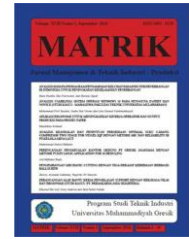




MATRIK

Jurnal Manajemen dan Teknik Industri-Produksi

Journal homepage: <http://www.journal.umg.ac.id/index.php/matriks>



OEE and FMEA Analysis of Cutting Sewing Machine at PT. XYZ

Latisha Aura Ilmanzani^{1*}, Wiwin Widiastih²

^{1,2}Department of Industrial Engineering, Faculty of Engineering, Universitas 17 Agustus 1945 Surabaya

Jl. Semolowaru No. 45 Surabaya, 60118, East Java, Indonesia

Email : 1412200112@surel.untag-sby.ac.id

*Corresponding Author

ARTICLE INFORMATION

doi: 10.350587/Matrik
v27i1.11743

Article History :

Article Submission
May 26, 2026

Reviewer Revisions
September 16, 2026

Publish
September 30, 2026

Keywords :

Downtime, Overall Equipment
Effectiveness (OEE), Six Big
Losses, Failure Mode and Effect
Analysis (FMEA), Cutting
Sewing Machine

ABSTRACT

This study examines the effectiveness of Cutting Sewing Machine 2 at PT. XYZ, a plastic sack manufacturer, over July-December 2025. The machine recorded the highest downtime among similar units at 7,670 minutes. A Total Productive Maintenance (TPM) approach was applied through Overall Equipment Effectiveness (OEE) calculation, Six Big Losses analysis, and Failure Mode and Effect Analysis (FMEA) to identify critical components. The average OEE was 63.82%, below the 85% world-class standard set by the Japan Institute of Plant Maintenance (JIPM). Reduce speed losses dominated at 91.32% of total time losses. Of 19 evaluated components, 9 were classified as critical under the 80% cumulative Pareto threshold; the looper recorded the highest Risk Priority Number (RPN = 256), followed by the hook (224) and needle bar (196). Recommendations include implementing Autonomous Maintenance and Planned Maintenance pillars to raise performance efficiency to 95% and quality rate to 99%, achieving the world-class OEE standard.



1. Introduction

Smooth production processes that contribute to increased output are highly dependent on optimizing machine performance to operate without disruptions. Equipment failures not only temporarily halt operations but also significantly reduce departmental productivity [1]. To maintain production optimality and stability, machine conditions must be maintained at peak performance. Through systematic and planned maintenance strategies, the risk of production breakdown can be minimized, ensuring that cutting quality standards are consistently maintained [2]. Therefore, effective machine management through a structured maintenance system is an indispensable requirement for manufacturing companies [3].

PT. XYZ is a plastic manufacturing company engaged in the production of sacks, plastic bags, and polypropylene sales, serving various industries including food and fertilizer sectors. The extensive production process demands that every machine operates optimally to achieve production targets. In the finishing area, the Cutting Sewing machine is used to cut and sew sacks.

Cutting Sewing Machine 2 experiences more frequent downtime compared to Cutting Sewing Machines 1 and 3, influenced by machine conditions and maintenance intervals that are infrequent or performed reactively after breakdowns occur. Based on machine downtime data for the period of July–December 2025, Cutting Sewing Machine 2 recorded the highest total downtime of 7,670 minutes. As a workstation located in the finishing area, the instability in performance during the cutting and sewing processes has the potential to create a domino effect (bottleneck) that hinders the smooth flow of materials to the packing line and triggers delays in product delivery to consumers [4].

Tabel 1. Downtime Data

Month	Breakdown (minute)	Setup (minute)	Total (minute)
July 2025	905	210	1115
August 2025	930	185	1115
September 2025	1060	200	1260
October 2025	1385	215	1600
November 2025	1010	210	1220
December 2025	1155	205	1360

Machine failures and fluctuating downtime losses each month indicate that the current maintenance system is not yet optimal. Maintenance is currently performed at relatively long intervals of two to six months, potentially causing machine conditions to go unmonitored and leading to sudden breakdowns. Therefore, the initial step in this study is to quantify these losses through Total Productive Maintenance (TPM) via the calculation of Overall Equipment Effectiveness (OEE) for Cutting Sewing Machine 2 [5].

