Advance Sustainable Science, Engineering and Technology (ASSET)
Vol. 7, No.2, April 2025, pp. 0250202-01 ~ 0250202-10
ISSN: 2715-4211 DOI: https://doi.org/10.26877/asset.v7i2.963

Improving Lathe Efficiency through Overall Equipment Effectiveness and Automatic Maintenance Methods

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Abstract. In the current industrial era, operational efficiency is key for companies. Machining service providers can be seen from the number of workshops. At CV. XYZ has a lathe problem, there is no method for maintenance. Therefore, the purpose of this study is to calculate machine maintenance in companies using the Autonomous Maintenance (AM) method. From the calculation results obtained during January-June 2024, the highest average OEE value was in May 88.82%, Availability Rate parameters 88.76%, Performance Rate 99.28%, Rate of Quality 100%. The lowest average OEE value occurred in January 52.11% with Availability Rate parameters 76.44%, Performance Rate 90.66%, Rate of Quality 75%. From these results, it is necessary to have machine maintenance with indications for each component: cleaning the dynamo regularly, ensuring the on-off button is connected which is expected to increase effectiveness, extend machine life, and reduce maintenance costs.

Keywords: lathe machine**,** maintenance planning, operational efficiency, optimiztaion of machne maintenance, OEE

(Received 2024-08-15, Accepted 2025-01-08, Available Online by 2025-03-03)

1. Introduction

In this industrial era 4.0, technology developing very rapidly, especially in the field manufacture [1]. Maintenance is an action taken to maintain equipment in good condition, with the hope of producing an output that meets established standards. Based on the definition above, it can be concluded that maintenance is closely related to preventive actions and industrial renewal [2]. Ensuring a system operationally effective is the major objective of maintenance and reliability effortS [3]. Apart from keeping facilities and equipment working effectively and efficiently, the maintenance process also helps smooth the production process due to timely product delivery, and also affects the level of availability of production facilities, production rate, quality of the final product, production costs, and operational safety. level of profit (profitability) of the company. Maintenance focuses on maintaining the reliability and readiness of equipment and reducing maintenance costs, maintenance usually focuses on reducing damage [4]. The lack of attention to the maintenance process is caused by the large need for funds, not only for lathe maintenance. However, the maintenance process must be prioritized because it is the main

thing so that the machine does not experience damage while operating [5]. Overall Equipment Effectiveness (OEE) is the value of the amount of effectiveness possessed by an equipment equipment or machines. OEE can be calculated by measuring the availability of machines/equipment, process efficiency performance of the process and rate of quality of a product [6]. The OEE is widely adopted in industry and also ongoing subject of research for further development [7]. To evaluate the impact on OEE, a discrete event simulation model was developed using the commercial software [8]. But, notwithstanding the high added value of OEE-improvement cycles to limit waste, OEE sometimes comes into conflict with today's flexibility needs and even penalizes these capabilities. Frequent product changes typically result in lower availability through more set-up [9]. OEE is the value of the effectiveness of a machine/equipment [10]. Overall Equipment Effectiveness (OEE) merupakan metode yang digunakan sebagai alat ukur (metrik) dalam penerapan program TPM guna menjaga peralatan pada kondisi ideal. Determine the causes of low Overall Equipment Effectiveness (OEE) values as well as identifying losses that occur, by providing recommendations for improvements in the factory [11] OEE is right in analyzing production increases and measuring the effectiveness of equipment use in production efficiency [12].

The company does not yet have a regular machine maintenance schedule, so this study aims to calculate the maintenance and repair schedule for each machine component using the Autonomous Maintenance (AM) approach and the OEE method [13]. The AM approach is useful for reducing the percentage value of the OEE produced. A lathe is one of the machines used in the production process of spare parts and so on [14]. The purpose of maintenance is to maintain the reliability of the machine so that the machine can continue to operate properly. A traditional lathe is a machine tool or ordinary lathe that produces cylindrical objects [15]. The main movement of the machine is rotation and consists of changing the shape and size of the object by cutting using cutting scissors. The working principle of a traditional lathe is that the workpiece rotates while the cutting tool is positioned slowly either horizontally or transversely. The rotation of the lathe is carried out by an electric motor which is then connected to the main shaft via a belt (V-belt). When the electric motor rotates, the main shaft rotates and the workpiece being held also rotates [16]. The main task of the lathe is to produce cylindrical workpieces. The process of machining the workpiece according to the desired shape and size by moving the tool either parallel or perpendicular to the axis of rotation of the workpiece is called a lathe [17]. The working principle of a lathe is that the workpiece rotates on its axis and the movement of the cutting tool is that the cutting tool moves parallel to the main axis, called longitudinal turning, and the cutting tool moves perpendicular to the main axis, called turning, the face of the cutting tool moves at an angle to the main axis, called conical turning or tapered turning [18]. The working principle of a lathe machine is that the workpiece rotates on its axis and the movement of the cutting tool, namely the cutting tool moves parallel to the main axis, is called longitudinal turning, and the cutting tool moves perpendicular to the main axis [19]

