SITEKIN: Jurnal Sains Teknologi dan Industri, Vol. 20, No. 2, June 2023, pp.649 - 656
ISSN2407-0939 prints/ISSN 2721-2041 on line

Identification Of Causes Of Damage In Lathe Using FMEA (Failure Mode And Effect Analysis) And RCA (Road Cause Analysis) Methods

M. Abdul Ghofur[1], Deny Andesta[2]
Industrial Engineering Study Program, Faculty of Engineering, Muhammadiyah University of Gresik
Jl. Sumatra No. 101, Mt. Malang, Randuagung,
Kebomas District, Gresik Regency, East Java, 61121

ABSTRACT

PT. XYZ is a service company in the field of construction and fabrication. The purpose of this research is to identify critical components in system failure on the lathe unit, to find out how often a failure on the lathe is likely to occur, to find out the causes of damage to the lathe machine components and to be able to find out the criteria of risk that has the highest risk score and RPN. The analysis process in this study needs to be done to minimize damage to the lathe. If there is damage to the lathe, the production process cannot run smoothly. For the production process to run smoothly, it is necessary to have machine maintenance activities. Machine maintenance activities aim to keep machines in good condition and ready for use in the production process. The method used in this research is FMEA and RCA. The FMEA method can be used as a system to prevent errors that are predicted to occur. This method is carried out by sorting the RPN value from the highest and then suggesting improvements to the lathe. Meanwhile, the RCA method is a structured approach to identifying influencing factors in one or more past events so that it can be used to improve performance. There are various structured evaluation methods to identify the root causes of problems. The results of this study are the two most significant RPN values, namely the Chuck and Gear components. The cause of the failure of these components is for the chuck. When setting, the chuck is not a flashlight, while the machine is not functioning properly for the gear.

Keywords: FMEA, Damage to Lathes, Lathes, RCA, RPN**,**

Introduction

The industrial world is experiencing rapid development, including the construction and steel fabrication industries. Actions that occur in the industrial world can create increasingly fierce production competition. So it is necessary to increase the effectiveness and efficiency of the production process[1]. This also applies to PT. XYZ in the Gresik area to minimize damage to production equipment, specifically lathes.

The lathe (Turning machine) is one of the machine tools that influence the production process and production results. If there is damage to the machine, the production process cannot run smoothly[2]. One of the functions of a lathe is that it can cut a rotated object. And to get a wide variety of screw results with different size ranges, this can be done by adjusting the ratio of the rotational speed of the workpiece and the translational velocity of the tool. This process can be done by exchanging translational gears, connecting the spindle shaft to the threaded rod [3]-[4].

To obtain maximum production results, PT. XYZ has carried out regular machine maintenance activities. Machine maintenance activities are activities aimed at getting good-quality production results. Suitable machine maintenance activities can maintain production consistency so the company can maintain production capacity[5]. Even so, there are still production defects in the production process at PT. XYZ. Factors influencing the occurrence of damage to lathe components can be obtained using the Failure Mode and Effect Analysis (FMEA) and Root Cause Analysis (RCA) methods. By identifying the cause of the damage, it can be seen how big the impact (Severity), the possibility of a risk (Occurace), risk detection (Detection), and the result is a Risk Priority Number (RPN) and what risks occur in each production process[6].

The problem faced by this company is to identify critical components in system failures on lathe units. However, this research is a continuation of previous fieldwork research, “Identification of causes of damage to lathes using the method (Failure Mode and Effect Analysis).” This study aims to identify component damage to the lathe. Therefore the previous research used the FMEA method, and this time, the researcher used an additional method, namely the RCA method, to get efficient results because the RCA method can find the cause and effect of a problem. and help find out the reasons for a problem.

