G-Tech : Jurnal Teknologi Terapan
Vol. 9, No. 2, 2025, p. 695-704
E-ISSN: 2623-064X | P-ISSN: 2580-8737

Analysis of Total Productive Maintenance (TPM) Using OEE and FMEA Methods on Plan-2 Dolomite Fertilizer Production Machine at PT. XYZ

Dias Afiansyah[1]✉, Efta Dhardikasari Priyana[2], Hidayat[3]

[1, 2, 3] Department of Industrial Engineering, Faculty of Engineering, Universitas Muhammadiyah Gresik, Indonesia

✉ **Corresponding Author :** Dias Afiansyah (e-mail: diasafiansyah4@gmail.com)

Article Information

Article History

Received : February 07, 2025
Revised : March 08, 2025
Published : April 04, 2025

***Keywords*:**
OEE;
FMEA;
Total Productive Maintenance

ABSTRACT

There are several aspects that affect the company's top priority, namely the smooth production process, one of which is machine performance. At PT XYZ during the period January - June 2024 had high downtime caused by ineffective maintenance management, resulting in disruption of production flow and reducing overall productivity. The purpose of this study is to determine the value of machine effectiveness using the OEE method and determine the factors that cause obstruction of the production process. From the calculation results, the average OEE value was 47.70%, below the world-class standard of 85%. In addition, this study identified six major losses with the highest value being equipment failure losses with an average of 48.38%, FMEA analysis showed the highest RPN value of 441 on the machine factor with the failure mode occurring, namely the presence of foreign objects in the raw material entering the crusher machine can cause significant damage to machine components. To increase the effectiveness of production machines at PT. XYZ, corrective actions are needed in machine maintenance and labor vigilance.

INTRODUCTION

There are a number of aspects that influence the company's first priority, which is a smooth production process., the factor that affects the smooth production process is machine performance (Aji & Haryadi, 2018). When the machine is damaged/delayed, the production process will be forced to stop and will have an impact on company productivity (Islam, 2020). The use of tools or machines to support operations to produce high-quality output has become unavoidable in all economic sectors (Amilia et al., 2021). This can be avoided by considering methods to enhance efficiency in order to achieve sustained production, such as performing routine maintenance on machinery or conducting ongoing inspections of machinery and equipment.(Alfarisi & Andesta, 2024).

PT XYZ is a manufacturing company engaged in the production of dolomite fertilizer, the company has several products, such as Magforin, Premium 100 Magnesium Dolomite Fertilizer, Magfertil 20+ Magnesium Dolomite Fertilizer, and Magfertil 6.0. During the production process, the machines or equipment used often experience disruptions due to ineffective maintenance management, which results in disruption of production flow and decreases overall productivity. One of the causes of not achieving machine productivity due to downtime, such as crusher machines entering foreign objects / metal in raw materials, fan belts on conveyor machines breaking, oil in the hummer mill drive engine dry due to the heat of the steam in the combustion process, and product clumping in the bag filter machine caused by high water content resulting in blockages in the bag filter machine. One way to maintain the quality of production machinery is to perform machine maintenance. If the machine is not properly maintained, the frequency of machine damage will increase so that it does not meet optimal capacity and product quality. With the problem of machine damage, the problem of the production process increasingly spreads to productivity, production quality, and production targets. Therefore, it is necessary to measure the performance and evaluate the plan 2 dolomite fertilizer production machine.