Total Productive Maintenance (TPM) is a methodology focused on improving machine productivity and efficiency through structured equipment management and maintenance [6]. OEE is used to describe the effectiveness level of a machine or equipment in performing its function during the production process, indicating the extent to which the machine can operate optimally according to its capacity [7].

After determining the machine effectiveness level, *Failure Mode and Effects Analysis* (FMEA) is applied. This research integrates OEE and FMEA, starting with the calculation of OEE values availability, performance, quality [8], followed by Six Big Losses analysis to identify the main triggers of machine performance degradation. The dominant losses serve as input for the FMEA method to map failure modes and their effects. Improvement priorities are determined based on the Risk Priority Number (RPN), derived from the product of severity, occurrence, and detection scores. The resulting RPN ranking forms the basis for adaptive improvement recommendations focused on the machine's critical points [9].

2. Research Methods

This study focuses on Cutting Sewing Machine 2 in the finishing area, which operated from July 2025 to December 2025 at PT. XYZ. Both primary and secondary data were used, including working hours, downtime, production output (good and defective products), as well as observations, documentation, and interviews with machine operators and technicians.

Data processing was conducted by calculating OEE values through its three main components: availability, performance, and quality. After computation, the OEE value and the component contributing most to high downtime can be identified [10].

1. Availability

$$\text{Availability} = \frac{\text{Operating Time}}{\text{Loading Time}} \times 100\% \quad (1)$$

2. Performance

$$\text{Performance} = \frac{\text{Processed} \times \text{Ideal CT}}{\text{Operation Time}} \times 100\% \quad (2)$$

3. Quality

$$\text{Quality} = \frac{\text{Processed} - \text{Defect}}{\text{Processed}} \times 100\% \quad (3)$$

The internationally accepted OEE standard set by the Japan Institute of Plant Maintenance (JIPM) is 85%.

Table 2. 1 *World Class OEE*

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

OEE analysis identifies six major loss factors (*Six Big Losses*) as the primary causes of suboptimal production equipment operation, classified into three categories: *downtime losses*, *speed losses*, and *quality losses* [11].

1. Downtime losses

a. Equipment failure

$$\frac{\text{Total Breakdown Time}}{\text{Loading Time}} \times 100\% \quad (4)$$

b. Setup and adjustment

$$\frac{\text{Total Setup Adjustment}}{\text{Loading Time}} \times 100\% \quad (5)$$

2. Speed losses

a. Idling and minor stoppages

$$\frac{\text{Idling and Minor Stoppages}}{\text{Loading Time}} \times 100\% \quad (6)$$

b. Reduce speed

$$\frac{\text{Operation Time} - (\text{ICT} \times \text{Processed})}{\text{Loading Time}} \times 100\% \quad (7)$$

3. Quality losses

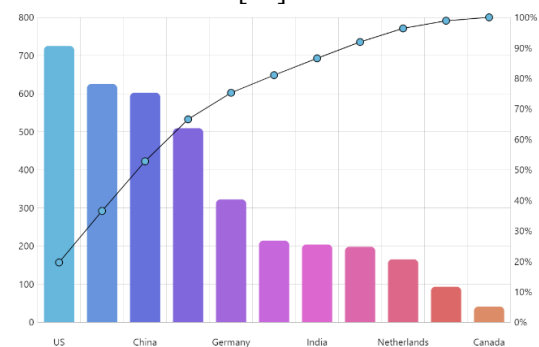
a. Reduce yield

$$\frac{\text{Ideal Cycle Time} \times \text{Total Scrap}}{\text{Loading Time}} \times 100\% \quad (8)$$

b. Defect

$$\frac{\text{Ideal Cycle Time} \times \text{Total Defect}}{\text{Loading Time}} \times 100 \quad (9)$$

The next step after Six Big Losses analysis is to visualize the results through a Pareto diagram. Problems are sorted by frequency of occurrence using a bar chart to facilitate priority mapping. In this chart, the highest bar represents the most frequently recurring problem, while the lowest bar refers to the rarest failure or constraint [12].