Research Methods

FMEA (Failure Mode Effects and Analysis)

Failure Mode and Effect Analysis(FMEA) is a technique for analyzing errors. The FMEA process involves as many subsystem components and devices as possible to identify errors, both the causes and effects of the damage[7]–[14]. There are steps in the FMEA process, namely:[15]-[16]

1. Identify the function in a production process
2. Identify potential failure modes of the production process.
3. Identify potential effects of production failures.
4. Identify the causes of production process failure.
5. Identify production process detection modes.
6. Determining the rating of severity (S), occurrenceancy (O), and detection (D) in the production process.
7. Calculating RPN (RPN = S x O x D)

***Severity*(S)**

*Severity*is the first step to analyze the risk by calculating how much impact events that affect process output. These impacts are ranked on a scale of 1 to 10, where 10 is the worst impact. [17]

Table 1. Severity criteria

Criteria	Ranking
Negligible severity(negligible bad influence). We do not need to think that this effect will affect the quality of the product. Consumers probably won't notice this flaw.	1
Mild severity(Mild bad influence). The consequences will be mild, consumers will not feel a decrease in quality.	2 3
Moderate severity(moderate adverse effects). Consumers will feel a decrease in quality, but it is still within tolerance limits.	4 5 6
High severity(High bad influence). Consumers will feel quality loss that is beyond tolerance limits.	7 8
Potential severity severity(Very high bad influence). The consequences are very influential on other qualities, consumers will not accept it.	9 10

***Occurcce*(O)**

Occurrence (O) It is probable that the cause will occur and result in the form of failure during the life of the unit. By estimating the probability of occurrence on a scale of 1 to 10. Where each ranking has its criteria. which are explained in Table 2.

Table 2. Occurrence criteria

Degrees	Occurrence	Rank
Remote	0.01 per 1000 items	1
Low	0.1 per 1000 items	2
	0.5 per 1000 items	3
Moderate	1 per 1000 items	4
	2 per 1000 items	
	5 per 1000 items	5
high	10 per 1000 items	6
	20 per 1000 items	7
Very high	50 per 1000 items	9

100 per 1000 items	10

***detection*(d)**

detection(d) is a measure of the ability to prevent or control damage that may occur. The scoring process is shown inTable 3.

Table 3. Detection criteria

Rank	Possibility of Control Detection	Based on the frequency of occurrence
1	This method of prevention is very effective. There is no chance a cause might arise.	0.1 per 1000 items
2	The probability of its occurrence is very low.	0.1 per 1000 items
3		0.5 per 1000 items
4	The probable cause of this occurring is moderate. Preventive methods are sometimes possible.	1 per 1000 items
5		2 per 1000 items
6		5 per 1000 items
7	The probable cause is still high. Prevention methods are less effective, the causes are still recurring.	10 per 1000 items
8		20 per 1000 items
9	The probability of this happening is very high. Prevention methods are not effective prevention always reoccurs.	50 per 1000 items
10		100 per 1000 items

RCA (Root Cause Analysis)

Root Cause Analysis (RCA)is a quality measuring tool that is useful in distinguishing the exact source of a problem from a condition. The organization conducts regular and systematic reviews of ongoing processes and proactively conducts system reviews, thereby significantly reducing the chances of recurrence[18][19]. The Root Cause Analysis (RCA) method is used to find the root causes of an existing problem. In this study, the RCA method was carried out using a Fishbone Diagram consisting of 4 critical factors: Man, Machine, Method, and Material[20]–[26].

Results and Discussion

The data below is the result of interviews with QC and lathe operators at PT. XYZ. Factors that affect the damage to the lathe are operators who do not know how to use the lathe, overuse, and no maintenance schedule for the lathe.[27]. This study aims to determine the cause of the damage and the number of defects that occur[28].

Table 4. Summary of lathe damage data

Total tools	Equipment maintenance inspection	Repair request
29	24	5

Table 5. Result of potential identification of Failure Mode and Potential Effect

No	Component	failure modes	Potential failure effects
1	V-Belts	Age of use	Make the machine stop working and impact on the production process
2	Bearings	Bearings broke	Make the machine stop working and impact on the production process
3	Chuck	Shoe is not a flashlight	Rotation on the workpiece becomes unfocused causing product results to be inconsistent
4	*Emergency switch*	Broken wires	As a result, if there is a work accident that occurs, the emergency button does not work
5	Gears	Worn gears	One of the machines is not working properly

Then an analysis was carried out using a Fishbone diagram to determine the 5 causal factors.

