SINTEK JURNAL: Jurnal Ilmiah Teknik Mesin
ISSN: 2088-9038, e-ISSN: 2549-9645
Homepage: http://jurnal.umj.ac.id/index.php/sintek

IMPROVING THE EFFECTIVENESS OF PRIMARY ROLLING MACHINE WITH OEE AND SIX BIG LOSSES METHOD

Rini Alfatiyah[1,*], Sofian Bastuti[1]
[1]Department of Industrial Engineering, Faculty of Engineering, Pamulang University
Surya Kencana Street No. 1, Pamulang, Tangerang - Indonesia, 15417

*E-mail: dosen00347@unpam.ac.id

Accepted: 11-04-2020 Revised: 24-11-2020 Approved: 01-12-2020

ABSTRACT

Each company wants to improve the efficiency of the production process so that it can compete in terms of price and quality with other companies. The company that is the object of this research is engaged in electronics manufacturing. The problem that occurs is the difference in production results between the company's target and the reality that occurs, with an indication of a decrease in the effectiveness of production machines. The highest reduction in machine effectiveness occurred in primary winding machines. The purpose of this research is to measure the value of the effectiveness of the primary rolling machine using the overall equipment effectiveness (OEE) method and six big losses. Furthermore, to analyze the factors that are the main priority as a basis for improvement proposals to increase production efficiency using a causal diagram. In the calculation, OEE measures effectiveness with 3 points of view, namely availability, performance, and quality. To determine the decrease in machine effectiveness, the six big losses method was used. The results showed that the average effectiveness level of the primary rolling machine during the study period was 80.7%, with an average value of 97.75% availability, 68.15% performance, and 99.65% quality. Meanwhile, the one that most affected the decrease in the effectiveness of the primary rolling machine was reduced speed losses.

Keywords*:* *primary rolling machine; downtime; OEE; six big losses.*

1. INTRODUCTION

Of the several factors that determine the success of the manufacturing industry, one of which is the absence of obstruction in the production process. Thus all activities on the production floor run well and the use of effective equipment and machines will produce quality products [1,2,3].

The company that is the object of this research is engaged in electronics manufacturing. Currently, the problem faced is the high value of downtime on several machines used in production. One of the machines experiencing the highest downtime is the primary rolling machine.

It is known where the amount of primary rolling machine downtime from January to June 2019 is 11311 minutes or 188.5 hours in 6 months. Each hour the machine is capable of producing 2000 units of rolls for 5th generation products, while the production target of the 5th generation products is 2,900 units per hour, the occurrence of downtime is due to damage to several production lines of primary rolling machines that have failed, for example, frequent twistel needles broken, broken nozzle, broken or worn spindle. So a better maintenance approach is needed and can minimize the downtime of primary rolling machines in the production area. To solve the problem, the overall equipment effectiveness

(OEE) method is used, which is to measure the effectiveness of using an equipment/machine. Followed by six big losses, to determine the performance of engine maintenance and as an evaluation for repairs to increase the effectiveness of machines or maintenance that has been carried out [4,5]. To calculate and increase the level of effectiveness in the end, it seems that there is a need for efforts to involve all factors such as technology, expertise, reliability, input-output, other resources in an integrated manner [6,7,8].

2. METHODS

2.1. Data Source

Data Source in this study are:

a) Primary Data
Primary data includes downtime, machine breakdown data, monthly production data, planned downtime data, and machine set-up data [9].

b) Secondary Data
Secondary data include company reports including the number of workers, production processes, machine tools, and company profiles [10,11].

2.2. Data Collection Technique

Data collection techniques such as:

a) Survey and Field Observation
The technique used is data collection by going directly to the field or research location to get the actual data needed in this study [12].

b) Interview
Interviews in this study are like submitting interviews to interested employees and company leaders as sources related to research, especially production maintenance and primary rolling machine operators [13].

2.3. Data Analysis Method

Several methods that can later be used in data processing from the problem in this study are [14]:

a. Availability Ratio;
b. Performance Efficiency;
c. Rate Of Quality Product;
d. Overall Equipment Effectiveness (OEE) analysis;
e. Six Big Losses Analysis;
f. Fishbone Diagram Analysis;
g. Proposed Problem Solving or Evaluation.

