Pengukuran Overall Equipment Effectiveness dan Model Optimasi untuk Meminimalkan Production Losses

Overall Equipment Effectiveness Assessment and Optimization Model to Minimize Production Losses

Aditia Ginantaka[1a], Tubagus Teja Lesmana[1]

[1]Agroindustrial Technology Department, Halal Food Science Faculty, Djuanda University, Ciawi Tol Road No. 1, Ciawi, Bogor 16720.
[a]Korespondensi : Aditia Ginantaka, E-mail: aditia.ginantaka@unida.ac.id

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ABSTRACT

The overall equipment effectiveness (OEE) assessment results on the roll wrap machine at PT Sugar Candy reached 69,1%. This OEE result must meet the company's requirements which apply an OEE value above 72,5%. The purpose of this research is to analyze the effectiveness of the roll wrap machine and identify the causes of the machine's ineffectiveness. In addition, this study also uses a fuzzy inference system to classify the variables of downtime loss, speed loss frequency, and OEE into linguistic variables to make it easier for operators to identify the machine's status. An improvement plan with a quantitative approach is proposed using goal programming by minimizing deviational variables at low, medium, and high OEE status frequencies. The results show that unscheduled machine maintenance decreases machine performance and is the main factor causing low machine availability. There are nine fuzzy rules for the inference process of machine OEE status at high, medium, and low-status levels. Following the company's internal target of achieving an OEE level at a medium position, while international standards reach a level of 85% with high status, the case study in this goal programming model simulation is assumed to be at 80%. Based on the goal programming calculation, for the OEE simulation case study at a level above 80% within 30 working days, the OEE status must reach a high level at least 20 times. The machine can achieve OEE with a medium level eight times, and a low level occurs a maximum of two times.

Keywords: fuzzy, goal programming, machine, performance

ABSTRAK

Hasil penilaian overall equipment effectiveness (OEE) pada mesin rollwrap di PT. Sugar Candy mencapai 69,1%. Hasil OEE ini perlu memenuhi persyaratan perusahaan yang menerapkan nilai OEE di atas 72,5%. Tujuan dari penelitian ini adalah untuk menganalisis keefektifan mesin roll wrap dan mengidentifikasi penyebab ketidakefektifan mesin tersebut. Selain itu, penelitian ini juga menggunakan sistem inferensi fuzzy untuk mengklasifikasikan variabel kerugian downtime, frekuensi kerugian kecepatan, dan OEE ke dalam variabel linguistik untuk memudahkan operator mengidentifikasi status mesin. Rencana perbaikan dengan pendekatan kuantitatif yang diusulkan menggunakan goal programming dengan meminimalkan deviational variable pada frekuensi status OEE rendah, sedang, dan tinggi. Hasil penelitian menunjukkan bahwa perawatan mesin yang tidak terjadwal menurunkan kinerja mesin dan merupakan faktor utama penyebab rendahnya ketersediaan mesin. Terdapat sembilan aturan fuzzy untuk proses inferensi status OEE mesin pada tingkat status tinggi, sedang, hingga rendah. Sesuai target internal perusahaan yang ingin mencapai OEE level pada posisi medium, sementara standar internasional mencapai level 85% dengan status tinggi maka studi kasus pada simulasi model goal programming ini diasumsikan pada level 80%. Berdasarkan perhitungan goal programming, untuk studi kasus simulasi OEE pada level di atas 80% dalam waktu 30 hari kerja, status OEE harus mencapai level tinggi minimal 20 kali. Mesin dapat mencapai OEE dengan level sedang delapan kali, dan level rendah terjadi maksimal dua kali.

Kata Kunci: fuzzy, goal programming, kinerja, mesin

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INTRODUCTION

Production facility maintenance strategy is a quality improvement decision in organizations and industries to maintain the facility's reliability. Improper maintenance management can lead to several losses. The production facilities are more quickly damaged, decreased equipment availability due to excessive downtime, decreased production quality, and increased raw material inventory costs, resulting in unreliable final product delivery performance (Ahuja & Khamba, 2008). Thus, efforts are needed to solve these problems by evaluating the performance of machines and facilities. Evaluation of equipment effectiveness in production should be optimized to gain optimum product output.