1. V-Belt Fisbone Diagram

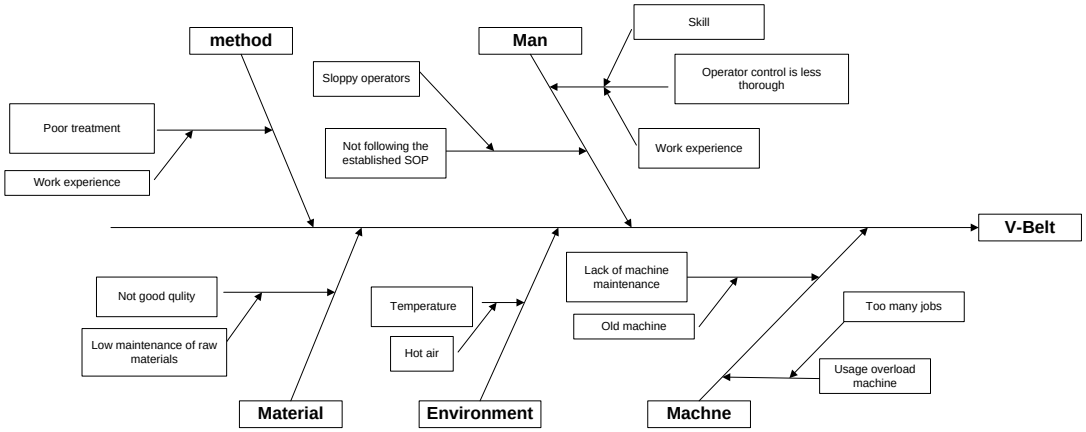

Figure 1. V-Belt Fisbone Diagram

Table 6. The fishbone diagram causes the V-Belt

Component	5M	Cause of defects
V-Belts	Man	Control operators Does not follow the SOP that is applied
	Machine	overload use Lack of machine maintenance
	Environment	Temperature
	Method	Lack of maintenance action
	Material	Not good quality

2. Fishbone Bearing Diagram

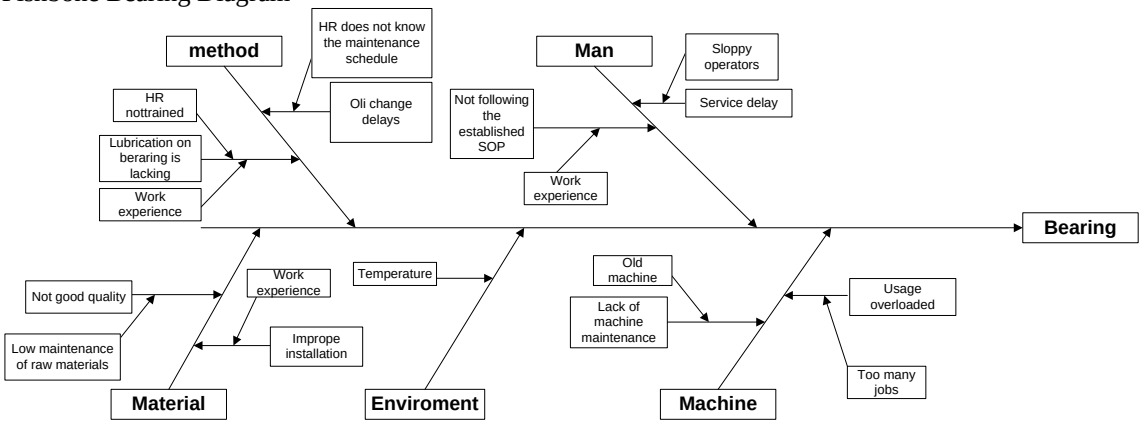

Figure 2. Fishbone Diagram of Bearing

Table 7. Fishbone diagram for bearings

Component	5M	Cause of defects
Bearings	Man	Service delay Does not follow the SOP that is applied
	Machine	overload use Lack of machine maintenance
	Environment	Temperature
	Method	Lack of maintenance action Bearing lubrication
	Material	Inappropriate installation