3. RESULTS AND DISCUSSION

Companies engaged in electronic manufacturing have several types of machines in department 3, including primary winding, a secondary winding, primary tapping, secondary tapping, and tin dyeing machines where the machines have different ages. The primary winding machine is selected based on the largest breakdown time in the production line in the production department 3. There are 4 units of primary rolling machines that produce 24 hours in 7 days. The following is breakdown data for machines in production line department 3.

Table 1. Downtime Data on Production Machines

No	Machine Name	Downtime (minute)	%
1	Primary Winding	11311	28.47
2	Secondary Winding	5924	14.96
3	Primary Tapping	4889	13.31
4	Secondary Tapping	4427	11.23
5	Tin dip	6397	16.14

Table 2. Downtime on Primary Rolling Machine

Month	Down Time (minute)				Total
	MC 1	MC 2	MC 3	MC 4	
January	1260	1563	221	126	3170
February	501	720	260	30	1511
March	603	806	90	220	1719
April	168	461	115	22	766
May	310	896	239	125	1570
June	510	1477	407	181	2575
Total	3352	5923	1332	704	11311

Based on Table 1 and Table 2, it is found that the primary rolling machine has the most

downtime and the primary rolling machine that has the most downtime is the primary rolling machine 2. Furthermore, the Primary Rolling 2 machine will be analyzed further.
To measure the effectiveness of the primary winding machine 2 using OEE. Before calculating the OEE value, data from data sheets, machine maintenance, and daily production ledgers are needed. The data used are from January 2019-June 2019, namely:

a) Breakdown

Table 3 Breakdown Data

Month	Breakdown **(Hours)**
January	21
February	9
March	8
April	4
May	10
June	19

b) Planned Downtime

Table 4. Planned Downtime Data

Month	***Planned Downtime*** **(Hours)**
January	3
February	2
March	3
April	4
May	5
June	0

c) Set-up

Table 5. Machine Setup Time Data

Month	**Total *Setup Time* (Hours)**
January	5
February	3
March	5
April	3
May	4
June	6

Production data for Primary Rollers 2 for the period January 2019-June 2019.

Table 6. Production data for Primary Rollers 2

Month	Total Available Time (Hours)	Total Product Processed (pcs)	Good Product (pcs)	Reject (pcs)	Total *Scrap* (Pcs)	Total Actual Press Hours (Hours)
January	744	612127	609357	2663	107	715
February	672	519280	517482	1779	19	640
March	744	546667	544948	1715	4	713
April	720	534971	533314	1647	10	687
May	744	507168	505394	1623	151	710
June	720	579080	576905	2174	1	686

3.1. Calculation of Availability

Steps To measure the value of availability, the following formula is used [15–19]:

$$Availability = \frac{Loading\ time - Downtime}{Loading\ Time} \times 100 \quad (1)$$

The results of the calculation of the availability value of the Primary Roll 2 machine that researchers have done, the results are as in Table 7 and Figure 1.

Table 7. Calculation of Availability

Bulan	*Loading Time* (Hours)	*Total Downtime* (Hours)	*Operation Time* (Hours)	*Availability* (%)
January	741	26	715	96,5
February	670	12	658	98,2
March	741	13	728	98,2
April	716	7	709	99,02
May	739	14	725	98,1
June	720	25	695	96,5
	Average			97,75

Examples of calculation formulas:

3.3. Loading time = Total Available time – planned downtime (2)
= 744 – 3 = 741

2. Downtime = Breakdown + Setup (3)
= 21 + 5 = 26

3. Operating time = Loading time – downtime
= 741 – 26 = 715 (4)

4. $Availability = \frac{(Loading\ Time - Downtime)}{Loading\ Time}\ x\ 100\%$

$$= \frac{(741\text{-}26)}{741} \; x\ 100\% = 96{,}5 \quad (5)$$

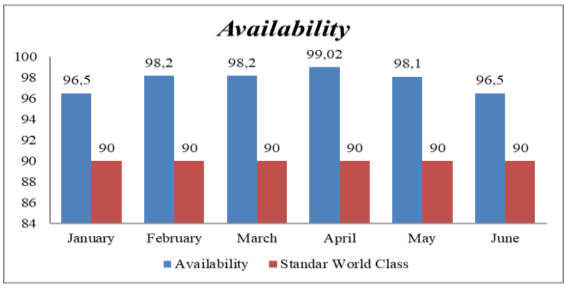

Figure 1. Availability

3.2. Calculation of Performance Efficiency

The Performance Efficiency value can be calculated using the following formula:

$$Performance\ Efficiency = \frac{(Processed\ Amount\ X\ Ideal\ cycle\ time)}{Operating\ Time} \; x\ 100\% \quad (6)$$