In this regard, maintenance and handling of machines that are not on target can cause damage problems. TPM is part of a maintenance system that has a high level of productivity involving all workers from top-level management to implementers (Supriatna et al., 2017). TPM aims to maintain machinery and equipment so that they can be used to support productioprocess activities in the long term. (Anthony, 2019). OEE is a machine's or piece of equipment's effectiveness value. (Hadi Ariyah, 2022). he purpose of OEE itself is used to measure the effectiveness of the machine maintenance system, so that this method can determine the quality of machine or equipment output (Tammya & Herwanto, 2021). The six major losses associated with inefficient equipment—breakdown losses, setup and adjustment, reduced speed losses, ideal and minor stoppage losses, and defect losses—are analyzed in the OEE calculation in order to fulfill quality standards (Nurwulan & Fikri, 2020). The FMEA approach will be used to assess the machine's or tool's performance once the effectiveness value has been determined. A process's failure rate can be ascertained or observed using FMEA (Failure Mode and Effects Analysis), which will thereafter be examined to enable failures to be appropriately predicted. (Suherman & Cahyana, 2019). In addition, FMEA is a type of risk analysis. The purpose of FMEA itself is used to determine what actions must be taken to reduce risk (Priambodo et al., 2021).

This research aims to analyze the effectiveness problems that occur in the dolomite fertilizer production machine at PT XYZ by using the OEE (Overall Equipment Effectiveness) method to determine the level of productivity effectiveness on the machine. In addition, this research also applies the FMEA (Failure Mode and Effects Analysis) method to identify problems in the dolomite fertilizer production process that can cause products to fail. The resulting recommendations include strategies to reduce high downtime, such as more scheduled preventive maintenance, operator training, and improved monitoring systems to identify potential faults before they occur, so as to improve overall production quality and efficiency.

RESEARCH METHODS

The methods used in this research are OEE and FMEA methods to calculate and evaluate machine performance to increase productivity at PT XYZ. This research uses other types of data: Machine Set Up, Machine Breakdown, Operation Time, Planned downtime, Unplanned Downtime, Downtime, Total Product, Wise Product, and Ideal Cycel Time. Data collection in the study was carried out by observing and interviews. The data sample taken by the research was the last 6 months of January – June 2024, Furthermore, data processing and analysis were carried out usingMicrosoft Excel software.

Overall Equiqment Effectiviness (OEE)

Overall Equipment Effectiveness (OEE) is a measure of TPM application to keep maintenance in ideal condition by eliminating six major losses. In determining the effectiveness of equipment in a factory, it is necessary to assume that the equipment can be operated (Muhaemin & Nugraha, 2022). OEE is a statistical measurement of machine efficiency. The OEE percentage shows whether the machine can run at optimal capacity. (Pradaka & Aidil SZS, 2021). The results of the OEE value are shown in a generic form which will be used to compare the effectiveness value between units in different departments, companies, and industries. (Atikno & Purba, 2021). Important components that affect the OEE value are availability, performance, and quality, the OEE formula can be seen as follows: (Oktafianto & Puspitasari, 2018)

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

Table 1. Oee calculation value

Deskrisi	Nilai
Availabilty Rate	>90%
Performance Rate	>95%
Quality Rate	>99%
Overall Equiqment Effectiviness (OEE)	>85%

Sumber: (Oktafianto & Puspitasari, 2018)

1. Availability
   Availability is the ratio between actual and planned machine operating time. Using the formula, a higher availability value can be found. (Sibarani et al., 2020)

$$\text{Availibity Rate} = \frac{\text{Operation Time}}{\text{Loading Time}} \text{ X}100\% \quad (2)$$

2. Performance Rate
   The Performance Rate metric quantifies the disparity between the actual production speed and the designed peak capacity of the machine. (Muhaemin & Nugraha, 2022)

$$\text{Performance Rate} = \frac{\text{Total Produksi x Ideal Cycle Time}}{\text{Operation Time}} \text{ X } 100\% \quad (3)$$

3. Quality Rate
   Rasio kualitas (*Quality Rate*) merepresentasikan proporsi produk yang memenuhi standar kualitas terhadap total output produksi (Dewanti & Putra, 2019)

$$\text{Quality Rate} = \frac{\text{Total Produksi} - \text{Deffect Produk}}{\text{Total Produksi}} \text{ X } 100\% \quad (4)$$