Gambar 2. 1 Pareto Diagram

After obtaining the Pareto diagram results, the analysis continues with FMEA identification on the highest loss factor.

$$\text{RPN} = \text{S} \times \text{O} \times \text{D} \quad (10)$$

Severity value (S) assessed based on the severity of the impact of the component failure on the halt of the entire plastic bag production line [13]. Occurrence value (O) assessed based on the frequency or how often the component experiences failure during the period of July–December 2025 [14]. Detection value (D) assessed based on the ability or difficulty level of the system/operator in detecting signs of damage before the component is completely broken [15].

This method aims to evaluate the robustness of the system design by identifying component failure modes and analyzing their cascading effects on operational reliability, tracing failure impacts from the smallest component level to the most critical item in the system [16].

3. Results and Discussion

Research data was collected through interviews with operators and technicians, covering operating time, planned time,

downtime, idle time, and production output. Cutting Sewing Machine 2 operates in three shifts from Monday to Sunday, with seven working hours per shift.

Data Collection

Table 3. 1 Production Output and Defect Percentage

Month	Process (sheet)	Good (sheet)	Defect (sheet)	Defect (%)
July 2025	315.004	309.988	5.016	1,59%
August 2025	271.682	264.100	7.582	2,79%
September 2025	202.271	196.086	6.185	3,06%
October 2025	139.679	133.561	6.118	4,38%
November 2025	165.859	157.278	8.581	5,17%
December 2025	136.020	131.243	4.777	3,51%

Table 3. 2 Maintenance Data

Month	Available Time (minute)	Planned (minute)	Loading Time (minute)	Idle Time (minute)	Downtime (minute)	Operation Time (minute)
July 2025	41760	5220	36540	805	1115	35425
August 2025	40320	5040	35280	790	1115	34165
September 2025	40320	5040	35280	775	1260	34020
October 2025	31680	3960	27720	710	1600	26120
November 2025	36000	4500	31500	790	1220	30280
December 2025	27360	3420	23940	540	1360	22580

OEE Calculation

The OEE value is calculated based on three main components, namely Availability,

Performance, and Quality. The detailed results of the calculation for each component are presented monthly.

Table 3. 3 Availability

Month	Loading Time (minute)	Total Downtime (minute)	Operation Time (minute)	Availability (%)
July 2025	36540	1115	35425	96,95%
August 2025	35280	1115	34165	96,84%
September 2025	35280	1260	34020	96,43%
October 2025	27720	1600	26120	94,23%
November 2025	31500	1220	30280	96,13%
December 2025	23940	1360	22580	94,32%
Average				95,82%

The Availability value is obtained from the comparison between Operation Time and Loading Time each month. Based on the table,

the highest Availability value occurred in July 2025 at 96,95%, while the lowest value occurred in October 2025 at 94,23%.

Table 3. 4 Performance

Month	Operation Time (minute)	Process Amount (sheets)	Ideal Cycle Time (minute)	Performance (%)
July 2025	35425	315.004	0,104	92,48%
August 2025	34165	271.682	0,104	82,70%
September 2025	34020	202.271	0,104	61,83%
October 2025	26120	139.679	0,104	55,61%

November 2025	30280	165.859	0,104	56,97%
December 2025	22580	136.020	0,104	62,65%
Average				68,71%

The highest Performance value occurred in July 2025 at 92,48%, while the lowest value occurred in October 2025 at 55,61%.

against the total products processed each month, with the highest quality value of 98,41% in July 2025.