Before calculating Performance Efficiency, it is better to calculate the ideal cycle time.

$$\text{Ideal Cycle Time} = \frac{24}{27494} = 0{,}000873\ \text{Hours/unit} \quad (7)$$

Calculating the Performance Efficiency from January 2019 - June 2019 with the following formula:

$$\text{Performance Efficiency} = \frac{(612127 \times 0{,}000873)}{715} \; x\ 100\% = 74{,}74\ \%$$

The results of the study of the Performance Efficiency value on the Primary Roll 2 machine are as in Table 8 and Figure 2.

Table 8. Calculation of Performance Efficiency

Month	Total Product Processed (pcs)	Ideal Cycle Time (Hours)	Operation Time (Hours)	Performance Efficiency (%)
January	612127	0,000873	715	74,74
February	519280	0,000873	658	68,90
March	546667	0,000873	728	65,55
April	534971	0,000873	709	65,87
May	507168	0,000873	725	61,07
June	579080	0,000873	695	72,74
Average				68,15%

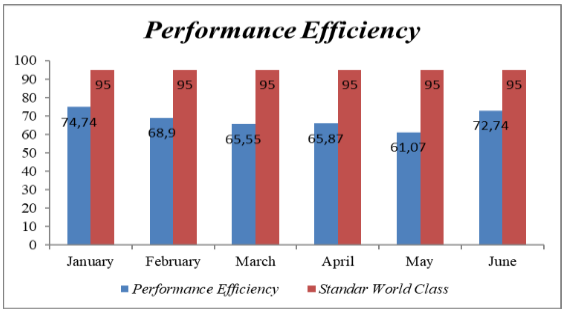

Figure 2. Performance Efficiency

3.3. Calculation of Rate of Quality Product

Rate of Quality Product can be calculated by the formula:

$$\text{Rate of Quality Product} = \frac{(Processed\ Amount - Defect\ Amount)}{Processed\ Amount} \; x\ 100\% \quad (8)$$

The results of the calculation of the Rate of Quality Product value for the Primary Roll 2 machine that the author has done, areas in Table 9 and Figure 3.

Table 9. Calculation of Rate of Quality Product

Month	Total Good Product (PCS)	Total Reject (PCS)	Rate of Quality Product
January	609357	2663	99,56
February	517482	1779	99,66
March	544948	1715	99,69
April	533314	1647	99,69
May	505394	1623	99,68
June	576905	2174	99,62
Average			99,65 %

Calculation of the Rate of Quality Product for the period of January 2019 - June 2019 as follows:

Rate of Quality Product

$$= \frac{(609357 - 2663)}{609357} \times 100\% = 99{,}56\%$$

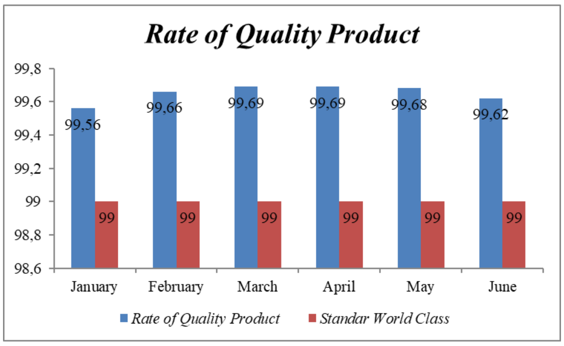

Figure 3. Rate of Quality Product

3.4. Calculation of Overall Equipment Effectiveness (OEE)

Finding the OEE value can be obtained from: OEE

= Availability (%) X Performance (%) X Rate of Quality (%)x100% (9)

The results of the calculation of the OEE value from the January 2019 - June 2019 period are as follows:

OEE = (96,5 x 74,74 x 99,56) x 100% = 71,81 %

The results of the research on the Overall Equipment Effectiveness value of the Primary Rolling Machine 2 that the author has done, can be seen in the results in Table 10.