Six Big Losses

Six big losses are six losses that cause the effectiveness value of the machine / equipment to be low (Sultoni & Saroso, 2019)

a. Equipment Failure Losses
   Losses due to equipment failure occur when the machine or equipment is not functioning properly or is damaged and needs to be stopped (Farichi & Murnawan, 2023)

$$\text{Equipment Failure Losses} = \frac{\text{Total Breakdown}}{\text{Loading Time}} \text{ X } 100\% \quad (5)$$

b. Setup and Adjusment Losses
   Congestion losses occur when the work system undergoes changes, such as product or equipment changes.(Amilia et al., 2021)

$$\text{Set Up \& Adjusment Losses} = \frac{\text{Total Set Up Mesin}}{\text{Loading Time}} \text{ X } 100\% \quad (6)$$

c. Idling and miror stoppages Losses
   Losses due to machine speed and efficiency these losses occur when the machine or equipment stops or runs at a slower speed than it should(Farichi & Murnawan, 2023)

$$\text{Idling \& Miror Stoppaged Losses} = \frac{\text{Non Productive Time}}{\text{Loading Time}} \text{ X } 100\% \quad (7)$$

d. Reduced speed losses

Reduced speed losses are losses that arise because the actual speed of the process is below the optimal speed of the machine (Farichi & Murnawan, 2023)

$$\text{Reduce Speed} = \frac{\text{Operation time - (Ideal Cycle Time x Total Product)}}{\text{Loading Time}} \text{ X } 100\% \quad (8)$$

e. Reduce Yield

Reduce Yield Is a loss incurred during the production process that has not reached an unstable state of production at the time the production process starts until the achievement of a stable process state (Prasmoro & Ruslan, 2020)

$$\text{Reduce Yield} = \frac{\text{(Ideal Cycle Time x Deffect Saat Setting)}}{\text{Loading Time}} \text{ X } 100\% \quad (9)$$

f. Product Deffect Losses

Product Defect Losses Is the state of the machine that does not produce products that are in accordance with the predetermined quality and scrap the remaining production runs (Prasmoro & Ruslan, 2020)

$$\text{Product Deffect Losses} = \frac{\text{(Ideal Cycle Time x Produk Deffect)}}{\text{Loading Time}} \text{ X } 100\% \quad (10)$$

Failure Mode

It is a structured technique or systematic model to identify and prevent failure modes (Khatammi & Wasiur, 2022). Three criteria—severity, occurrence, and detection—are connected by RPN to define the highest level of failure risk. According to the formula below, a system component's reliability decreases with increasing RPN value. (Rinoza & Ahmad Kurniawan, 2021):

$$RPN = S \text{ x } O \text{ x } D \quad (11)$$

RESULTS AND DISCUSSION

Data Collection

Data collection is carried out in January - June 2024 where the data is in the form of historical data on engine damage to plan-2 where the data is obtained from the results of primary and secondary data collection

a. Data Setup & Breakdown

Table 2. Data Setup dan Breakdown

month	Set Up Mesin (Minute)	Breakdown (Minute)
January	540	20.976
February	-	31.824
March	720	8.381
April	765	12.296
May	960	6.890
June	-	-

Sumber : Data Perusahaan, Januari – Juni 2024

b. Data of Downtime

Table 3. Data Downtime

Month	Operation time (Minute)	Planned down time (Minute)	Unplaned downtime (Minute)	Downtime (Menit)
Januar	5.760	12.120	26.220	38.880
Februaı	-	9.936	31.824	41.760
March	23.040	6.912	13.968	21.600
April	19.200	5.670	17.565	24.000
May	23.520	7.056	11.484	19.500
June	37.440	5.760	-	5.760

Sumber : Data Perusahaan, Januari – Juni 2024

c. Data of Production

Tabel 4. Data Production

Month	Total Product (Kg)	Wise Produk (Kg)	Ideal Cycel Time (Menit)
January	3.765.000	11.295	0,00153
February	4.644.000	-	-
March	1.131.000	7.917	0,02037
April	2.526.000	27.786	0,00760
May	2.913.000	23.304	0,00807
June	4.812.000	43.308	0,00778

