

Analysis of Machine Effectiveness VL. GSK 6039 on Wheelhub Front Turning Process Using OEE and FMEA Methods at PT. XYZ

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Article Information	ABSTRACT
Article History Received : month dd, yyyy Revised : month dd, yyyy Published : month dd, yyyy	PT XYZ is a company in the field of spare parts manufacturing services such as wheelhub fronts. The machine used in the machining process is the VL. GSK 6039 machine which results in defects such as visual defects and oversize. This study was conducted to evaluate machine performance and defect factors using OEE and FMEA methods. OEE analysis showed a value of 38% below the international standard of 85%. In addition, 3 factors were found, namely humans, methods, and machines, from visual defects and oversize. Visual defects obtained RPN value 574 and oversize obtained RPN value 742. From these results, improvement suggestions are made, namely increased supervision, training, and rest hours for workers, guidance and improvement of SOP standards, increased machine maintenance and maintenance, and training in correct measuring instruments. In order to be implemented effectively, the company must form a special team of management representatives, technicians, and operators to oversee the implementation of improvements, periodic evaluations by comparing changes in OEE values before and after implementation, training every 2 weeks or once a month, placing a work area coordinator to ensure it is running properly, developing a more structured machine maintenance schedule, and implementing scheduled 60-30 minute breaks.
Keywords: <i>VL. GSK 6039;</i> <i>OEE;</i> <i>FMEA;</i> <i>Defective Products;</i> <i>Machine Effectiveness.</i>	

INTRODUCTION

In supporting productivity to be maintained, it is also supported by good product quality, in maintaining productivity and quality, good machine performance is needed, when machine performance is said to be not in good condition, the impact on quality decreases, and will have an impact on customer satisfaction (Pratama & Yuamita, 2021). Therefore, companies must be able to produce and maintain machines, in order to produce products with the right quality and specifications to meet consumer needs.

PT XYZ is a service, manufacturing, and repair company for factory machinery spare parts as well as heavy mining equipment. The problem found is defects due to the VL. GSK 6039 machine, defects that often occur in the machine are of 2 kinds, namely oversize and visual defects. Companies often face challenges about quality, according to established procedures about quality, according to established procedures from companies and customers. Quality control also helps the company because it reduces the number of unqualified products and avoids repair costs such as raw materials and labor that have an impact on the company's profits.

VL. GSK 6039 is a vertical CNC machine that is often used for mining spare parts work, for example Wheelhub Front. Predictive maintenance method is used in machine maintenance management, where daily maintenance standards and routine maintenance are applied with the help of five senses or sophisticated monitoring tools. Although automus maintenance has been carried out according to maintenance standards, problems are still found, namely the discrepancy between the entered program and the actual results, due to machine damage, the production results do not meet the production standards used. Figure 1 shows the target part finish and part finish per month in November - December 2024 and January 2025.

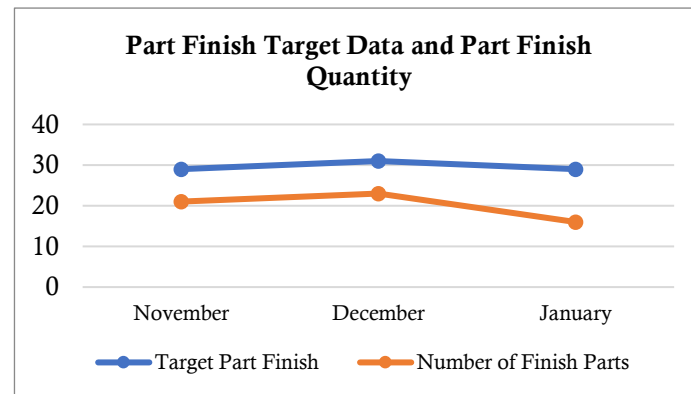


Figure 1. Part Finish Target and Part Finish Quantity

To overcome this problem, an identification was carried out regarding the process of working on wheelhub front spare parts experiencing defects caused by the VL. GSK 6039 machine. The methods used are Overall Equipment Effectiveness (OEE) as a calculation carried out to determine the value of the effectiveness of available machines or equipment (Saputra, 2025) and Failure Mode and Effect Analysis (FMEA) as an analysis to find effects or impacts that are likely to make mistakes in a product or in the production process (Choluq & Chriswahyudi, 2022).