Table 10. Calculation of OEE

Month	Availability (%)	Performance (%)	Rate of Quality (%)	OEE (%)
January	96,5	74,74	99,56	71,81
February	98,2	68,90	99,66	67,43
March	98,2	65,55	99,69	64,17
April	99,02	65,87	99,69	65,02
May	98,1	61,07	99,68	59,72
June	96,5	72,74	99,62	69,93
		Average		66,35

Based on Table 10, it can be seen that the average OEE value on the Primary Roll 2 machine is 66.35%, this value is still far from the World Class OEE standard of 85%. The lowest OEE occurred in May which was 59.72%.

3.5. Six Big Losses Analysis

a) Equipment Failure/Breakdown Losses

$$= \frac{Breakdown}{Loading\ Time} \times 100\% = \frac{21}{741} 100\% = 2{,}83 \quad (10)$$

The percentage value of Primary Roll 2 machine breakdown losses is as in Table 11.

Table 11. Calculation of Breakdown losses

Month	Breakdown (Hours)	Loading Time (Hours)	Equipment failure/ Breakdown Losses (%)
January	21	741	2,83
February	9	670	1,34
March	8	741	1,08
April	4	716	0,56
May	10	739	1,35
June	19	720	2,64
Average			1,63

b) Set-up and adjustment Losses

$$= \frac{Total\ Set\text{-}up\ \&\ Adjustment\ Time}{Loading\ Time} \times 100\%$$

$$= \frac{5}{741} \times 100\% = 0{,}67 \quad (11)$$

The percentage value of the Setup & Adjustment Losses for Primary Roll 2 machine can be seen as follows in Table 12

Table 12. Setup & Adjustment Losses

Month	Setup & Adjustment time (Hours)	Loading Time (Hours)	Setup & Adjustment Losses (%)
January	5	741	0,67
February	3	670	0,45
March	5	741	0,67
April	3	716	0,42

May	4	739	0,54
June	6	720	0,83
	Average		0,60

c) Idling and Minor Stoppages

$$= \frac{Nonproductive\ Time}{Loading\ Time}\ x\ 100\% = \frac{0}{741}\ 100\% = 0,00 \quad (12)$$

The percentage value of Idling and Minor Stoppages for Primary Roll 2 machines is as shown in Table 13.

Table 13. Calculation of Idling and Minor Stoppages

Month	Total NonProductive Time (Minute)	Total NonProductive Time (Hours)	Loading Time (Hours)	Idling and minor Stoppages Losses (%)
January	0	0	741	0,00
February	1080	18	670	2,69
March	900	15	741	2,02
April	1320	22	716	3,07
May	900	15	739	2,03
June	540	9	720	1,25
	Average			1,84

d) Reduced Speed Losses

$$= \frac{(Operation\ Time) - (Ideal\ Cycle\ Time\ x\ Total\ Product)}{Loading\ Time}\ x\ 100\%$$

$$= \frac{(715) - (0,000873\ x\ 612127)}{741}\ x\ 100\% = 33,80 \quad (13)$$

The percentage value of Reduced Speed Losses for Primary Roll 2 machines can be seen as follows in Table 14

Table 14. Reduced Speed Losses

Month	Operation Time	Total Product Proces	Ideal Cycle Time	Loading Time	Reduced Speed Time	Reduced Speed Losses (%)
January	715	612127	0,000873	741	0,34	33,80
February	658	519280	0,000873	670	0,45	45,15
March	728	546667	0,000873	741	0,53	52,54
April	709	534971	0,000873	716	0,52	51,81
May	725	507168	0,000873	739	0,64	63,75
June	695	579080	0,000873	720	0,37	37,48
		Average				47,42

e) Defect Losses

$$= \frac{(Ideal\ Cycle\ Time\ x\ Total\ Reject)}{Loading\ Time}\ x\ 100\%$$

$$= \frac{(0,000873\ x\ 2663)}{741}\ x\ 100\% = 0,31 \quad (14)$$

The value of Defect losses for primary rolling machine 2 is as in Table 15.