3. Fishbone Diagram of Chuck

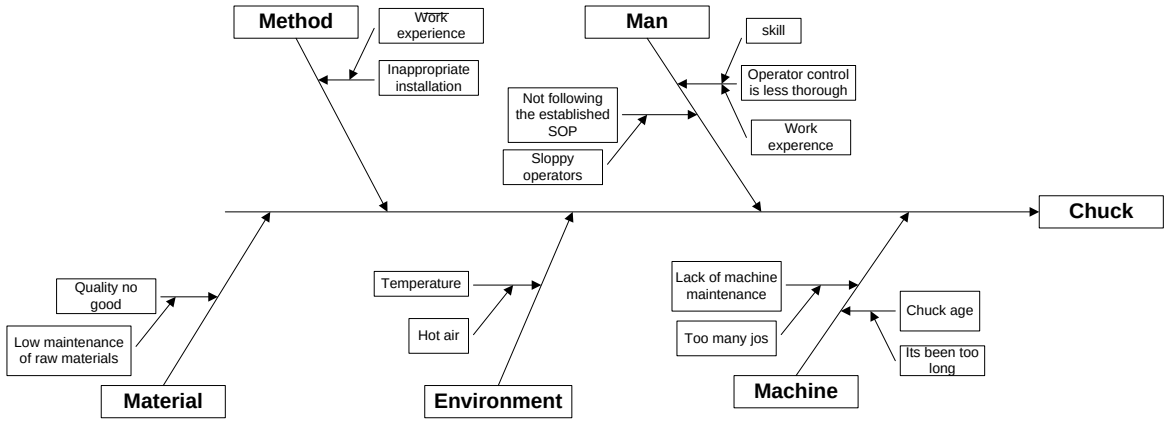

Figure 3. Fishbone Diagram of Chuck

Table 8. Chuck cause Fishbone diagram

Component	5M	Cause of defects
Chuck	Man	The control operator is less thorough Does not follow the SOP that is applied
	Machine	Chuck's age Lack of machine maintenance
	Environment	Temperature
	Method	Inappropriate installation
	Material	Treatment is not good Not good quality

4. Fishbone Diagram of Switch Emergency

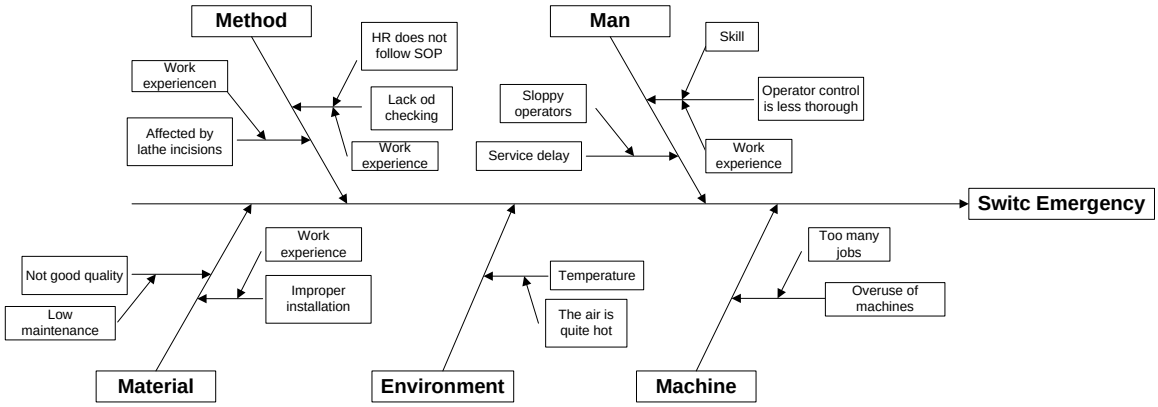

Figure 4. Fishbone Diagram of Switch Emergency

Table 9. Fishbone diagram causes Switch Emergency

Component	5M	Cause of defects
Switch Emergency	Man	The control operator is less thorough
	Machine	Service delay
		Overuse of machines
	Environment	Temperature
	Method	Lack of checking
		Exposed to lathe dirt incision
	Material	Inappropriate installation
		Not good quality