RESEARCH METHODS

Overall Equipment Effectiveness (OEE)

A tool for measuring the overall performance of a machine or piece of equipment that indicates the equipment's ability to do what it is supposed to. This method is also referred to as a major part of the maintenance system that is widely used by some of the largest companies in Japan (Siagin et al., 2022). Some improvements to increase the OEE percentage in terms of Availability, Performance, and Quality (Susanto et al., 2021).

To find the results of the OEE value can use 3 main ratios with the formula below (Alfarisi & Andesta, 2024) :

$$\text{OEE} = \text{Availability} \times \text{Performance} \times \text{Quality rate} \quad (1)$$

- Availability Ratio

A ratio that describes the utilization of available time on machine operations. Calculations used to measure Availability Ratio (Suseno & Aji, 2022).

$$\text{Availability} = \frac{\text{Operation Time}}{\text{Loading Time}} \times 100\% \quad (2)$$

Loading time is the available time (Availability Time) days/month minus the planned machine downtime (Planned Downtime). Operating time is the result of reducing loading time with machine downtime (Non Operating Time).

$$\text{Loading Time} = \text{Total Available Time} - \text{Planned Downtime} \quad (3)$$

$$\text{Operating Time} = \text{Loading Time} - \text{Total Downtime} \quad (4)$$

- **Performance Ratio**

A ratio to show the actual production output then multiplied by the Ideal Cycle Time divided by the Operation Time (Felisah et al., 2025).

$$\text{Performance Ratio} = \frac{\text{Processed Amount} \times \text{Ideal Cycle Time}}{\text{Operation Time}} \times 100\% \quad (5)$$

- **Rate of Quality**

A ratio that indicates the ability of equipment to make products that conform to standards (Siagian & Santoso, 2022).

$$\text{Rate of Quality} = \frac{(\text{Processed Amount} - \text{Defect Amount})}{\text{Processed Amount}} \times 100\% \quad (6)$$

Failure Mode and Effect Analysis (FMEA)

A method for identifying and analyzing potential failures and consequences that aims to plan the production process properly and can avoid production process failures from unwanted losses (Siregar, 2023). This methodology involves scoring each failure based on three parameters, namely Severity, Occurrence, and Detection. The scores range from 1 to 10 and serve to identify potential failures that are prioritized for improvement efforts (Rozikin et al., 2025). Risk Priority Number (RPN) a numerical value used to measure the risk level of a failure mode, from the multiplication of Severity, Occurrence, and Detection values (Prasetyo et al., 2025). (RPN = SxOxD)

Severity

Assess the severity of the consequences caused to consumers and to the continuity of the next process which is also indirectly detrimental (Amalia et al., 2022).

Table 1. Severity

Rank	Level Criteria	Description
1	Negligible Severity	Bad potential that can be ignored
2 dan 3	Mild Severity	Slight bad potential
4,5, dan 6	Moderate Severity	Bad potential is still in the tolerance limit position
7 dan 8	High Severity	Bad potential shows beyond the tolerance limit high repair costs
9 dan 10	Potential Safety Problems	Harm to user safety

Occurance

To provide results on the potential frequency of a problem as a result of the potential sources posed by the event (Aiman & Nurrudin, 2023).

Table 2. Occurance

Rank	Level Criteria	Description
1	1 from 1.000.000	The degree of likelihood that the cause of the value resulting in the potential failure mode
2	1 from 20.000	The rate at which this failure is possible is rare
3	1 from 40.000	
4	1 from 1.000	
5	1 from 400	The degree to which this failure is possible is often possible
6	1 from 80	
7	1 from 40	
8	1 from 20	The degree to which this failure is likely to occur
9	1 in 8	
10	1 in 2	
		At this level it is almost certain that potential failures will definitely occur

Detection

Used to detect the extent of the cause of the failure that occurs so as to avoid or find the source mode of failure (Ulfa & Adnan, 2021).