Overall Equipment Effectiveness is a method used as a measuring tool (metric) to maintain equipment in ideal condition. Using OEE as a performance indicator requires a certain time period, for example shift, daily, weekly, monthly or yearly. OEE calculations can be used at various levels in a company environment. In the corporate environment, especially production factories, it is very effective to use OEE measurements [20].

$$\text{OEE} = Availability\ x\ Performance\ x\ Quality\ Yield \text{ x } 100\% \ldots(1)$$

$$Availability = \frac{ToalTime-PlannedDT-UnplannedDT}{TotalTime-PlannedDT} x100\% \ldots(2)$$

$$Performance = \frac{Output\ x\ Waktu\ Siklus}{TotalTiime-PlannedDT-UnplannedDT} x100\% \ldots(3)$$

$$Quality = \frac{Output-Defect}{Output} x100\% \ldots(4)$$

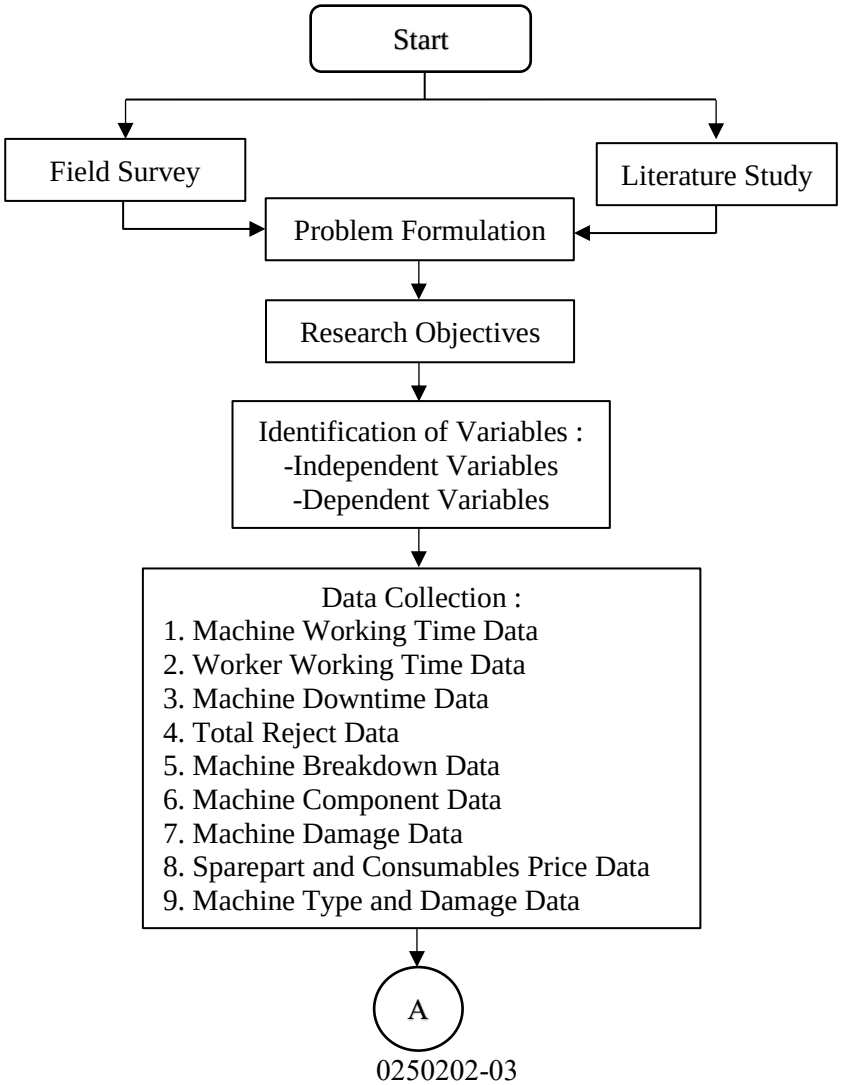
Tabel 1. Starndar Pengukuran OEE

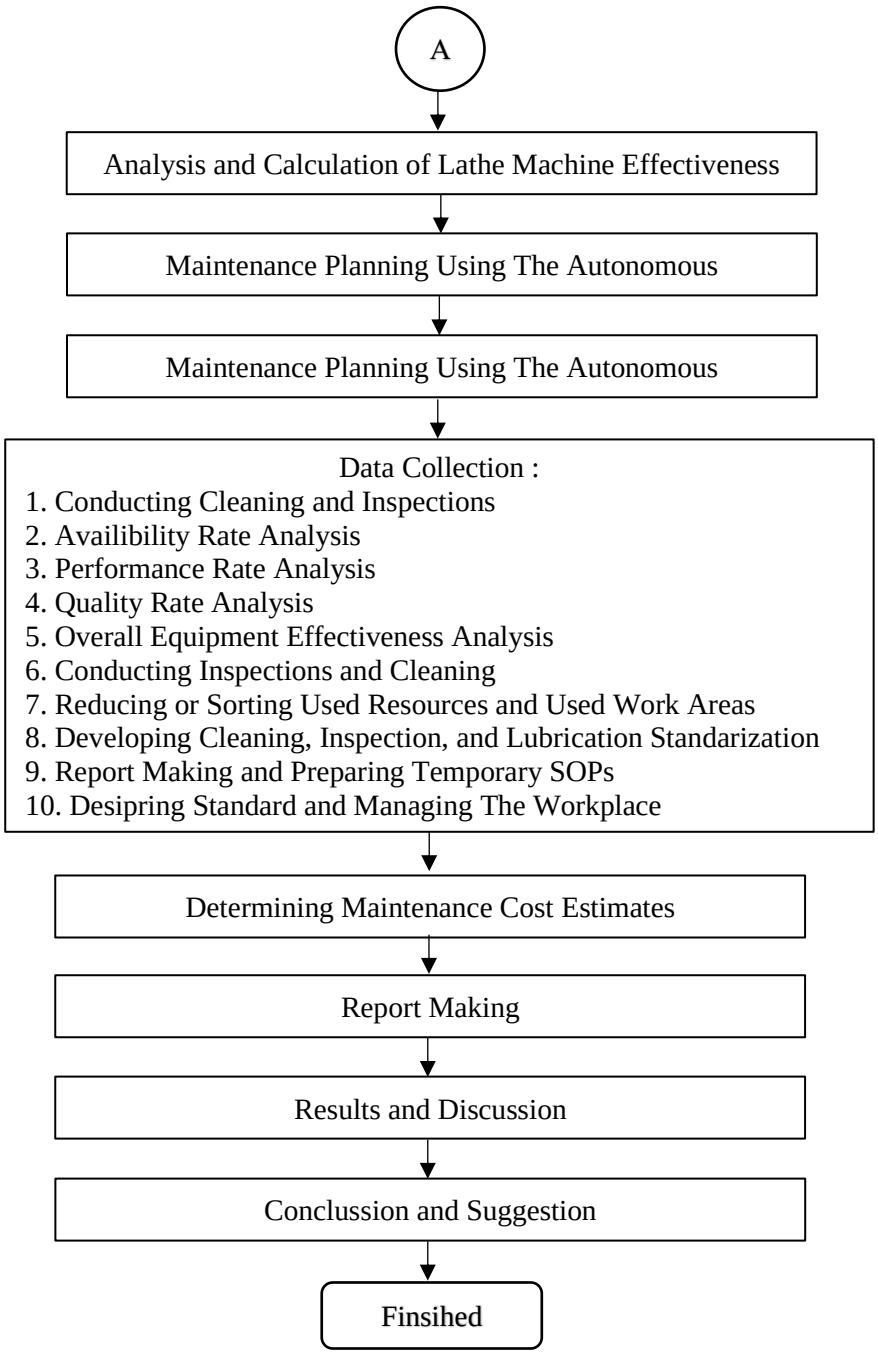
OEE Factor	World Class
Availability	90%
Performance	95%
Quality	99%
OEE	85%

Autonomous Maintenance (AM) is designed to identify the causes of equipment failure and quality problems that arise from human thinking and behavior, without drastically changing thinking. Zero failure and zero defects will never be achieved [8]