Performance measurement is also a critical thing that can influence decision-making in the company. Wrong decisions will impact losses in the form of little money, resources, and time (Wudhikarn, 2013). Total productive maintenance (TPM) is one approach developed to solve the maintenance problem of machines and production facilities. One form of TPM practice is to measure Overall Equipment Effectiveness (OEE). This method is a technique for assessing the machine's actual performance by comparing the machine's output with the total output that may be generated (Almeanazel, 2010). OEE is frequently used to compare and control the production progress by using unadorned and relevant metrics to increase manufacturing performance. This method could also identify the efficiency gap of maintenance between the present and projected situations (Saiful *et al.,* 2014). Thus, assessing the OEE also tells the company the current performance and the weaknesses and gives initial information to improve the performance (Almeanazel, 2010).

Overall Equipment Effectiveness (OEE) calculates the machine effectiveness rate by measuring three main ratios: availability, performance, and quality (Vijayakumar & Gajendran, 2014). This method measures productivity losses, for instance, engine breakdown conditions, measures the quality of engine output based on the number of engine output defects (defects), and measures the amount of engine idle conditions (idle machines) that make the engine not operate optimally (Abdelbar *et al.,* 2019). In addition, to identify the problem that affected the decrease in the effectiveness of the machine, it is necessary to analyze it so that the solution that will be obtained can be more targeted. Sugar Candy, Co.Ltd is a confectionery company located in Bogor. One roll wrap machine often has problems compared to other similar machines. The machine's OEE value was observed in June-August 2020, which was 43%, 49%, and 54%. The international OEE standard is 85%, and the internal OEE standard of Sugar Candy, Co. Ltd. is 72.5%. Therefore, it is necessary to conduct research that can provide solutions by analyzing and identifying the problems of the rollwrap machine.

The assessment of OEE is usually used in high-capacity processing manufacture where stoppages should be minimized because they could affect high cost in lost production (Abdelbar *et al.,* 2019). However, the OEE method could not precisely prioritize machine problems. It is unreliable when used to assess machines with a high capacity variety, product type, production cost, etcetera (Wudhikarn, 2016). This method measures different variables that represent machine loss of availability time and the quality of production output but could not identify the loss reasons (Jauregui *et al.,* 2015). It motivates officers to optimize the effort to achieve zero production defects and zero breakdowns and minimize production losses by maximizing equipment effectiveness and arrangement with the competent operator and maintenance officer (Kigsirisin *et al.,* 2016).

The result of OEE assessment values expressed in percentages often causes operators difficulty establishing the status or categorization of OEE values. Therefore, it is necessary to determine the machine status with a fuzzy logic approach that makes it easier for users to receive information on OEE measurement results (Djatna & Munichputranto, 2015). OEE measurements can determine global maintenance management and recommended production planning to increase machine productivity (Afefy, 2013). Therefore, an operational decision-making plan for achieving the OEE value by the company's target is needed. This study aims to analyze the effectiveness of roll wrap machine maintenance. The second objective is to identify the cause of the roll wrap machine's ineffectiveness. The final goal is to provide suggestions for improvements to the effectiveness of roll wrap machine maintenance.

RESEARCH METHOD

Data was collected by direct observation to identify unplanned downtime according to the six significant loss categories, including equipment failure losses (breakdown), setup and adjustment, minor and idling stops, reduced speed, reject, and rework. Based on routine business processes, several assumptions are used to identify the variables that affect the Availability Rate, Performance Rate, and Rate of Quality values. Observations were also made on actual production, which would later be compared with production targets based on cycle time. Cycle time is the process cycle time expected to be achieved under optimal conditions or without disturbance (Fajrah & Noviardi, 2018). Based on the actual production, identifying the number of rejected products that needed reworking was also done.

The calculation of six big losses is divided into three big categories, namely downtime, speed losses, and quality losses (Almeanazel, 2010):

(1) Downtime

- Equipment Failure (breakdown losses)
  Breakdown losses are conditions where the existing machine/equipment is damaged. This variable compute using equation (1).

$$\textit{Breakdown losses}\ (\%) = \frac{\textit{Downtime time}}{\textit{loading time}} \times 100\% \qquad (1)$$

- Set up and adjustment losses
  Setup and adjustment losses are the time required for machine setup, starting from the machine stopping until it usually operates. Setup and adjustment losses compute using equation (2).

$$\textit{Set up and adjustment losses}\ (\%) = \frac{\textit{Setup time}}{\textit{loading time}} \times 100\% \qquad (2)$$

(2) Speed losses

- Reduced speed (RS)
  A reduction or decrease in operating speed causes reduced speed, that compute using equation (3).