Table 3. Detection

Rank	Level Criteria	Description
1	1 from 1.000.000	A highly effective and productive prevention method Allows that the cause will occur in low mode
2	1 from 20.000	
3	1 from 4.000	
4	1 from 1.000	The probability of a cause occurring is moderate. In prevention or detection methods, sometimes the cause occurs repeatedly
5	1 from 400	
6	1 from 80	
7	1 from 40	The likelihood of the cause occurring is very high and prevention or detection methods are less effective because the cause occurs repeatedly or continuously
8	1 dalam 20	
9	1 in 8	
10	1 in 2	

RESULTS AND DISCUSSION

Data Collection

Data collection was carried out in November - December 2024 and January 2025 by direct observation, interviews, and documentation at PT XYZ. Those involved include production employees/operators, production supervisors, and quality control.

Table 4. Time Data VL. GSK 6039 Machine

Month	Shift/Month	Hour/Shift	Available Time (Minute)	Planned Downtime (Minute)	Downtime (Minute)	Loading Time (Minute)
November	54	8	11340	1350	1205	9990
December	54	8	11340	1350	1198	9990
January	54	8	11340	1350	1185	9990

Source: Company Data

In table 4 above, calculations will be made to determine the Availability Ratio, Performance Ratio, Quality Ratio, and OEE.

Table 5. Part Target Data, Defect Types, and Number of Finish Parts

Month	Target Part Finish	Type of Disability			Number of Defective Products	Number of Finish Parts
		Visual Defect	Oversize			
			OD	ID		
November	29	2	2	4	8	21
December	31	5	1	2	8	23
January	29	4	3	6	13	16
Total	89	11	6	12	29	60

Source: Company Data

Table 5 above shows the target part finish, type of defect, number of part finishes during November-December 2024 and January 2025. The data shows 2 types of defects in Wheelhub Front spare parts products at PT XYZ. The types of defects consist of visual defects with a total of 11, oversize with a total of OD 6, and ID 12.

Data Processing

Processing process on the VL. GSK 6039 machine in the process of working on Wheelhub Front spare parts which will be calculated Availability, Performance, Quality and OEE, making fishbone diagrams to determine causal factors, FMEA analysis, calculating RPN values, and making suggestions for improvement.

OEE Calculation of VL. GSK 6039 Machine

The steps in calculating OEE on the VL. GSK 6039 machine as follows :

a. Availability Ratio Calculation

November calculation example :

$$\text{Loading Time} = 11340 - 1350 = 9990$$

$$\text{Operating Time} = 9990 - 1205 = 8785$$

$$\text{Availability} = \frac{\text{Operation Time}}{\text{Loading Time}} = \frac{8785}{9990} \times 100\% = 88\%$$

The results of the Availability Ratio calculation will be shown in figure 2 below :

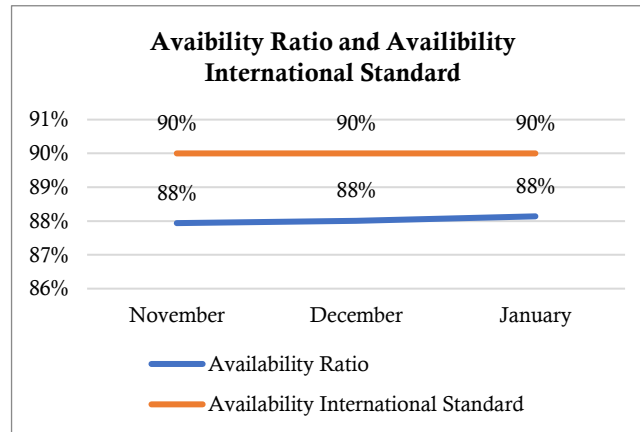


Figure 2. Availability Ratio

Based on figure 2 above shows the calculation results of the Availability Ratio in November of 88%, December of 88%, and January of 88%, so it still does not meet the international standard of 90%.