Quality obtained from the comparison between Process Amount minus Defect Amount

Table 3. 5 Quality

Month	Process Amount (sheets)	Defect Amount (sheets)	Availability (%)
July 2025	315.004	5.016	98,41%
August 2025	271.682	7.582	97,21%
September 2025	202.271	6.185	96,94%
October 2025	139.679	6.118	95,62%
November 2025	165.859	8.581	94,83%
December 2025	136.020	4.777	96,49%
Average			96,58%

Table 3. 6 OEE Calculation Summary

Month	Availabilty (%)	Performance (%)	Quality (%)	OEE (%)
July 2025	96,95%	92,48%	98,41%	88,23%
August 2025	96,84%	82,70%	97,21%	77,85%
September 2025	96,43%	61,83%	96,94%	57,80%
October 2025	94,23%	55,61%	95,62%	50,11%
November 2025	96,13%	56,97%	94,83%	51,93%
December 2025	94,32%	62,65%	96,49%	57,01%
Average				63,82%

Based on the recap of the OEE calculation results, the highest value was in July 2025 at 88,23%, while the lowest value was in October 2025 at 50,11%. The average OEE for the period of July – December 2025 was 63,82%, indicating that the machine performance is still

below the World Class OEE standard set by JIPM.

Six Big Losses Calculation

The Six Big Losses calculation results for Cutting Sewing Machine 2 are presented in Table 3.7 below.

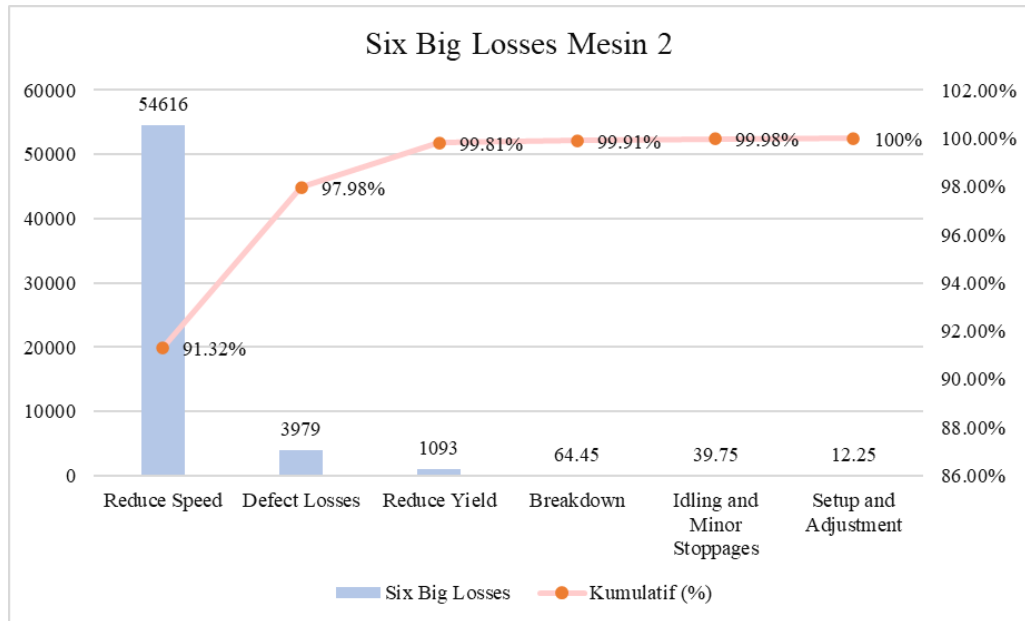
Table 3. 7 Accumulated Six Big Losses

Six Big Losses	Total Time Losses (minute)	Persentase
Reduce Speed	54616	91,32%
Defect Losses	3979	6,65%
Reduce Yield	1093	1,83%
Breakdown	64.45	0,11%
Idling and Minor Stoppages	39.75	0,07%
Setup and Adjustment	12.25	0,02%
Total	59805.28	100%

Based on Table 3.7, the Pareto diagram accumulation shows that the largest percentage belongs to reduce speed losses at 91,32%,

followed by defect losses at 6,65%, reduce yield at 1,83%, and the lowest is setup and adjustment losses at 0,02%. It can be concluded that reduce

speed, defect, and reduce yield require more intensive maintenance attention.