2. Methods

This research was conducted at the XYZ Lathe Workshop located at Jl. Wirabumi No.72, Demeling, Gedangan, Gedangan District, Sidoarjo Regency, East Java 61254. The research will be conducted in March 2024 until the required data is fulfilled. The dependent variables in this study are the effectiveness of the lathe and the machine maintenance schedule at the XYZ lathe workshop. The independent variables are machine working time data, worker working time data, machine downtime data, total reject data, machine damage data, machine component data, machine damage data, spare part and consumable price data, maintenance action data and machine types and specifications. Data collection was obtained from primary data from the company and through interviews. The Flowchart steps can be seen below:





Picture 1. Flowchart

3. Results and Discussion

Table 2. Lathe Machine Working Time Data

Month	division of working time	Time	
	(Day)	Work (Hour)	Work (Minute)
January	24	172	10.320
February	24	179	10.740
March	24	168	10.080
April	24	168	10.080
May	24	162	9.720
June	24	168	10.080

Table 3. Data on Workers' Working Time

Day	Work Hour	Rest Hour
Monday	07.00 - 15.00	12.00 - 13.00
Tuesday	07.00 - 15.00	12.00 - 13.00
Wednesday	07.00 – 15.00	12.00 – 13.00
Thursday	07.00 – 15.00	12.00 – 13.00
Friday	07.00 – 15.00	12.00 – 13.00
Saturday	07.00 – 15.00	12.00 – 13.00

Table 4. Lathe Machine Downtime Data

Month	Work Hour	*Planned Downtime* (Minute)			
	(Minute)	*Warm Up*	*Initial Cleaning*	lubricant inspection	Total
January	10.320	81	86	85	252
February	10.740	85	93	88	266
March	10.080	80	80	80	240
April	10.080	80	80	80	240
May	9.720	78	74	71	223
June	10.080	80	80	80	240

Table 5. Total Reject Data, Breakdown Time and Production Results

Month	Reject	*Breakdown (hour)*	(Minute)	Production result
January	1	35	2.100	4
February	1	36	2.160	4
March	0	20	1.200	3
April	0	17	1.020	3
May	0	9	540	2
Juni	0	21	1.260	3

Table 6. Calculation of Performance Efficiency for January 2024 – June 2024

Month	Total Product Proccesed (unit)	Ideal Cycle Time (menit)	Operation Time (menit)	Performance Efficiency (menit)	Standard (%)
January	4	1.749	7.716	90,66%	95%
February	4	1.832	8.048	91,05%	95%
March	3	2.717	8.400	97,03%	95%
April	3	2.717	8.400	97,03%	95%
May	2	4.333	8.734	99,28%	95%
Juni	3	2.717	8.340	97,03%	95%

Table 7. Calculation of Rate of Quality Product for January 2024 – June 2024

Month	Total Product Proccesed (unit)	Total Reject (unit)	Rate of Quality (%)	Standard (%)
January	4	1	75%	99%
February	4	1	75%	99%
March	3	0	100%	99%
April	3	0	100%	99%
May	2	0	100%	99%
Juni	3	0	100%	99%

Table 8. OEE Calculation for January 2024 – June 2024

Month	Availability Rate	Performance Rate	Rate of Quality	OEE	Standard
January	76,64%	90,66%	75%	52,11%	85%
February	79,93%	91,05%	75%	54,58%	85%
March	80,20%	97,03%	100%	77,81%	85%
April	85,36%	97,03%	100%	82,82%	85%
May	88,76%	99,28%	100%	88,12%	85%
Juni	87,81%	97,03%	100%	85,20%	85%
Rata - rata				73,77%	

Table 9. Identification of Impacts that Will Occur on Components

Number	**Component**	**Sources of Contamination and Causes Impact**	**Impact**
1	Dynamo	• Dust, dirt and metal debris or production waste • Cable short circuits, wear and loose connections	• Dust, dirt and metal debris or production waste can cause overheating • Cable short circuits, wear and loose connections can cause short circuits