5. Fishbone Diagram of Gear

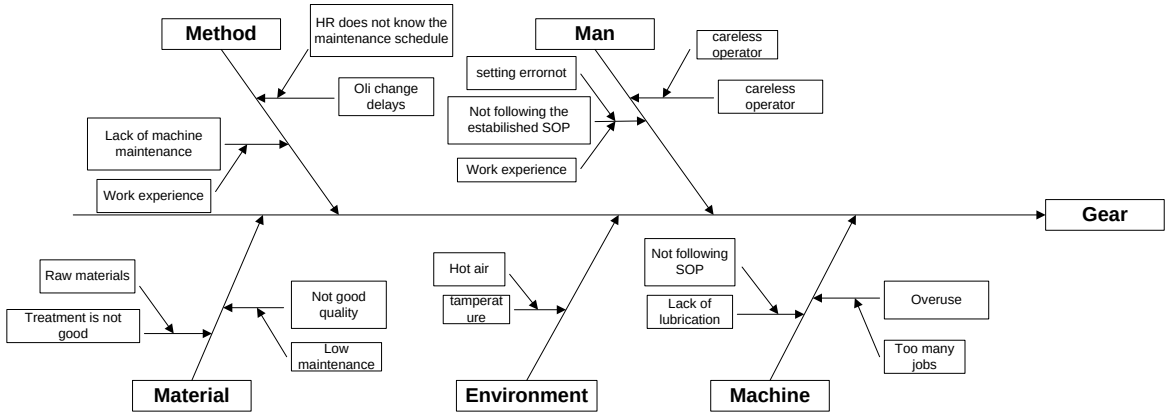

Figure 5. Fishbone Diagram of Gear

Table 10. Gear cause Fishbone diagram

Component	5M	Cause of defects
Gears	Man	Service delay
		Does not follow the SOP that is applied
	Machine	Overuse of machines
		Lack of lubrication
	Environment	Temperature
	Method	Oil change delays
		Lack of machine maintenance
	Material	Not good quality
		Treatment is not good

Data processing

Based on the data obtained from the identified components from lathe damage, the 5 components will be carried out using the FMEA approach.

Table 11. The results of determining the SOD and calculating the RPN

No	Component	failure modes	Potential failure effects	S	O	D	RPN
1	V-Belts	Age of use	Make the machine stop working and impact on the production process	3	5	4	60
2	Bearings	Bearings broke	Make the machine stop working and impact on the production process	3	6	5	90
3	Chuck	The shoe is not a flashlight	Rotation on the workpiece becomes unfocused, causing product results to be inconsistent	9	7	10	630
4	*Switch Emergency*	Broken wires	As a result, if there is a work accident that occurs, the emergency button does not work	2	5	8	80
5	Gears	Worn gears	One of the machines is not working properly	9	8	9	648

Based on Table 11, the 2 highest RPN values are 630 and 648 because there is a critical component. From the 2 RPN values, it can be seen from the failure mode, potential effects and causes of failure as follows:

1. *Chuck* is a machine component that clamps the workpiece in the turning process. Because the shoe is not a flashlight, it can cause the workpiece to be not a flashlight, causing inappropriate product results.
2. *Gears*is a component that serves to drive the wheels. Because the gear is worn, it causes one of the machines not to function properly.

Proposed solutions

From the results of interviews for control on the 2 largest RPN values included to focus improvements on the main causes of component failure. Power of the potential presence of non-flashlight shoes on Chuck and Gear can be seen in the table below.

Table 12. Corrective action for chuck

Component	5M	Cause of defects	Corrective action
Chuck	Man	The control operator is less thorough	• Provide regular supervision • Always follow SOP Posting SOPs near production machines.
	Man	Not following the established SOP	• By being given training and insight to workers. • Following SOPs
	Machine	Chuck's age	• By carrying out regular maintenance so that the chuck can still be used for a long time. • Add maintenance lock book
	Machine	Lack of machine maintenance	• Provide appropriate machine maintenance schedule.
	Environment	Temperature	• Air circulation is made so that the temperature in the room does not increase. • Added blowers
	Method	Inappropriate installation	• Provided good SOP procedures • Installation instructions are provided.
	Material	Treatment is not good	• By carrying out extra supervision, the quality control department must ensure that raw materials can still be used.
	Material	Not good quality	• The quality control section must ensure that the material is the best and selected.