Picture 3. 1 Pareto Diagram

FMEA Identification

The following presents the FMEA identification results, categorizing values according to each component.

Based on FMEA calculations using SOD values, the highest RPN belongs to the looper component at 256, while the lowest is the suction component at 12. To determine which components require priority repair, a cumulative 80% Pareto threshold was applied.

Based on the 80% cumulative Pareto threshold, there are 9 critical components that require priority attention: the looper (RPN 256, 14,72%) through the V-belt (RPN 90, 5,18%). These nine failure components carry the highest risk levels and demonstrably contribute to increased downtime and reduced production output.

Table 3. 8 Result RPN and Rank

Failure	Component	S	O	D	RPN	Rank
Worn/blunt feed dog teeth	Feed dog	7	6	4	168	4
Unstable feed roller	Feed roller	7	5	4	140	5
Shifted looper position	Looper	8	8	4	256	1
Worn looper shaft	Looper shaft	6	5	4	120	6
Worn pulley	Pulley	5	2	3	30	14
Worn brake pad/jammed brake	Machine brake	6	2	2	24	16
Blunt/cracked hook	Hook	8	7	4	224	2
Folder shifted from position	Folding	5	4	3	60	10
Unstable tension disc	Tension disc	6	6	3	108	7
Suction leakage	Suction	3	2	2	12	19
Unstable pressure, leaking seal	Regulator	5	2	3	30	15
Weak foot spring	Presser foot	5	3	3	45	13
Clogged/leaking oil channel	Lubrication system	6	4	4	96	8
V-belt slipping	V-belt	6	5	3	90	9
Worn/bent needle bar	Needle bar	7	7	4	196	3
Unstable speed	Motor	8	2	3	48	12

Loose bearing	P. Bearing	5	2	2	20	17
Sensor error	Sensor	7	2	4	56	11
Leaking/clogged hose	Steam hose	4	2	2	16	18

Table 3. 9 Cumulative Percentage

Failure	Component	RPN	Percentage	Cumulative
Shifted looper position	Looper	256	14,72%	14,72%
Blunt/cracked hook	Hook	224	12,88%	27,60%
Worn/bent needle bar	Needle bar	196	11,27%	38,87%
Worn/blunt feed dog teeth	Feed dog	168	9,66%	48,53%
Unstable feed roller	Feed roller	140	8,05%	56,58%
Worn looper shaft	Looper shaft	120	6,90%	63,48%
Unstable tension disc	Tension disc	108	6,21%	69,70%
Clogged/leaking oil channel	Lubrication system	96	5,52%	75,22%
V-belt slipping	V-belt	90	5,18%	80,39%
Folder shifted from position	Folding	60	3,45%	83,84%
Sensor error	Sensor	56	2,76%	86,60%
Unstable speed	Motor	48	3,22%	89,82%
Weak foot spring	Presser foot	45	2,59%	92,41%
Worn pulley	Pulley	30	1,73%	94,13%
Unstable pressure, leaking seal	Regulator	30	1,73%	95,86%
Worn brake pad/jammed brake	Machine brake	24	1,38%	97,24%
Loose bearing	P. Bearing	20	1,15%	98,39%
Leaking/clogged hose	Steam hose	16	0,92%	99,31%
Suction leakage	Suction	12	0,69%	100%

Improvement Recommendations

Implementation of Total Productive Maintenance (TPM) on the Cutting Sewing machine is focused on integrating the Autonomous Maintenance (AM) and Planned Maintenance (PM) pillars to address recurring disruptions in critical components. Through the AM pillar, operators are actively involved in daily Cleaning, Lubricating, Inspection, and Tightening (CLIT) activities, including regular cleaning of sack cuttings and thread residue in the feed dog, needle bar, and looper/hook housing areas using a brush or compressed air, as well as daily visual inspection of oil indicators, tension disc gap, and V-belt condition. Meanwhile, the PM pillar is allocated to technician teams to handle precision mechanical components through periodic inspection of looper shaft wear tolerance, repolishing of scratched looper or hook tips, calibration of needle movement timing, and scheduled replacement of worn fabric-pulling components such as feed dog teeth and feed roller rubber.