$$RS\ (\%) = \frac{(\text{actual cycle time-theoritical cycle time}) \times \text{output}}{\textit{loading time}} \times 100\% \qquad (3)$$

- Idling and Minor Stoppages (I&MS)
  Idling and Minor Stoppages compute using equation (4). This variable is caused by the machine stopping for a moment or being disturbed by external factors.

$$I\,\&\,MS\ (\%) = \frac{(\text{total production - output}) \times \text{theoritical cycle time}}{\text{loading time}} \times 100\% \qquad (4)$$

(3) Quality losses (QL)

- Quality defect process defect
  Quality defect process defect is the result of a production process that does not meet the standards of quality control, which could compute using equation (5).

$$QL(\%) = \frac{\text{total reject} \times \text{theoritical cycle time}}{\textit{loading time}} \times 100\% \qquad (5)$$

- Yield / Rework Losses (RL)

Yield losses are caused by testing raw materials when setting up machines that will operate until a stable process is achieved. These losses could compute using equation (6).

$$RL(\%) = \frac{\text{ideal cycle time} \times \text{scrap}}{\textit{loading time}} \times 100\% \quad (6)$$

Overall equpment effectiveness

The initial calculation is done using the roll wrap machine's daily data. OEE calculation is done in several steps (Kigsirisin *et al.,* 2016):

(1) Availability Rate (AR)

The availability rate is a ratio that describes the machine's willingness to operate or the utilization of the time available for machine operation activities used in the production process. The availability rate could compute using equation (7).

$$AR = \frac{\text{operation time}}{\text{loading time}} \times 100\% \qquad (7)$$

(2) Performance Rate (PR)

The performance computes using equation (8). This ratio is a ratio that describes the effectiveness of production activities based on the actual operation of the equipment.

$$PR = \frac{\text{actual output}}{\text{Target output}} \times 100\% \qquad (8)$$

(3) Rate of Quality (QR)

Quality rate is the effectiveness of production activities based on the quality of the products produced. This value is a parameter of the production quality, which is computed using equation (9).

$$QR = \frac{\text{output-defect}}{\text{output}} \times 100\% \qquad (9)$$

(4) Overall Equipment Effectiveness (OEE)

The OEE calculation aims to measure the effectiveness of the overall production equipment by multiplying the contributing OEE factors, namely AR, PR, and QR (Prabowo, Hariyono, & Rimawan, 2020) using equation (10).

$$OEE = AR \times PR \times QR \times 100\% \quad (10)$$

Analysis of the six big losses

The factors causing the ineffectiveness of maintenance activities in the roll wrap machine were identified after the production process. The causative factors of failure resulting in the high breakdown are analyzed using a fishbone diagram and explaining the causes of low-performance rates and alternative solutions and their implementation in the table above. There will also be a more in-depth analysis and problem-solving through the 5W and 1H analysis: what, why, where, when, who, and how.

OEE inference using Fuzzy lnference System

OEE variables are classified based on several linguistic variables. The OEE value inference process uses the Tsukamoto fuzzy method, which has several steps: fuzzification, inference, and defuzzification. Based on the basic OEE formula and the identification of the six big losses factors, the variables assigned to identify the fuzzy set are based on the duration of downtime and the frequency of downtime. These two variables are factors that influence the level of OEE values.

Optimization Model with Goal Programming

Goal Programming analysis aims to minimize the deviational variable based on the goals, targets, or goals that have been set with the effort that can be achieved. The researcher determines the components based on the goal programming method: the objective function, target constraints, and non-negative constraints. The general mathematical model for goal programming can be formulated as equation (11).

Minimize objective function (Z) (11)

$$Z = \sum_{i=1}^{m} d_i^+ + d_i^-$$

Subject to:

$$a_{ij}x_j + d_i^- - d_i^+ = b_i ,$$

where:

a = Coeficient i^{th} constraint decision variable j^{th}

x = decision variable j^{th}

d_i^+ = Overachieving level of deviation variable objective function goal i^{th}

d_i^- = Underachieving level of deviation variable objective function goal i^{th}

b_i = right hand side value desired on goal i^{th}

RESULT AND DISCUSSION

Analysis of the Effectiveness of Rollwrap Machine Maintenance

The stages in the analysis of machine effectiveness begin with data processing from data on the production process results during the November period. The results of the calculations that have been carried out obtained an initial result of the size of the OEE value of the roll wrap machine, as shown in Table 1. Based on Table 1, it can be seen that the OEE level in November was 69,1%. This value still needs to be below the company's expectations, which is worth 72,5%, and is still far from the world-class standard, which is worth 85%. The quality rate is classified as consistent and stable at an average of 99%. Low OEE values are affected by fluctuations in the availability rate and performance rate variables. The lowest AR value is 51,85%, while PR is 55,68%. Both values were achieved in early November. The value is moving up but fluctuating until mid-November. The highest AR score was 99,26%, while the PR was 90,99%. During one month of operation, the AR and PR variables had an average value of 85,56% and 81,40%, respectively. This value imbalance makes the machine's OEE value low.