Table 15. Defect Losses

Month	Loading Time (Hours)	Ideal Cycle Time (Hours/Pcs)	Total Reject (pcs)	Defect Losses
January	741	0,000873	2663	0,31
February	670	0,000873	1779	0,23
March	741	0,000873	1715	0,20
April	716	0,000873	1647	0,20
May	739	0,000873	1623	0,19
June	720	0,000873	2174	0,26
		Average		0,23

f) Reduced Yield/Scrap

$$= \frac{(Ideal\ Cycle\ Time\ x\ Total\ Scrap)}{Loading\ Time}\ x\ 100\%$$

$$= \frac{(0,000873\ x\ 107)}{741}\ x\ 100\% = 0,012606 \quad (15)$$

The percentage value of Reduced Yield / Scrap for primary rolling machine 2 is shown in Table 16

Table 16. Reduced Yield/Scrap

Month	Loading Time (Hours)	Ideal Cycle Time	Scrap (Pcs)	Yield/Scrap Losses (%)
January	741	0,000873	107	0,012606
February	670	0,000873	19	0,002476

March	741	0,000873	4	0,000471
April	716	0,000873	10	0,001219
May	739	0,000873	151	0,017838
June	720	0,000873	1	0,000121
		Average		0,0058

The results of the value of Six big losses for primary rolling machine 2 that the author has done are as in Table 17

Table 17. Six Big Losses Percentage

No	Six Big Losses	Percentage
1	Equipment failure/breakdowns Losses	1,63%
2	Set-up and adjustment	0,60%
3	Idling and minor stoppages	1,84%
4	Reduced Speed Losses	47,42%
5	Defect Losses	0,23%
6	Reduced yield losses	0,0058%

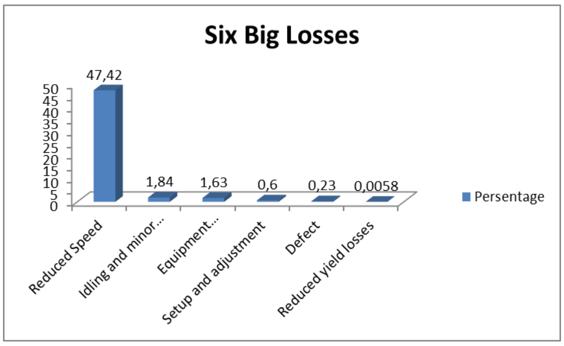

Figure 4. Six Big Losses Percentage

The results of the Six Big Losses analysis show that the highest Losses is at Reduced Speed of 47.42%. Second is Idling and minor stoppages followed by Equipment Failure/breakdowns, Setup, and Adjustment, Defect, Reduced Yield Losses. From the analysis above, it can be seen that the value that affects is Reduced Speed.

3.6. Fishbone Diagram Analysis

Looking for the causative factor of the Reduced Speed of primary roller 2 with a fishbone diagram as in Figure 5

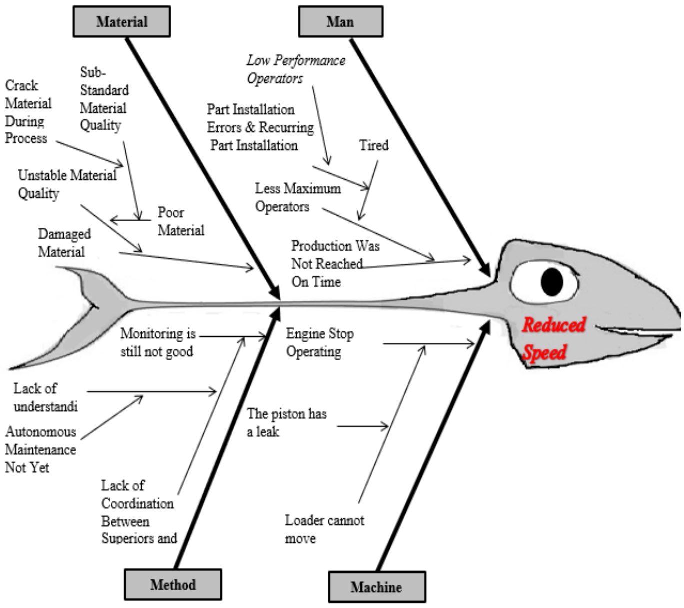

Figure 5. Fishbone Diagram

Based on the Cause and Effect Diagram Analysis, the factors of decreasing machine production speed are caused by:

a) The human factor is low-performance operators;
b) The engine factor is the piston leaks;
c) The autonomous maintenance method factor is not running well;
d) The material factor is a material that is easy to crack.

The next step is to find the most influential factors to determine the cause of the problem. In this case, a consensus will be carried out using the NGT (Nominal Group Technique) calculation to determine the most influential causative factors. NGT is a structured problem-solving tool using the ideas of consensus participants or reviewers. Participants involved in this consensus are workers who are directly involved with related work.