4. Conclusion and Recommendations

Based on the analysis conducted on Cutting Sewing Machine 2 at PT. XYZ, it can be concluded that machine performance during July – December 2025 was not yet optimal. The decline in machine effectiveness was caused by low average performance (68,71%) and quality (96,58%) values, despite an acceptable availability rate (95,82%). As a result, the average OEE value of 63,82% does not meet the standard established by JIPM.

Based on Six Big Losses data processing for Cutting Sewing Machine 2, reduce speed losses (54,616.44 minutes), defect losses (3,978.94 minutes), and reduce yield losses (1,093 minutes) were identified as the primary contributors to performance degradation, resulting in high unplanned downtime.

Through FMEA application, the Six Big Losses were broken down into component-level identification. A total of 19 components were identified, of which 9 components have the highest failure risk based on the cumulative

80% Pareto threshold: the looper (RPN 256), hook (RPN 224), through to V-belt (RPN 90).

To improve machine performance, it is recommended that the maintenance team enhance planning to better estimate repair time requirements and consider preventive scheduling to prevent component failure before it occurs during active production. With the implementation of these recommendations, performance is expected to reach 95% and quality to reach 99%, thereby enabling the OEE value to achieve the world-class standard target of 85%.

5. References

- [1] E. O. Arnanda, Y. P. Negoro, and D. Andesta, 'Analisis Kinerja Mesin Departemen Amonia Menggunakan Metode OEE dan Fuzzy FMEA Pada Kegagalan Berdampak Tinggi di Produsen Pupuk', *J. Teknol. Dan Manaj. Ind. Terap.*, vol. 5, no. 1, pp. 238–247, Jan. 2026, doi: 10.55826/jtmit.v5i1.1514.
- [2] M. R. Hardiyanti, Y. P. Negoro, A. Dina, and A. Harmayanti, 'Evaluasi OEE dan Six Big Losses pada Mesin CNC Cutting Industri Konstruksi Manufaktur CV Karya Utama Teknik', *J. Manaj.*, 2026.
- [3] M. Musyafa'ah and A. Sofiana, 'Analysis of Total Productive Maintenance (TPM) Application Using Overall Equipment Effectiveness (OEE) and Six Big Losses on Disamatic Machine PT. XYZ', *OPSI*, vol. 15, no. 1, p. 56, Jun. 2022, doi: 10.31315/opsi.v15i1.6630.
- [4] R. F. Armaputra and S. S. Dahda, 'Effectiveness Analysis Using Overall Equipment Effectiveness (OEE) and Failure Modes And Effect Analysis (FMEA) Methods at PT. XYZ', *G-Tech J. Teknol. Terap.*, vol. 9, no. 4, pp. 2030–2041, Oct. 2025, doi: 10.70609/g-tech.v9i4.8047.
- [5] K. Anshar and M. R. Alkhairi, 'Penerapan Metode OEE Dan FMEA Dalam Mengukur Kinerja Mesin Auto Cutter Untuk Meminimalisir Six Big Losses Di PT. XYZ', 2024.
- [6] D. Siagian, I. N. Gusniar, and I. Dirja, 'Analisis Total Productive Maintenance Dengan Metode OEE Dan FMEA Pada Mesin Extruder GW-350', *Steam Eng.*, vol. 4, no. 1, pp. 14–20, Sep. 2022, doi: 10.37304/jptm.v4i1.5343.
- [7] A. G. Ramadhani, D. Z. Azizah, F. Nugraha, and M. Fauzi, 'Analisa Penerapan TPM (Total Productive Maintenance) Dan OEE (Overall Equipment Effectiveness) Pada Mesin Auto Cutting Di PT XYZ', *J. Ilm. Tek. Dan Manaj. Ind.*, vol. 2, no. 1, Jul. 2022, doi: 10.46306/tgc.v2i1.25.
- [8] R. D. Oktafia, R. Septiari, and S. Sumanto, 'PENERAPAN TPM MENGGUNAKAN OEE DAN SIX BIG LOSSES UNTUK MENGEVALUASI EFEKTIVITAS MESIN RING FRAME (STUDI KASUS : PT. XYZ)', *J. Valtech*, vol. 8, no. 2, pp. 164–170, Nov. 2025, doi: 10.36040/valtech.v8i2.15871.
- [9] A. J. Ramadhan and M. Jufriyanto, 'Analisis Kinerja Mesin Mobile Bagging Unit (MBU) Dengan Menggunakan Metode OEE (Overall Equipment Effectiveness) Dan FMEA (Failure Mode and Effect Analysis)', *J. Teknol. Dan Manaj. Ind. Terap.*, vol. 5, no. 1, pp. 281–292, Jan. 2026, doi: 10.55826/jtmit.v5i1.1510.
- [10] R. F. Armaputra and S. S. Dahda, 'Effectiveness Analysis Using Overall Equipment Effectiveness (OEE) and Failure Modes And Effect Analysis (FMEA) Methods at PT. XYZ | G-Tech: Jurnal Teknologi Terapan', Oct. 2025, Accessed: May 24, 2026. [Online]. Available: <https://ejournal.uniramalang.ac.id/g-tech/article/view/8047>
- [11] H. Ardy and W. Widiasih, 'Analysis of Bolt Former Machine Effectiveness Using Overall Equipment Effectiveness (OEE) and Six Big Losses: Analisis Efektivitas Mesin Bolt Former Menggunakan Overall Equipment Effectiveness (OEE) dan Six Big Losses', *PROZIMA Product. Optim. Manuf. Syst. Eng.*, vol. 8, no. 1, pp. 25–34, Jun. 2024, doi: 10.21070/prozima.v8i1.1688.
- [12] S. Z. Nisriina and W. Widiasih, 'Analisis Efektivitas Mesin Moulding 1 Menggunakan Metode OEE dengan Pendekatan Cause Effect Diagram di PT. Sarana Kreasi Lestari', *J. Ind. View*, vol. 7, no. 1, pp. 35–49, Jul. 2025, doi: 10.26905/jiv.v7i1.14975.