Sumber : Data Perusahaan, Januari – Juni 2024

Data Rocessing

The processing process on the dolomite fertilizer production machine includes calculating the OEE value, calculating the value of the six major losses, making a Fishbone diagram to find out what factors cause material losses and facilitate FMEA analysis, calculating SOD and RPN through FMEA, and then making suggestions for improvement. calculation

a. Availability

calculations such as January below:

$$\text{Availibity Rate} = \frac{\text{Operation Time}}{\text{Loading Time}} \text{ X } 100\%$$

$$= \frac{5.760}{32.520} \text{ X } 100\%$$

$$= 17{,}71\ \%$$

By doing ama calculations, it can be seen in the table below

Table 5. Availability calculation

Month	Operation Time (Minute) (T)	Loading Time (Minute) (S)	Availability U=(T/S)*100	Standart Availibity (>)	Information
January	5.760	32.520	17,71%	90%	Does not meets the standart
February	-	31.824	-	90%	Does not meets the standart
March	23.040	37.728	61,07%	90%	Does not meets the standart
April	19.200	37.530	51,16%	90%	Does not meets the standart
May	23.520	35.964	65,40%	90%	Does not meets the

					standart
June	37.440	37.440	100,00%	90%	Does not meets the standart
	Average		59,07%	90%	Does not meets the standart

b. Performance Rate
calculations such as January below:

$$\text{Performance Rate} = \frac{\text{Total Produksi x Ideal Cycle Time}}{\text{Operation Time}} \quad X100\%$$

$$= \frac{3.765.000 \text{ x } 0,00149}{5760} \quad X100\%$$

$$= 97,39\%$$

By doing ama calculations, it can be seen in the table below

Table 6. Performance calculations

Month	Total Product (kg) (B)	Ideal Cycel Time (M)	Operation Time (Menit) (T)	Performance V=((B*M)/T*100%	Standart Performance (>)	Information
January	3.765.000	0,00149	5.760	97,39%	95%	Meets the standart
Februar y	4.644.000	0	-	-	95%	Meets the standart
March	1.131.000	0,02017	23.040	99,01%	95%	Meets the standart
April	2.526.000	0,00731	19.200	96,17%	95%	Meets the standart
May	2.913.000	0,00803	23.520	99,45%	95%	Meets the standart
June	4.812.000	0,00744	37.440	95,62%	95%	Meets the standart
		Average		97,53%	95%	Memenuhi standart

c. Quality Rate
calculations such as January below:

$$\text{Quality Rate} = \frac{\text{Total Produksi} - \text{Deffect Produk}}{\text{Total Produksi}} \quad X100\%$$

$$= \frac{3.765.000 - 11.295}{3.765.000} \quad X100\%$$

$$= 99,7\%$$

By doing ama calculations, it can be seen in the table below

Table 7. Quality calculations

Month	Total Produksi (Kg) (B)	wise produk (kg) (J)	Quality Rate W=((B-J)/B))*100	Standart uality Ra (>)	Information
January	3.765.000	11.295	99,7%	99%	Meets the standart
Februariy	4.644.000	-	100,0%	99%	Meets the standart
March	1.131.000	7.917	99,3%	99%	Meets the standart
April	2.526.000	27.786	98,9%	99%	Does not meets the standart

May	2.913.000	23.304	99,2%	99%	Meets the standart
June	4.812.000	43.308	99,1%	99%	Meets the standart
	Average		99,4%	99%	Meets the standart

d. Perhitungan Nilai OEE

calculations such as January below:

OEE = *Availability x Performance Rate x Quality Rate*
= 12,90% x 97,39% x 99,70%
= 12,5

