Performance Indicator) when the maintainability value is more than 80%. Based on the results of the table above, the maintainability value of each critical component has reached a value of more than 80%. Assuming that the line feeder component has a maximum repair time of 3 hours, the transmission component has a maximum repair time of 5.5 hours, the electric sensor component has a maximum repair time of 1.5 hours, and the pneumatic component has a maximum repair time of 2.5 hours.

3.6 Availability

In the action of production machinery maintenance, availability value is very important to know to measure the parameters of machine readiness in running functional production. In another sense, availability is a state of readiness of a machine/equipment both in quantity and quality in accordance with the needs used to carry out the operation process. Availability can be used to evaluate the success or effectiveness of maintenance activities performed. Availability is divided into two categories, namely inherent availability and operational availability.

1. Inherent Availability

Inherent Availability is the probability that a system or equipment will operate satisfactorily under specified conditions in an ideal support environment at any time. It does not include preventive maintenance or planned actions.

$$Ai = \frac{MTBF}{MTBF+MTTR}$$

2. Operational Availability

It is the probability, taking into account factors such as downtime, logistics, etc., that a system or piece of equipment used under certain conditions in an ideal support environment will operate satisfactorily at all times.

$$Ao = \frac{Uptime}{Operational\ cycle+MTBF}$$

The Ai and Ao values of each critical component of the spout assembly machine can be calculated using the above equation. The following is a summary of the results of the maintainability value calculation.

Table 7. Availability Value of Critical Parts

No	Parts	Inherent Availability	Performance Indicator (95%)	Operational Availability	Performance Indicator (95%)
1	Line feeder	98%	Achieved	94%	Not Achieved
2	Transmission	98%	Achieved	92%	Not Achieved
3	Electrical Sensor	99%	Achieved	94%	Not Achieved
4	Pneumatic	98%	Achieved	85%	Not Achieved

The availability value will reach the IVARA standard (Maintenance Key Performance Indicator) when the availability value is more than 95%. According to the above formula, the inherent availability values of each critical part have reached the IVARA level, but the operational availability values have not reached the IVARA level.

3.7 Preventive Maintenance Schedule

Scheduling and performing preventive maintenance, coupled with effective maintenance activities, aims to eliminate causes of system failure. [11] Maintenance scheduling is an effort to keep the production machine operating optimally by maintaining, repairing, and replacing critical components on the machine according to predetermined maintenance intervals. The schedule is determined based on the results of observations and discussions with the manager of the spout production area at the plant, where routine weekly inspections take place to maintain the condition of critical components on the spout assembly machine. The repair, component replacement, and overhaul periods are shown in the table below.

Table 8. Availability Value of Critical Parts

No	Parts	Repair (Day)	Replace (Weeks)	Remarks	Range Interval
1	Line Feeder	15	8	Replacement of vibrator support mica parts	Based on the changeover Previous
2	Transmission	32	9	Replacement of V-Belt motor parts	Based on the changeover Previous
3	Electrical Sensor	178	50	Replacement of photoelectric sensor parts	Based on the changeover Previous
4	Pneumatic	118	33	Replacements of silencer, vacuum, dan solenoid valve parts	Based on the changeover Previous

Based on the repair schedule interval shown above, the preventive maintenance schedule is determined as follows:

3.8 Preventive Maintenance Cost Estimation

In this study, an estimate is made to calculate the maintenance costs, limiting the overhaul to the overhaul period. In this cost estimate, it is obtained based on the results of a survey of the types of needs of the main components and critical components on the spout assembly machine. For the calculation of the total cost of optimal maintenance, the relevant maintenance costs are considered, namely the preventive maintenance costs and the maintenance costs caused by breakdowns [7].

Table 9. Maintenance Failure Cost

MAINTENANCE FAILURE COST					
No	**Description**	**Parts**	**MTTR (Hours)**	**Frequency (times)**	**Cost**
1	For the implementation of repairs and cleaning, 1 mechanic is needed at a cost of IDR 24,557,- / hour. The average time required for cleaning and replacing components (MTTR) is; Mechanic Cost x MTTR x Frequency	Line Feeder	1,8	28	Rp1.237.672
		Transmission	3,2	9	Rp707.241
		Electrical Sensor	0,8	18	Rp353.620
		Pneumatic	1,4	6	Rp206.278
2	Opportunity lost to make a profit due to the machine experiencing	Line Feeder	1,8	28	Rp78.775.200

	damage Rp1,563,000, -/hour. The time required to repair, check, and replace components (MTTR) is Profit x MTTR	Transmission	3,2	9	Rp45.014.400
		Electrical Sensor	0,8	18	Rp22.507.000
		Pneumatic	1,4	6	Rp13.129.200
Total					**Rp161.930.611**

Table 10. Preventive Maintenance Cost (2025-2026)