The OEE equation computes the aggregation of variables that represents the ratio of the actual output of the machine divided by the total maximum output of the machine set up on the optimum machine conditions after the maintenance process (Almeanazel, 2010). This is relevant to the results of the relatively unstable availability rate and performance rate in November 2020. Based on these data, 14,6% of losses occur in availability, which indicates no balance between operating time and load time, resulting in downtime. The causes of losses that affect availability are equipment failure and breakdown, as well as setup and adjustment (Annamalai & Suresh, 2019). This downtime is included in the category of planned downtime. The determination of downtime can vary depending on the machine being analyzed in the study (Brodny, 2019), Downtime is assumed to be a condition where the machine does not consume electricity. So availability is defined as a condition where the machine consumes electric current as an energy source to drive the engine motor. Meanwhile, according to (Mwanza & Mbohwa, 2015); (Afefy, 2013), downtime includes all events that stop planned production activities for an extended period (usually a few minutes), for example equipment failures, material shortage, and changeover time.

Losses of 18,6% that occur at a performance rate indicate that the machine's use is inefficient because it does not match the engine capacity that should be. The causes of these losses are included in the category of speed losses, namely idling and minor stoppages, and reduced speed. In case studies in research (Annamalai & Suresh, 2019), speed losses are caused by disruption of sensor readings and obstruction of work on the shaft. Several cases were also caused by inconsistency flanked through the particular and real speed of the equipment. Based on (Mwanza & Mbohwa, 2015), unplanned breakdown of the machines caused by the limitedness of spare parts, lack of raw materials, and others. The performance calculation resulted from the design cycle time to produce the product multiplied by the machine's output and then divided by the designed machine operating time. Meanwhile, the quality level computes by the process quantity minus the number of reject quantities, then divided by the total amount processed (Afefy, 2013). The OEE standard deviation with a value of 15 indicates the distribution of values is uneven, and the distance between the lowest OEE point at 32,8% and the best OEE is 87,2% with an average of 69,1%. Thus, further analysis is needed to identify losses that cause ineffectiveness in the roll wrap machine.

Table 1. Roll wrap Machine OEE Result at November

Date	AR	PR	QR	OEE	World Class	Sugar Candy, Co.Ltd
1st	60,7%	55,7%	97,1%	32,8%	85%	72,5%
2nd	67,8%	70,9%	98,5%	47,3%	85%	72,5%
3rd	62,2%	71,4%	98,7%	43,9%	85%	72,5%
4th	51,9%	76,8%	98,1%	39,1%	85%	72,5%
5th	64,4%	78,5%	98,8%	49,9%	85%	72,5%
6th	80,7%	57,2%	99,1%	45,7%	85%	72,5%
7th	88,9%	73,2%	99,0%	64,4%	85%	72,5%
……	……	…….	…..	……	…..	…..
30th	90,7%	91,0%	99,4%	82,1%	85%	72,5%
Average	85,6%	81,4%	99,2%	69,1%	85%	72,5%
SD	12,6	9	0,6	15		

AR: Availability Rate; PR: Performance Rate; QR: Quality Rate; SD: Standard Deviation

Roll wrap Machine Ineffectiveness Problem Identification

Based on the results of calculating the November 2020 OEE value, it did not reach the company's target. Therefore identification was carried out using the six big losses method to see more specifically the number of losses. The following is a recapitulation of the calculation of the six big losses in this study, which can be seen in Table 2. Based on Table 2, it can be concluded that the most significant factors that cause losses that affect the effectiveness of the roll wrap machine are the equipment failure (EF) factor, with an average value of 10%, and the Idling minor stop with an average value of 8%.