By doing ama calculations, it can be seen in the table below

Table 8. Oee Calculations

Month	Availibity Rate (%)	Performance Rate (%)	Qualitity Rate (%)	OEE (%)	Standart Oee(%)	Information
January	17,71%	97,39%	99,70%	17,2%	85%	Does not meets The standart
February	-	-	99,00%	0,0%	85%	Does not meets the standart
March	61,07%	99,01%	99,30%	60,0%	85%	Does not meets the standart
April	51,16%	96,17%	99,90%	49,6%	85%	Does not meets the standart
May	65,40%	99,45%	99,20%	64,2%	85%	Does not meets the standart
June	100,00%	95,62%	99,10%	95,1%	85%	Does not meets the standart
		Average		47,70%	85%	Does not meets the standart

After doing the OEE calculation above, it can be seen that the plan-2 dolomite fertilizer production machine has a percentage of 47.70%. This average is below the OEE standard value (<85%), therefore further calculations are needed to determine and calculate the six big losses.

Calculation Six Big Losses

After comparing the cloth cutting machine's OEE value results to the ideal OEE value standard, the corporation must take corrective action to raise the machine's OEE value. As a result, the six significant losses must be calculated using the results in the table below:

Table 9. Calculation Six Big Losses

Bulan	Equipment Failure Losses(%)	Set Up & Adjustment Losses(%)	Idling &Miror Stoppaged Losses(%)	ReduceSpeed Losses(%)	Reduce Yield(%)	Product Deffect Losses(%)
Jan	48,38%	1,66%	37,27%	0,46%	0,31%	0,05%
Feb	100,00%	0%	31,22%	0,00%	0,00%	0%
Maret	7,41%	1,91%	18,32%	0,60%	1,27%	0,42%
April	32,59%	2,03%	15,03%	1,95%	1,62%	0,54%
Mei	19,16%	2,67%	19,62%	0,36%	1,56%	0,52%
Juni	0,00%	0%	15,38%	4,38%	2,58%	0,86%
Average	48,38%	1,66%	37,27%	0,46%	0,31%	0,05%

From the table above, it is shown that the percentage of the six big losses factor that is most dominant is equiment failure losses and idling & miror stoppages losses, this factor causes the low OEE value on each machine, so it will continue to analyze the cause and effect diagram (fishbone diagram).