b. Performance Ratio Calculation

November calculation example :

$$\% \text{ Working Hours (Minutes)} = 1 \times \frac{11340}{9990} = 1,14$$

$$\text{Cycle Time (Minutes)} = \frac{9990}{21} = 475,71$$

$$\text{Ideal Cycle (Minutes)} = 475,71 \times 1,14 = 540$$

$$\text{Ideal Product Process} = \frac{540}{2} = 270$$

$$\text{Performance Ratio} = \frac{21 \times 270}{8785} \times 100\% = 65\%$$

The results of the Performance Ratio calculation will be shown in figure 3 below :

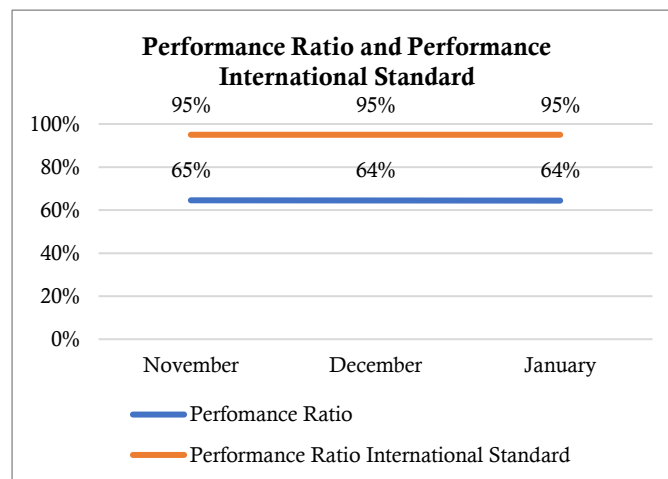


Figure 3. Performance Ratio

Based on figure 3 above shows the calculation results of the Performance Ratio in November of 65%, December of 64%, and January of 64%, so it has not met the international standard of 95%.

c. Rate of Quality Calculation

November calculation example :

$$\text{Rate of Quality} = \frac{(29-8)}{29} \times 100\% = 72\%$$

The results of the Rate of Quality calculation will be shown in figure 4 below :

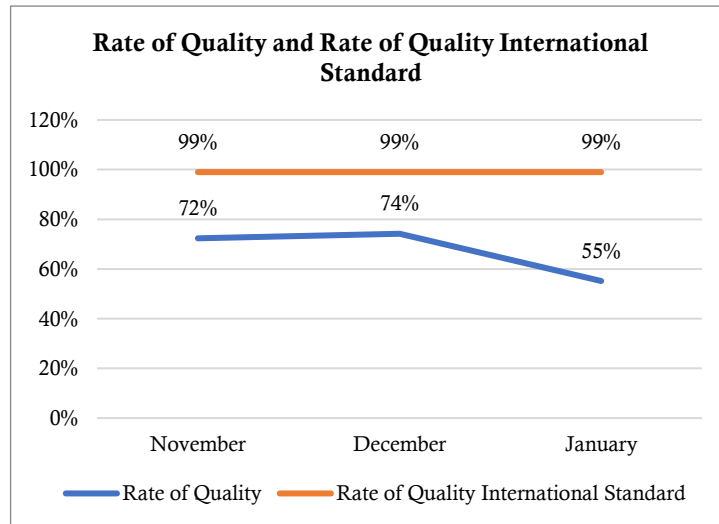


Figure 4. Rate of Quality

Based on figure 4 above shows the calculation results of the Rate of Quality in November of 72%, December of 74%, and January of 55%, so it has not met the international standard of 99%.

d. Calculation of OEE Value

$$\text{OEE} = 88\% \times 64\% \times 67\% = 38\%$$

The results of the OEE calculation will be shown in figure 5 below :