Table 18. Calculation of NGT

No.	Causative Factor	Participant (Evaluator)					Score
		1	2	3	4	5	
1.	Low performance operators	2	2	3	2	1	10
2.	The piston has a leak	4	3	4	4	4	19

3.	Autonomous maintenance is not running well	3	4	2	3	3	15
4.	The material is easy to crack	1	1	1	1	2	6

Determination of the dominant cause above, using the formula:

$NGT \geq 1/2\ N+1$ (16)

$NGT \geq 1/2\ 20+1$

$NGT \geq 11$

Information: N = Σ Participant * Σ Causative Factor.

Based on the above calculations, the score that is above the calculation of the NGT value is the dominant factor causing the reduced speed. These factors are The piston has a leak and the Autonomous maintenance is not running well.

3.7. Proposed solutions to the Reduced Speed Losses problem

The recommendations for improvement proposals are shown in Table 19.

Table 19. Proposed Improvements to Reduced Speed Losses

No	Causative Factors	Proposed Improvement
1.	The piston has a leak	Make a periodic machine maintenance checklist
2	Autonomous maintenance is not running well	Make maintenance standards, if the damage is minor it can be handled by the machine operator directly and if the damage is major it can be handled by the maintenance division.

4. CONCLUSION

Based on the results and discussion, it can be concluded that: The value of the effectiveness of the primary rolling machine 2 based on the overall equipment effectiveness method is 66.35%, this value is still far from the World Class OEE standard of 85%. The type of six big losses that shows the highest losses in the primary rolling machine is Reduced Speed (decrease in production speed) of 47.42%. Second is Idling and minor stoppages followed by Equipment Failure/breakdowns, Setup, and Adjustment, Defect, Reduced Yield Losses. From there, it can be seen that the value that affects is Reduced Speed. The dominant factor causing or affecting the highest six big losses (Reduced Speed) is the piston leaks, Autonomous maintenance has not been running. The recommendations given to improve the performance of the primary winding engine are: make a periodic machine maintenance checklist, and make maintenance standards, if the damage is minor it can be handled by the machine operator directly and if the damage is major it can be handled by the maintenance division.

ACKNOWLEDGEMENTS

The author would like to express his gratitude to all who contributed to the completion of this research, especially all operational staff of PT. Induktorindo Utama.

REFERENCES

[1] Z. I. Martomo and P. W. Laksono, "Analysis of total productive maintenance (TPM) implementation using overall equipment effectiveness (OEE) and six big losses: A case study," *AIP Conf. Proc.*, vol. 1931, 2018, doi: 10.1063/1.5024085.

[2] L. Hassani, "Ladan Hassani THE IMPACT OF OVERALL EQUIPMENT EFFECTIVENESS ON PRODUCTION LOSSES IN MOGHAN CABLE & WIRE," vol. 9, no. 4, pp. 565–576, 2004.

[3] N. S. Ningrum and A. Muhsin, "Line Machining Propeller Shaft Untuk Produk Flange Menggunakan Metode Overall Equipment Effectiveness (Oee) (Studi Kasus Di Pt Hino Motors Manufacturing Indonesia)," *J. Optimasi Sist. Ind.*, vol. 9, no. 2, pp. 109–118, 2016, [Online]. Available: http://jurnal.upnyk.ac.id/index.php/opsi/article/view/2167.

[4] I. G. A. Widyadana, "Pengukuran Overall Equipment Effectiveness (OEE) di PT Astra Otoparts Tbk . Divisi Adiwira Plastik," *J. Titra*, vol. 3, no. 1, pp. 41–48, 2015, [Online]. Available: http://studentjournal.petra.ac.id/index.php/teknik-industri/article/download/2981/2686.