Number	Component	Sources of Contamination and Causes Impact	Impact
2	Switch On/Off	• Deformed switches and connectors that do not fit properly • Dust, oil or metal debris	• Deformed switches and connectors that do not fit properly can cause overheating • Dust, oil, or metal debris may cause malfunction
3	Gear	• Overwriting residual production components or objects • Gear teeth suffer from abnormal wear and lack of lubricating action	• Components or production waste objects that fall on the gear can cause cracks and scratches • Lack of lubrication in the gear can cause wear and breakage of the gear transmission
4	Sledge	• Rough and scratched surface • Lack of lubrication measures and use of lubrication that does not comply with factory specifications	• Rough or scratched surfaces may indicate the need for maintenance • Using lubricants that do not meet specifications can cause faster wear
5	Trajectory Sledge	• Contaminated by dirt, metal debris and production waste • Lack of cleaning measures for tracks that are contaminated with dirt, metal debris and residual production fluids	• Contamination by dirt, metal debris and residual production fluids can cause cracks and scratches • Lack of cleaning measures for tracks that are contaminated with dirt, metal debris and production waste can cause corrosion
6	Bor Center	• Contaminated by dirt, metal debris and production waste • Lack of cleaning measures for tracks that are contaminated with dirt, metal debris and residual production fluids	• Contamination by dirt, metal debris and residual production fluids can cause cracks and scratches • Lack of cleaning measures for tracks that are contaminated with dirt, metal debris and production waste can cause corrosion

Table 10. Proposed Improvements

Working time system	Total production hour per week	Time available to carry out maintenance	Suggested Time to Perform Maintenance
One shift (working day)	42 hour	17 hour/day + 1 rest day = 126 hour	After the machine is operationalelah mesin beroperasi

From the calculation results above, the OEE value is obtained for each month. There are also improvements for each machine component in the company. Based on previous research, this study has the advantage of being able to find out and provide input for components, not only calculating OEE values and scheduling machines periodically, but with this Autonomous Maintenance (AM) approach, it is expected to reduce the OEE percentage value. Based on the results of previous research, if the OEE value is above 85%, periodic improvement efforts are needed to increase machine effectiveness. According to research (Gianfranco et al., 2022), an OEE value above 85% is considered necessary to carry out periodic machine repairs. Implementation of the stages of the autonomous maintenance method on a lathe, the results of maintenance activities include (1) a list of components, namely the machine base, machine table, machine body, transmission system, electric motor and spindle and identification of contamination, and recommendations for equipment used to perform cleaning, (2) an identification table of the impacts that will occur on contaminated components, (3) preparation of cleaning standards, inspection of basic machine components, machine table, machine body, transmission system, electric motor, spindle and lubrication of the machine body groove rod using SAE 10 (4) preparation of work reports that are used as historical data regarding 61 maintenance activities that have been carried out, preparation of SOP for inspection of damaged components, namely the transmission system, machine base, machine body as a guideline in the inspection and cleaning process, (5) preparation of a maintenance schedule in the form of inspection, cleaning and lubrication. The advice given is to always calculate the Overall Equipment Effectiveness (OEE) on each machine in the company, so that representative information is obtained for the purposes of maintenance and continuous improvement in an effort to increase the effectiveness of machine use. Using the Overall Equipment Effectiveness (OEE) method is relatively easier and can be done by each operator. Conduct training for each operator and maintenance personnel. In order to improve the operator's ability and expertise in carrying out their work. Operators can carry out maintenance activities continuously with a predetermined schedule, so that maintenance activities increase. The limitation of this study is that it only focuses on one machine.

4. Conclusion

The conclusion of this research is that from the six months in 2024, namely January, February, March, April, May and June, the highest average OEE (Overall Equipment Effectiveness) value was in May at 88.82%, with an Availability Rate parameter of 88 .76%, Performance Level of 99.28%, Quality Level of 100%. Meanwhile, the lowest average OEE (Overall Equipment Effectiveness) value occurred in January at 52.11%, with Availability Rate parameters at 76.44%, Performance Rate at 90.66%, Rate of Quality at 75%. From the results of the OEE (Overall Equipment Effectiveness) calculations that have been carried out, the average OEE value is 73.77%, the OEE value for the period January – June 2024 is below the ideal OEE standard, namely 85% (Japan Institute of Plant Maintenance). From this average value, it can be seen that the effectiveness of the lathe on CV. XYZ as a whole is not optimal so it can reduce the production process. In addition, operators are also expected to be able to predict damage that will occur so that they can take action to minimize damage. In further research, it is recommended to use two methods as a comparison of the results of the machine's effectiveness value and provide improvement efforts not only on the machine, but also on operators, raw materials, and other relevant things; in addition, further research can focus on several machines to help the company's problems more broadly.

Acknowledgements

Thank you to the journal for helping the author in providing a place for publication. Don't forget to say thank you to CV. XYZ as a place for collecting thesis data, as well as thanks to the author's parents and friends for providing encouragement and support for the author in completing the research.

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