- [13] M. H. Aiman and M. Nuruddin, ‘Analisis Kecacatan Produk Pada Mesin Pemotongan Dengan Menggunakan Metode FMEA di UD. Abdi Rakyat’, *J. Tek. Ind. J. Has. Penelit. Dan Karya Ilm. Dalam Bid. Tek. Ind.*, vol. 9, no. 2, p. 577, Jul. 2023, doi: 10.24014/jti.v9i2.23835.
- [14] A. Saputra, S. Rahayu, and H. Windyatri, ‘Analisis Peningkatan Overall Equipment Effectiveness (OEE) Mesin Surface Mount Technology (SMT) Melalui Failure Mode And Effect Analysis (FMEA)’, *J. Teknol. Dan Manaj. Ind. Terap.*, vol. 4, no. 3, pp. 537–547, Jul. 2025, doi: 10.55826/jtmit.v4i3.788.
- [15] B. N. Nabila, S. S. Dahda, and E. D. Priyana, ‘Penerapan Failure Mode and Effect Analysis (FMEA) dan Fault Tree Analysis (FTA) pada Mesin Produksi untuk Peningkatan Keandalan’, vol. 4, no. 4, 2025.
- [16] A. Hermawan, D. Doto, and R. Akmal, ‘Penerapan Metode Overall Equipment Effectiveness (OEE) Dan Failure Mode and Effect Analysis (FMEA) Pada Mesin Adhesive Di PT. Asia Chemical Industry’, *J. Ilm. Tek. Dan Manaj. Ind.*, vol. 2, no. 2, pp. 197–220, Dec. 2022, doi: 10.46306/tgc.v2i2.38.

(This page is intentionally left blank)