Table 13. Corrective action for *Gears*

Component	5M	Cause of defects	Corrective action
Gears	Man	Service delay	• Create an appropriate maintenance schedule • set the machine's working time so as not to be late during service.
	Man	Not following the established SOP	• Operators are given a manual on how the machine works
	Machine	Overuse	• Reducing the production process so that the machine is not continuously used.
	Machine	Lack of lubrication	• Operators should be given the training to be more thorough in the setting. • Operators must also understand the SOP.
	Environment	Temperature	• Air circulation is made so that the temperature in the room does not increase. • Added blowers
	Method	Delayed oil change	• Make an appropriate maintenance schedule and set the time for working on the machine so it is not late during service time.
	Method	Lack of machine maintenance	• Check the readiness of the machine carefully before or after use.
	Material	Not good quality	• The quality control section must ensure that the material is the best and selected.
	Material	Treatment is not good	• With extra supervision. • The quality control department must ensure that raw materials can still be used or not.

Conclusion

Based on the results of the research that has been done, several conclusions can be drawn, namely there are 9 critical components in the lathe, there are 2 largest RPN values, namely the Chuck component, the cause is when the Chuck setting is not a flashlight with a value of 630 while in the Gear component the cause is the machine does not function properly. both with a value of 648. The possibility of a failure

occurring can be seen from the largest RPN value in the 2 components seen in the occurrence value table which states that the higher the rating value in the table, the more often the possibility of failure occurring. In the table of occurrence ratings 9 and 10 which have a very high degree of failure category. Proposed improvements based on these 2 critical components are: Carry out regular maintenance,

References

[1] B. S. Wijaya, D. Andesta, and E. D. Priyana, "Minimasi Kecacatan pada Produk Kemasan Kedelai Menggunakan Six Sigma, FMEA dan Seven Tools di PT. SATP," *J. Media Tek. dan Sist. Ind.*, vol. 5, no. 2, p. 83, 2021, doi: 10.35194/jmtsi.v5i2.1435.

[2] D. Komarasakti, "Analisis Biaya Pemeliharaan Mesin Terhadap Kualitas Produksi Pada Pt. X," *J. Comput. Bisnis*, vol. 2, no. 1, pp. 52–59, 2008.

[3] Hindom, "Pengaruh Variasi Parameter Proses Pemesinan," *Poros Tek. Mesin*, vol. 4, pp. 36–48, 2015.

[4] I. Nurdiansah, Marno, and A. Santosa, "Analisa Kerusakan Mesin Bubut Al Pin 350 Dengan Metode Failure Mode and Effect Analysis (FMEA)," *J. Ilm. Wahana Pendidik.*, vol. 8, no. 1, pp. 704–708, 2022, doi: 10.5281/zenodo.5921782.

[5] A. Andriyani and R. Rumita, "Analisis Upaya Pengendalian Kualitas Kain Dengan Metode Failure Mode and Effect Analysis (Fmea) Pada Mesin Shuttel Proses Weaving PT Tiga Manunggal Synthetic Industries," *Progr. Stud. Tek. Ind. Fak. Tek. Univ. Diponegoro*, vol. 6, no. 1, pp. 1–8, 2017.

[6] Anizar, "Manajemen Risiko K3 Pada Divisi Produksi Menggunakan Fmea Dan Rca Di Pt.Xyz," *Univ. Muhammadiyah Kudus*, vol. 1, p. 3, 2009.

[7] M. Rizki *et al.*, "Aplikasi End User Computing Satifaction pada Penggunaan E-Learning FST UIN SUSKA," *SITEKIN J. Sains, Teknol. dan Ind.*, vol. 19, no. 2, pp. 154–159, 2022, Accessed: Jun. 05, 2022. [Online]. Available: http://ejournal.uin-suska.ac.id/index.php/sitekin/article/view/14730.