Fishbone Diagram

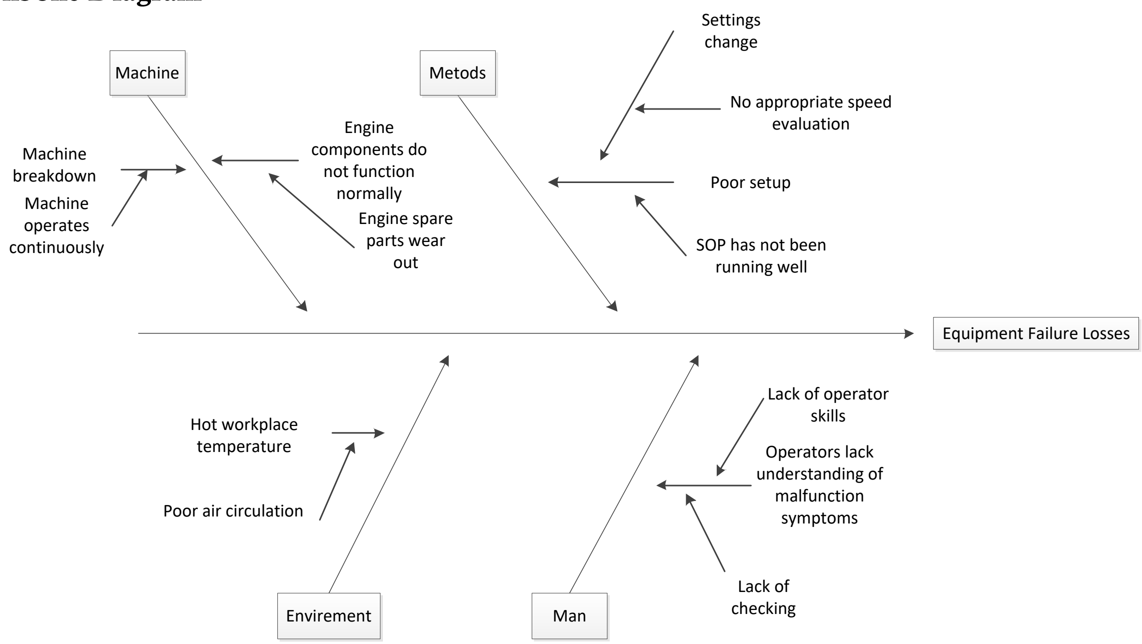

Image 1. Fishbone Diagram

By using the fishbone diagram, the root cause of the problem can be identified. From the above calculations it can be seen that the most influential factor is Equipment Failure Losses, then further identification is carried out regarding the high breakdown losses.

1. Human: Lack of checking on the machine because the operator does not understand the symptoms of damage that arise during the production process.
2. Environment: Poor air circulation causes hot working environment conditions, so that employees work in stressful conditions and reduce concentration at work.
3. Method: SOPs that have not been running properly result in less than optimal machine settings, the absence of appropriate speed evaluation makes setting measurements change.
4. Machine: The machine operates continuously causing engine spare parts to wear out, resulting in machine damage because the engine components do not function normally.

FMEA

After finding several factors causing failure, at this stage an analysis is carried out using the FMEA method, namely by looking for the cause of failure, and potential failure from the effect of failure. Furthermore, the weighting value is given according to the conditions that occur, the value is filled in by workers who deal with the machine directly. After obtaining the severity, occurance, and detection values, they will then be accumulated into an RPN value. This RPN value will be the first priority in taking corrective action.

Table 10. RPN Value Calculacion

Cause Factor	Potential Failure	Cause Failure	Saverity rating	Occurance rating	Detection rating	RPN
Human	Lack of understanding and accuracy of operators, so that the machine can stop because the parameter settings are not appropriate	Lack of focus and experience	7	6	6	252
Machine	Inability to achieve the desired fineness (below 95% mesh 100) can result in irregular particles	Worn roll mill machine components	5	5	6	150
	The presence of foreign matter in the raw material entering the crusher can cause significant damage to machine components	Machine component damage	9	7	7	441
Methods	Long machine idle cases	Downtime high	5	4	3	60
	Preventive maintenance that is applied less effectively so that it causes high downtime	Inadequate planning	6	5	4	120
	The wood burning process can produce inconsistent energy, disrupting the production process.	Inappropriate combustion techniques	6	4	5	120
Environment	Rainy weather can cause high humidity levels, which can cause fertilizer to clump and clog the filter machine	Unpredictable weather changes	6	6	6	216
Material	Improper quality of MgO and CaO levels	Poor raw materials	3	3	4	36
	High moisture content of dolomite	Inappropriate storage	6	4	6	144

CONCLUSION

Based on the results of calculations that have been obtained during January-June 2024, the average value of the effectiveness level of Overall equipment Effectiveness on production machinery in 2024 is 40.34%, still far below the world class standard of 85%. While the average availability value on the production machine is 50.06%. The average performance rate on the production machine is 97.53%. The average quality rate on production machines is 99.4%.

The factor that causes the biggest Losses that hinder the achievement of OEE on dolomite fertilizer production machines in 2024 is the low OEE value on the plan-2 production machine caused by the high value of six big losses, namely equipment failure losses with a value of 48.38% with an average breakdown of 13.394 minutes.Shows the frequent occurrence of machine breakdowns so that it can hinder the course of the production process and affect the company's productivity level. From the results of the RPN calculation, the largest value is obtained in the Man factor with a value of 441 with a failure mode that occurs The presence of foreign objects in the raw materials that enter the crusher machine can cause significant damage to machine components.