After getting the most significant results that cause losses in the roll wrap machine, next, we will analyze these losses in more detail to identify problems that cause inefficiency in the roll wrap machine. Table 3 shows the data obtained as a result of the breakdown of the roll wrap machine. Based on Table 3, the three highest defect factors are wrapper head unit issues, fine-tuning, and product replacement, each having a value of 17,39%, 15,36%, and 13,80%. Thus, some of these factors become priority issues that must be resolved immediately in addition to other problems.

Table 2. Percentage of Six Big Losses

Date	**Availability**		**Performance**		**Quality**	
	EF	S&AD	RS	M&IS	QD	YD
1st	28%	11%	7%	16%	4%	1%
2nd	26%	7%	4%	13%	3%	1%
3rd	33%	4%	4%	12%	2%	1%
4th	42%	6%	3%	8%	4%	1%
5th	36%	0%	7%	4%	2%	1%
6th	13%	6%	7%	11%	2%	1%
7th	0%	11%	4%	12%	3%	1%
....	.....	.....	.....	.....	....	....
30th	7%	3%	2%	5%	2%	1%
X	10%	5%	4%	8%	2%	1%

EF: Equipment Failure; S&AD :Set up & Adjustment; RS: Reduced Speed; M&IS: Minor & Idling Stop; QD: Quality Defect; YD: Yield Defect; X = Average

The problem factors on the roll wrap machine that cause low availability and performance values are known. To be more explicit in the subsequent improvement, we can map them using a fishbone diagram, as shown in Figure 1. Based on the fishbone diagram, we can see the problems due to humans, machines, methods, and the environment. Research (Gupta & Vardhan, 2016) identify the machine problem using why–why analysis, and then future action plans with the target time accomplished were initiated on the machine to improve their production efficiency. Research (Gupta & Vardhan, 2016); (Vijayakumar & Gajendran, 2014) and (Stadnicka & Antosz, 2018) show that the causes of losses in availability include setup, cleaning activities (Mahmoud, Fahmyaly, Mohib, & Afefy, 2019), tool changes and adjustments, 5S activities, and unplanned breaks. Performance losses include start-up and material loading. Meanwhile, losses in quality are caused by measurement activities, repaired products, and scraps. In a case study in a reputed tractor manufacturing industry, shutdown losses, availability losses, operator performance losses, quality losses, and cost losses affect the cost of the manufacturing process. When measured based on the value of money, the highest contribution of losses, as identified, were energy loss, breakdown loss, set-up loss, yield loss, and tool change loss.

Table 3. Problem Breakdown of Rollwrap Machine

Problem	**Time (minute)**	**Percentage**
Wrapper Head	1840	17,39%
Fine tunning	1625	15,36%
Product Replacement	1460	13,80%
Product Unwrap	1200	11,34%
Problem material	695	6,57%
wrapper Feed	655	6,19%
Discarge Unit	640	6,05%
Creamper	495	4,68%
Breafing	450	4,25%
No Operator	390	3,69%
Infeed Bar	365	3,45%
Electric	200	1,89%
cleaning machine	200	1,89%
Belt wrapper	170	1,61%
Code failure print	132	1,25%
Setup Printer	65	0,61%
Total	10,582	100,00%