PREVENTIVE MAINTENANCE COST					
No	**Description**	**Parts**	**Time (Hours)**	**Frequency (times)**	**Cost**
1	For the implementation of repairs. 1 mechanic is needed at a cost of IDR 24,557, - / hour. The average time required for cleaning and replacing components (MTTR) is; Mechanic Cost x Maintenance Time	Line Feeder	1	12	Rp294.684
		Transmission	1,5	11	Rp405.191
		Electrical Sensor	0,5	2	Rp24.557
		Pneumatic	1	3	Rp73.671
2	Opportunities lost due to idle machines Rp1,563,000,-/hour. The time required to repair, check, and replace components (MTTR) is Profit x Maintenance Time	Line Feeder	1	12	Rp18.756.000
		Transmission	1,5	11	Rp25.789.500
		Electrical Sensor	0,5	2	Rp1.563.000
		Pneumatic	1	3	Rp4.689.000
Total					**Rp51.595.603**

In conducting maintenance activities, several components and supporting tools are needed to support the smooth running of maintenance actions.

Table 11. Cost of Supplies and Supporting Components

Estimated Maintenance and Replacement Cost for Supporting Components					
No.	**Parts / Other Support**	**Qty**	**Unit**	**Cost/Unit**	**Total**
1	Alcohol 95% Onemed	20	Litre	Rp40.000	Rp800.000
2	Lap Kanebo	4	Pcs	Rp14.500	Rp58.000
3	latex Gloves	8	Box	Rp37.000	Rp296.000
4	Grease Food Safety	4	Can	Rp2.250.000	Rp9.000.000
5	Medical Mask	8	Box	Rp20.000	Rp160.000
6	Mounting Bracket Sensor	8	Pcs	Rp30.000	Rp240.000
7	Fin Grease Food Safety	4	Can	Rp995.000	Rp3.980.000
8	Pneumatic Polyurethane Hose 8 x 6	1	Roll	Rp555.000	Rp555.000
9	V- Belt bando B-33	11	Pcs	Rp35.000	Rp385.000
10	Photoelectric sensor	4	Pcs	Rp1.903.000	Rp7.612.000
11	vacuum valve	6	Pcs	Rp189.000	Rp1.134.000
12	solenoid valve	6	Pcs	Rp325.500	Rp1.953.000
13	silencer	6	Pcs	Rp31.800	Rp190.800
14	Mica Support Vibrator Line Feeder	12	Pcs	Rp7.500	Rp90.000
Total					**Rp26.453.800**

The total estimated cost required to perform preventive maintenance on the spout assembly machine is:
Total Cost = Cost of preventive maintenance in 2025-2026 + cost of supporting components in 2025-2026
= Rp51.595.603,- + Rp26.453.800,-
= Rp78.049.403,-

3.9 Calculation of Cost Savings Comparison Before and After Preventive Measures

Save on downtime costs by scheduling component replacements before they are damaged and according to predetermined preventive maintenance schedules.
The savings that will be obtained are :
= (Rp161.930.611,-) – (= Rp78.049.403,-)
= Rp Rp83.881.208,-

Or the percentage of savings is:
$= \frac{\boldsymbol{Rp83.881.208}}{\boldsymbol{Rp161.930.611}}$ x 100%
= **51,8%**

Thus, if preventive maintenance is performed according to a predetermined schedule with overhaul to overhaul calculations, the estimated savings are 51.8%

4. CONCLUSION

Based on the RPN value of FMEA, there are 4 most critical components on the spout assembly machine, namely the line feeder, transmission, electrical sensor, and pneumatic. Reliability value, electrical sensor component 0.5 at (t) = 96 operating hours, transmission (t) = 108 operating hours, line feeder (t) = 120 operating hours, and pneumatic (t) = 729 operating hours. Maintainability of line feeder components is maximally maintained for 3 hours = 81.1%, transmission 5.5 hours = 82%, electrical sensor 1.5 hours = 84.6%, pneumatic 2.5 hours = 83%. The results of the maintainability value above have entered the IVARA standard (80%). Inherent availability (AI) and operational availability (AO). AI line feeder = 98%, transmission = 98%, Electrical sensor = 99%, and pneumatic = 99%. While the AO value of the line feeder component = 94%, transmission = 92%, electrical sensor = 94%, and pneumatic = 85%. The percentage value of AI components has reached the IVARA standard, but the AO value has not reached the IVARA standard (95%). Maintenance schedule planning is line feeder repair = 15 days, replacement = 8 weeks, transmission; repair = 8 days, replacement = 9 weeks, electrical sensor; repair = 178 days, replacement 50 weeks, pneumatic; repair = 118 days, replacement = 33 weeks. Through the predetermined maintenance cost savings for the company with the comparison results, the estimated savings are Rp83,881,208 or 51.9%**.**

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