Based on the results of the analysis showing that the level of Overall Equipment Effectiveness (OEE) on dolomite fertilizer production machines at PT XYZ is still far below world-class standards, it is recommended that the company make comprehensive improvements in machine maintenance management. Therefore, improving preventive and corrective maintenance programs is very important to reduce the frequency of machine breakdowns, especially those related to equipment failure losses. In addition, training for operators and related staff is also needed to increase awareness of the importance of keeping raw materials clean, in order to minimize the risk of foreign objects that can damage the machine. By implementing these improvements, PT XYZ can increase overall productivity, as well as achieve the expected efficiency targets.

ACKNOWLEDGMENTS

My gratitude goes to PT MGI for providing information and activity support and supporting this research, and thanks also to my parents, supervisors, colleagues who helped in this research, and someone who has accompanied me in this research.

REFERENCES

Aji, N., & Haryadi, D. (2018). Pengaruh Penjadwalan Produksi dan Tata Letak Terhadap Kelancaran Proses Produksi di PT. Sinar Mulia Megah Abadi. *Sosiohumanitas*, *20*(1). https://doi.org/10.36555/sosiohumanitas.v20i1.46

Alfarisi, M. I., & Andesta, D. (2024). Analisis Efektivitas Mesin Pemotong pada Kain Kapas Menggunakan Metode OEE dan FMEA di UMKM IBS. *G-Tech : Jurnal Teknologi Terapan*, *8*(1), 186–195.

Amilia, K., Dahda, S. S., & Ismiyah, E. (2021). Analisis Kinerja Fasilitas Produksi Dioctyle Phtalate Dan Diisononyl Phthalate Dengan Menggunakan Metode Overall Equipment Effectiveness Di Pt. Petronika. *JUSTI (Jurnal Sistem dan Teknik Industri)*, *1*(2), 164. https://doi.org/10.30587/justicb.v1i2.2600

Anthony, M. B. (2019). Analisis Penerapan Total Productive Maintenance (TPM) Menggunakan Overall Equipment Effectiveness (OEE) Dan Six Big Losses Pada Mesin Cold Leveller PT. KPS. *JATI UNIK : Jurnal Ilmiah Teknik dan Manajemen Industri*, *2*(2), 94–103. https://doi.org/10.30737/jatiunik.v2i2.333

Atikno, W., & Purba, H. H. (2021). Sistematika Tinjauan Literature Mengenai Overall Equipment Effectiveness (OEE) pada Industri Manufaktur dan Jasa. *Journal of Industrial and Engineering System*, *2*(1), 29–39.

Dewanti, G. K., & Putra, M. F. (2019). Perhitungan Nilai Overall Equipment Efectiveness (OEE) Mesin Printing Amplas Kertas. *Jurnal Optimasi Teknik Industri (JOTI)*, *1*(2), 1. https://doi.org/10.30998/joti.v1i2.4175

Farichi, M. K., & Murnawan, H. (2023). ANALISIS PENGUKURAN EFEKTIFITAS MESIN PACKING DI UNIT 2 MENGGUNAKAN OVERALL EQUIPMENT EFFECTIVENESS (OEE) DENGAN PENDEKATAN TOTAL PRODUCTIVE MAINTENANCE (Studi Kasus : PT. XYZ). *Teknika*, *01*(1), 66–80.

Hadi Ariyah. (2022). Penerapan Metode Overall Equipment Effectiveness (OEE) Dalam Peningkatan Efisiensi Mesin Batching Plant (Studi Kasus : PT. Lutvindo Wijaya Perkasa). *Jurnal Teknologi dan Manajemen Industri Terapan*, *1*(2), 70–77. https://doi.org/10.55826/tmit.v1iii.10

Islam, S. S. (2020). Analisis Preventive Maintenance Pada Mesin Produksi dengan Metode Fuzzy FMEA. *JTT (Jurnal Teknologi Terpadu)*, *8*(1), 13–20. https://doi.org/10.32487/jtt.v8i1.766

Khatammi, A., & Wasiur, A. R. (2022). Analisis Kecacatan Produk Pada Hasil Pengelasan Dengan Menggunakan Metode FMEA (Failure Mode Effect Analysis). *Jurnal Serambi Engineering*, *7*(2), 2922–2928. https://doi.org/10.32672/jse.v7i2.3853

Muhaemin, G., & Nugraha, A. E. (2022). Penerapan Total Productive Maintenance (TPM) Pada Perawatan Mesin Cutter di PT. XYZ. *Jurnal Ilmiah Wahana Pendidikan*, *8*(9), 205–219.