[5] K. Hafiz and E. Martianis, "Analisis Overall Equipment Effectiveness (OEE) pada Mesin Caterpillar Type 3512B," *SINTEK J. J. Ilm. Tek. Mesin*, vol. 13, no. 2, p. 87, 2019, doi:

10.24853/sintek.13.2.87-96.
[6] D. Syamsuddin, D. E. Budiasih, A. Pamoso, and S. M. T. Si, “Analisis Overall Equipment Effectiveness (Oee) Dan Risk Based Maintenance (Rbm) Pada Mesin Huron Di Pt Xyz Overall Equipment Effectiveness (Oee) and Risk Based Maintenance (Rbm) Analysis on Huron Machine in Pt Xyz,” vol. 5, no. 2, pp. 2501–2508, 2018.
[7] H. A. Prabowo and D. I. R, “Improve the Work Effectiveness With OEE (Overall Equipment Effectiveness) As the Basis for Optimizing Production,” *Pasti*, vol. IX, no. 3, pp. 286–299, 2019.
[8] F. Alamsyah, “Analisis Akar Penyebab Masalah Dalam Meningkatkan Overall Equipment Effectiveness (OEE) Mesin Stripping Hipack III Dan Unimach DI PT PFI Firman,” *J. OE*, vol. VII, no. 3, pp. 289–302, 2015, [Online]. Available: http://publikasi.mercubuana.ac.id/index.php/oe/article/view/542/482.
[9] R. Alfatiyah, S. Bastuti, and D. Kurnia, “Implementation of statistical quality control to reduce defects in Mabell Nugget products (case study at Pt. Petra Sejahtera Abadi),” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 852, no. 1, 2020, doi: 10.1088/1757-899X/852/1/012107.
[10] S. Bastuti, D. Kurnia, and A. Sumantri, “Analisis Pengendalian Kualitas Proses Hot Press Pada Produk Cacat Outsole Menggunakan Metode Statistical Processing Control (Spc) Dan Failure Mode Effect and Analysis (Fmea) Di Pt. Kmk Global Sports 2,” *J. Teknol.*, vol. 1, pp. 72–79, 2018.
[11] R. Alfatiyah and W. Marthin, “Redesign Kursi dan Meja Perkuliahan Dengan Metode Quality Function Deployment (QFD) Secara Ergonomis Di Program Studi Teknik Industri, Universitas Pamulang,” *Pros. Semin. Ilm. Nas.*, pp. 76–88, 2017.
[12] R. Alfatiyah, “Analisis Kegagalan Produk Cacat Dengan Kombinasi Siklus Plan- Do-Check-Action (PDCA) Dan Metode Failure Mode And Effect Analysis (FMEA),” *J. Ilm. Dan Teknol. oleh Univ. Pamulang*, vol. 2, no. 1, pp. 39–47, 2019.
[13] S. Bastuti, “Analisis Kegagalan Pada Seksi Marking Untuk Menurunkan Klaim Internal Dengan Mengaplikasikan Metode Plan–Do–Check–Action (PDCA),” *J. SINTEK*, vol. 11, no. 2, pp. 113–122, 2017.
[14] R. Sumaedi, “Analysis of Air Conditioner Precision (PAC) Machine Using Overall Equipment Efectiveness (OEE) Method (Case Study at Data Center XYZ Company Jakarta),” vol. 5, no. 1, 2020.
[15] K. M. Cheh, “Analysis of Overall Equipment Effectiveness (OEE) within different sectors in different Swedish industries,” pp. 1–65, 2014, [Online]. Available: http://www.diva-portal.se/smash/get/diva2:903747/FULLTEXT01.pdf.
[16] A. P. Herry, F. Farida, and N. I. Lutfia, “Performance analysis of TPM implementation through Overall Equipment Effectiveness (OEE) and Six Big Losses,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 453, no. 1, 2018, doi: 10.1088/1757-899X/453/1/012061.
[17] D. Nusraningrum and E. G. Senjaya, “Over all Equipment Effectiveness (OEE) Measurement Analysis on Gas Power Plant with Analysis of Six Big Losses EQUIPMENT EQUIPMENT TOTAL BREAKDOWN 2017,” *Int. J. Bus. Mark. Manajement*, vol. 4, no. 11, pp. 19–27, 2019.
[18] U. Mardono, A. Rohimah, and E. Rimawan, “Six Big Losses Approach and Kaizen Philosophy Implementation to Improve Overall Equipment Effectivenes (OEE) (Case Study : PT . ABC , Areinforced Steel Manufacturer),” vol. 3, no. 6, pp. 165–171, 2018.
[19] A. Sutoni, W. Setyawan, and T. Munandar, “Total Productive Maintenance (TPM) Analysis on Lathe Machines using the Overall Equipment Effectiveness Method and Six Big Losses,” *J. Phys. Conf. Ser.*, vol. 1179, no. 1, 2019, doi: 10.1088/1742-6596/1179/1/012089.