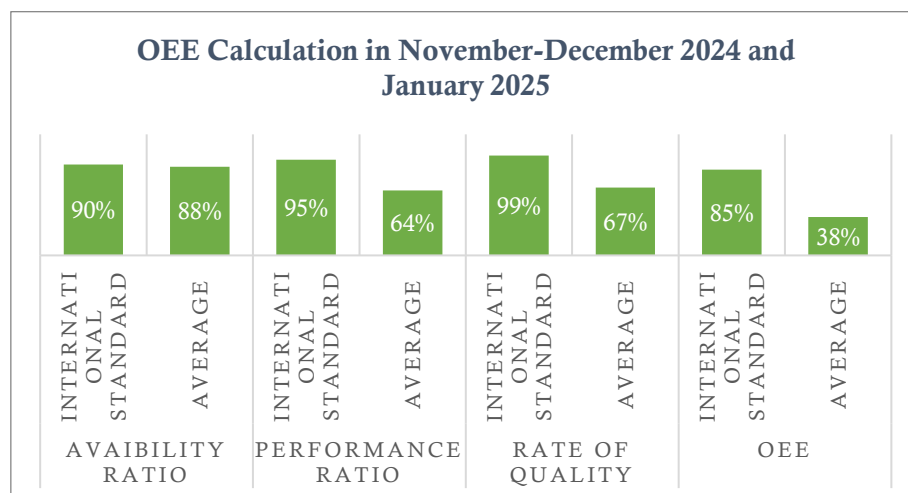


Figure 5. Overall Equipment Effectiveness

Based on figure 5 above shows the calculation of OEE in November-December 2024 and January 2025. With the results of the calculation of the Availability Ratio of 88%, December was 64%, and January was 67%. Resulting in an OEE value of 38%, so it has not met the international standard of 85%.

Fishbone Diagram

Fishbone Diagram is used to find the cause of failure. The results of fishbone data processing resulted in 3 factors causing defects.

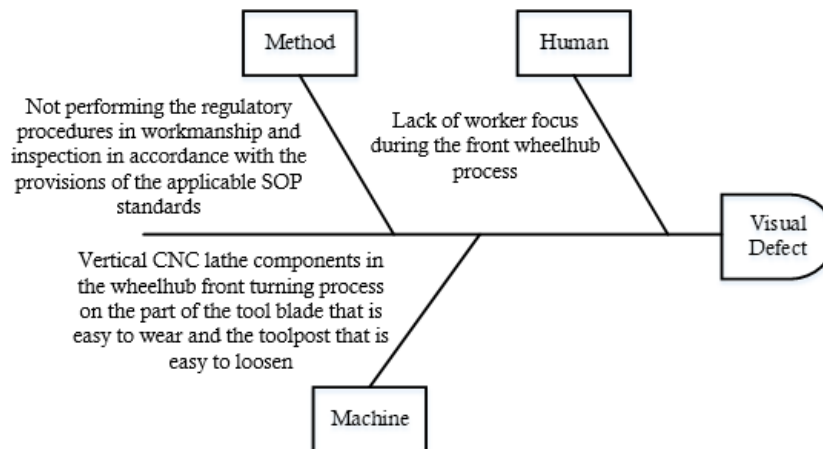


Figure 6. Visual Defect

In figure 6 above, there are human problems namely the lack of worker focus during the front wheelhub process, methods namely not performing the regulatory procedures in workmanship and inspection in accordance with the provisions of the applicable SOP standards, and machine namely vertical CNC lathe components in the wheelhub front turning process on the part of the tool blade that is easy to wear and the toolpost that is easy to loosen.

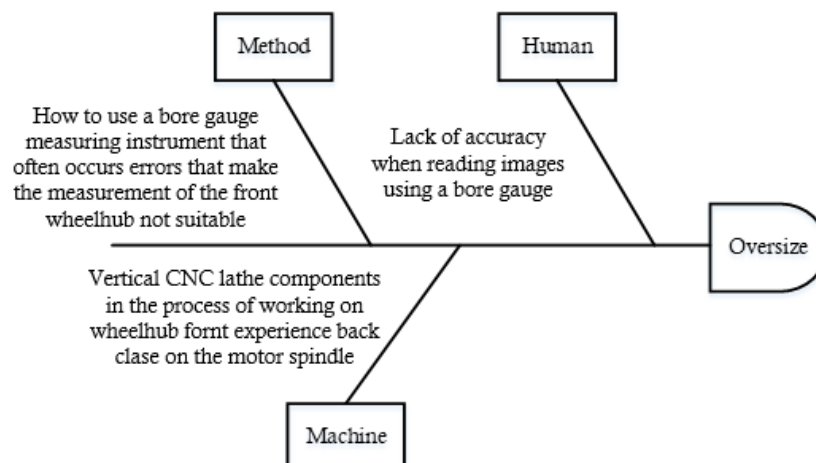


Figure 7. Oversize

In figure 7 above, there are human problems namely the lack of accuracy when reading images using a bore gauge, method namely how to use a bore gauge measuring instrument that often occurs errors that make the measurement of the front wheelhub not suitable, and machine namely vertical CNC lathe components in the process of working on wheelhub front experience back clasp on the motor spindle.