Nurwulan, N. R., & Fikri, D. K. (2020). Analisis Produktivitas dengan Metode OEE dan Six Big Losses: Studi Kasus di Tambang Batu Bara. *Jurnal IKRA-ITH Ekonomika*, *3*(3), 30–35.

Oktafianto, A., & Puspitasari, D. (2018). Analisis Efektifitas Mesin Berdasarkan Perhitungan Nilai Overall Equipment Effectiveness pada Mesin Pembuat Rokok (Single Procession Unit 02 dan Single Procession Unit 03) di PT Djarum. *Industrial Engineering Online Journal*, *Vol. 6*, *No*, 1–11.

Pradaka, M. A., & Aidil SZS, J. (2021). Analisis Total Productive Maintenance Menggunakan Metode OEE dan FMEA pada Pabrik Phosporic Acid PT Petrokimia Gresik. *Jurnal Teknik Industri*, *11*(3), 280–289. https://doi.org/10.25105/jti.v11i3.13087

Prasmoro, A. V., & Ruslan, M. (2020). Analisis Penerapan Total Productive Maintenance (TPM) dengan Metode Overall Equipment Effectiveness (OEE) pada Mesin Kneader (Studi Kasus PT. XYZ). *Journal of Industrial and Engineering System*, *1*(1), 53–64. https://doi.org/10.31599/jies.v1i1.167

Priambodo, B., Nursanti, E., & Laksmana, D. I. (2021). Analisa Risiko Lift (Elevator) dengan Metode FMEA. *Jurnal Teknologi dan Manajemen Industri*, *7*(2), 7–12.

Rinoza, M., & Ahmad Kurniawan, F. (2021). Analisa Rpn (Risk Priority Number) Terhadap Keandalan Komponen Mesin Kompresordouble Screw Menggunakan Metode Fmea Di Pabrik Semen Pt. Xyz. *Cetak) Buletin Utama Teknik*, *17*(1), 1410–4520.

Sibarani, A. A., Muhammad, K., & Yanti, A. (2020). Analisis Total Productive Maintenance Mesin Wrapping Line 4 Menggunkan Overall Equipment Effectiveness dan Six Big Losses di PT XY, Cirebon - Jawa Barat. *Jurnal Rekayasa Sistem & Industri (JRSI)*, 82. https://doi.org/10.25124/jrsi.v7i2.425

Suherman, A., & Cahyana, B. J. (2019). Pengendalian Kualitas Dengan Metode Failure Mode Effect And Analysis (FMEA) Dan Pendekatan Kaizen untuk Mengurangi JumlahKecacatan dan Penyebabnya. *Seminar Nasional Sains dan Teknologi*, *16*, 1–9.

Sultoni, A., & Saroso, D. S. (2019). Peningkatan nilai OEE pada mesin printing kaca film menggunakan metode FMEA dan TPM. *Operations Excellence: Journal of Applied Industrial Engineering*, *11*(2), 131. https://doi.org/10.22441/oe.v11.2.2019.022

Supriatna, E. R., Marie, I. A., & Witonohadi, A. (2017). Autonomous Maintenance Pada Plant Ii Pt. Ingress Malindo Ventures. *Jurnal Teknik Industri*, *5*(3). https://doi.org/10.25105/jti.v5i3.1518

Tammya, E., & Herwanto, D. (2021). Analisis Efektivitas Mesin Debarker Dengan Menggunakan Metode Overall Equipment Effectiveness (OEE) Di PT. XYZ Kuningan, Jawa Barat. *Jurnal Sains, Teknologi dan Industri*, *19*(1), 20–27.