[8] A. Anastasya and F. Yuamita, "Pengendalian Kualitas Pada Produksi Air Minum Dalam Kemasan Botol 330 ml Menggunakan Metode Failure Mode Effect Analysis (FMEA) di PDAM Tirta Sembada," *J. Teknol. dan Manaj. Ind. Terap.*, vol. 1, no. I, pp. 15–21, 2022, doi: https://doi.org/10.55826/tmit.v1iI.4.

[9] A. Wicaksono and F. Yuamita, "Pengendalian Kualitas Produksi Sarden Mengunakan Metode Failure Mode And Effect Analysis (FMEA) Dan Fault Tree Analysis (FTA) Untuk Meminimalkan Cacat Kaleng Di PT XYZ," *J. Teknol. dan Manaj. Ind. Terap.*, vol. 1, no. III, pp. 145–154, 2022.

[10] A. Wicaksono and F. Yuamita, "Pengendalian Kualitas Produksi Sarden Mengunakan Metode Failure Mode and Effect Analysis (FMEA) Untuk Meminimumkan Cacat Kaleng Di PT. Maya Food Industries," *J. Teknol. dan Manaj. Ind. Terap.*, vol. 1, pp. 1–6, 2022, doi: https://doi.org/10.55826/tmit.v1iI.6.

[11] A. S. M. Absa and S. Suseno, "Analisis Pengendalian Kualitas Produk Eq Spacing Dengan Metode Statistic Quality Control (SQC) Dan Failure Mode And Effects Analysis (FMEA) Pada PT. Sinar Semesta," *J. Teknol. dan Manaj. Ind. Terap.*, vol. 1, no. III, pp. 183–201, 2022.

[12] N. Badariah, D. Sugiarto, and C. Anugerah, "(FMEA) dan Expert System (Sistem Pakar)," *Semin. Nas. Saints dan Teknol.*, vol. 1, no. November, pp. 1–10, 2016.

[13] M. A. Nasir and D. Andesta, "Pendekatan Metode Failure Mode and Effect Analysis Dalam Analisis Risiko Kecelakaan Kerja Di Unit Fabrikasi Baja PT. XYZ," *J. Serambi Eng.*, vol. 7, no. 4, 2022, doi: 10.32672/jse.v7i4.4634.

[14] B. Khrisdamara and D. Andesta, "Analisis Penyebab Kerusakan Head Truck-B44 Menggunakan Metode FMEA dan FTA," *J. Serambi Eng.*, vol. VII, no. 3, 2022.

[15] A. Khatammi and A. R. Wasiur, "Analisis Kecacatan Produk Pada Hasil Pengelasan Dengan Menggunakan Metode FMEA (Failure Mode Effect Analysis)," *J. Serambi Eng.*, vol. 7, no. 2, pp. 2922–2928, 2022, doi: 10.32672/jse.v7i2.3853.

[16] Y. M. Fitriani, D. Andesta, and H. Hidayat, "Analisis Risiko Kerusakan Pada Mesin Las FCAW Dengan Pendekatan Metode Failure Mode And Effect Analysis (Studi Kasus : PT. Swadaya Graha)," *J. Serambi Eng.*, vol. 7, no. 4, 2022, doi: 10.32672/jse.v7i4.4663.

[17] M. R. Fernandi, "Analisis Kualitas Produk Minyak Goreng Kemasan Standing Pouch (STP) MEnggunakan Metode FMEA (Failur Mode and Effect Analisys) PADA …," vol. VII, no. 3, pp. 3646–3657, 2022.

[18] J. M. Destree Christian, Agung Sutrisno, "Penerapan Metode Root Cause Analysis (Rca) Untuk Menentukan Akar Penyebab Keluhan Konsumen Destree Christian, Agung Sutrisno, Jefferson Mende Jurusan Teknik Mesin Universitas Sam Ratulangi," vol. 7, 2018.

[19] Kuswardana, "Analisis Penyebab Kecelakaan Kerja Menggunakan Metode RCA (Fishbone Diagram Method And 5 – Why Analysis) di PT . PAL Indonesia," *Conf. Saf. Eng. Its Appl.*, pp. 141–146, 2017.