Calculation of RPN Value Using FMEA Method

RPN is a criticality marker used to evaluate corrective actions based on failure modes. The following is a table of RPN calculations on failure types, namely visual defects and oversize sizes :

Table 6. FMEA Method RPN Calculation

Failure Type	Failure Factors	Severity	Occurrence	Detection	RPN	Total RPN	Priority
Visual Defect	Human	5	5	4	100	574	2
	Method	6	6	5	180		
	Machine	7	7	6	294		
Oversize	Human	6	7	5	210	742	1
	Method	7	8	5	280		
	Machine	6	7	6	252		

It is concluded in table 6 that the results of the RPN value of the type of failure in the oversize size are the top priority caused by humans by 210, methods by 280, and machines by 252, so the total RPN result is 742. The second priority is visual defects caused by humans by 100, methods by 180, and machines by 294, so the total RPN result is 574.

So the results of the above conclusions will make suggestions for improvement to reduce or avoid losses caused by the type of failure of visual defects and oversize. Suggested improvements will be explained in table 7 below :

Table 7. Improvement Suggestions

Failure Type	Failure Factors	Causes of Failure	Improvement Suggestions
Visual Defect	Human	Lack of worker focus during the front wheelhub process	Increase supervision, training, and sufficient rest hours so that workers can focus on their work
	Method	Not performing the regulatory procedures in workmanship and inspection in accordance with the provisions of the applicable SOP standards	Conduct socialization guidance to workers about SOP standards that apply to the company and strictly improve SOP standards
	Machine	Vertical CNC lathe components in the wheelhub front turning process on the part of the tool blade that is easy to wear and the toolpost that is easy to loosen	Improvements in machine maintenance and upkeep are carried out daily at the beginning of work and at the end of work, and periodic replacement of machine components
Oversize	Human	Lack of accuracy when reading images using a bore gauge	Conduct training on the correct and thorough use of measuring instruments in accordance with the SOP standards that apply to the company
	Method	How to use a bore gauge measuring instrument that often occurs errors that make the measurement of the front wheelhub not suitable	Conduct training on how to use the bore gauge correctly in accordance with the SOP standards that apply to the company
	Machine	Vertical CNC lathe components in the front wheelhub machining process experience back clasp on the motor spindle	Perform routine repairs and replacement of engine components that have black clasp

From the results of table 7 above, it is known that suggestions for improving the RPN value of visual defects and oversize. That way the company can reduce the impact that occurs such as reducing products that must be reworked or discarded, reducing greater machine damage, reducing wasted time, reducing the risk of work accidents, and reducing large costs, thereby gaining the trust of customers.

CONCLUSION

Based on research on the VL. GSK 6039 machine using the OEE method obtained the results of the calculation of Availability Ratio of 88%, Performance Ratio of 64%, and Rate of Quality of 67%, with an OEE value of 38% which is still far below the international standard of 85%. It was identified that the type of failure that often occurs is oversize with a total RPN of 742 and both visual defects with a total RPN of 574. After the results are known, improvement suggestions will be given, namely increased supervision, training, and rest hours for workers, guidance and improvement of SOP standards, increased machine maintenance and maintenance, and training on correct measuring instruments. In order to be implemented effectively, the company must form a special team of management representatives, technicians, and operators to oversee the implementation of improvements, periodic evaluations by comparing changes in OEE values before and after implementation, training every 2 weeks or once a month, placing a work area coordinator to ensure it is running properly, developing a more structured machine maintenance schedule, and implementing a scheduled 60-30 minute break time.

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