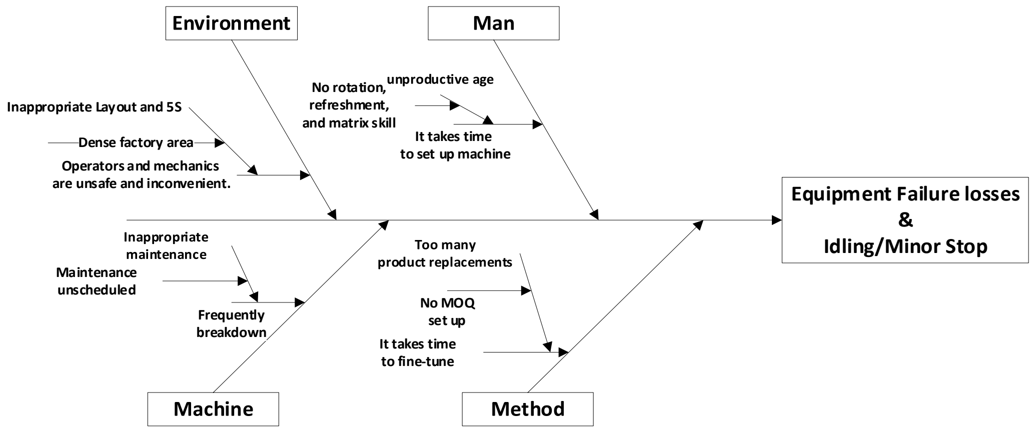

Figure 1. Fishbone Diagrams for problem identification on roll wrap machine

Improvement Implementation Plan

Identification of roll wrap machine problems has been determined. Next, determine the corrective steps to solve the problem on the machine. It can use 5W1H analysis. In an effort to reduce losses is to apply an operational maintenance process approach consisting of corrective and preventive (Abdelbar *et al.,* 2019). Based on the Table 4, human factors improvement can be made by refreshing training and worker rotation. As described in the research (Almeanazel, 2010), skill development for the worker can improve the ability and skill of the operator, especially regarding the setup and fine-tuning of the machine. Thus, it can increase the output of the machine. Problems from an engine point of view that cause a high enough breakdown can be done by maintaining the engine according to a predetermined schedule. Sharing knowledge can be done so that the machine downtime is not too long, and the operator can help with minor damage. Analysis of corrective actions from a machine perspective with effective machine maintenance scheduling is one of the preventive maintenance efforts. The problem of a large number of orders or changes to the production plan can be carried out by reviewing existing methods, the minimum order quantity (MOQ) system on the roll wrap machine, and conducting production and PPIC commitment meetings; this can reduce the number of fine-tuning and product replacement which is a problem on the roll wrap machine. This approach to the perspective of this method is included in the resource allocation sub-process, which is a corrective maintenance effort (Abdelbar *et al.,* 2019). Meanwhile, from an environmental perspective, the efforts made are reviewing the layout of machines and buildings through the gradual re-layout. Besides that, the efforts made are making machine inspection reports included in the preventive maintenance category (Abdelbar *et al.,* 2019). Preventive maintenance includes actions that are still minimally applied, as described in research (Mwanza & Mbohwa, 2015), only about 24% of the total maintenance activities.

Table 4. Alternative solution and corrective action

Problem Dimensions	Alternative solution	Corrective action
Man	Matrix skill, rearrangement operator based on productive age	Refreshment training, Workers engagement, Competent worker rotation
Machine	Effective machine maintenance, The spread of skillful mechanics	Regular and effective TPM schedule, Freshment training, mechanic and operator knowledge sharing
Method	Review of schedule/planning process Setting MOQ on rollwrap machine	Weekly Meeting, production order and PPIC
Environment	Review machine layout and building, machine inspection report	Gradualy Relayout, Effective 5S, inspection form consistency report

Workers are usually not involved in maintaining the machine corresponding to their duty. The reasons for their limitedness of improvement were; a lack of competency for maintenance, specialization, lack of awareness to take on more burden, and the current culture in the company (Mwanza & Mbohwa, 2015). Regarding the causes of the problems, 47,1% are caused by a lack of spares, 26,5% by poor cooperation of the maintenance department with other departments, and 11,8% lack appropriate skills and knowledge. Three primary approaches will improve the production process and the effectiveness of the maintenance process. The first is automation in monitoring the maintenance management system, the second is appropriate production planning, and the last is total quality management; those approaches will help the company's production activity with optimum performance rate and reduce losses (Afefy, 2013).

Classification in determining the status of the OEE value is carried out using the fuzzy inference system. Determining the level of the OEE value aims to make it easier for operators to identify the status group of OEE values (Djatna & Munichputranto, 2015). The membership function of the fuzzy set that becomes the input is the duration of downtime losses and the frequency of speed losses. Meanwhile, the output is the OEE value. As shown in Table 5, each fuzzy set for input and output variables is classified by three membership functions. The form of the triangular membership function of the fuzzy set for OEE variables is shown in Figure 2. The determination of the basis of fuzzy logic rules in the inference process is shown in Table 6. For example, if the duration of downtime is 175 minutes with the frequency of speed losses two times per day, based on the rules that have been set, it will produce an OEE with a value of 87,5 % or is included in the high category. With this fuzzy calculation, management can determine the strategy regarding how many times the status must be medium, low, and high in one month to get an average OEE value in 1 month that meets the company's standard expectations.

Table 5. Variables and the value for each fuzzy set membership function

No	Variable	Membership Function	
		Linguistic	**Numeric**
1	Downtime losses	short	0-200
		average	100-300
		long	200-500
2	Speed losses frequency	rare	0-3
		moderate	2-4
		frequent	3-6
3	OEE	low	30-75
		medium	65-85
		high	75-100

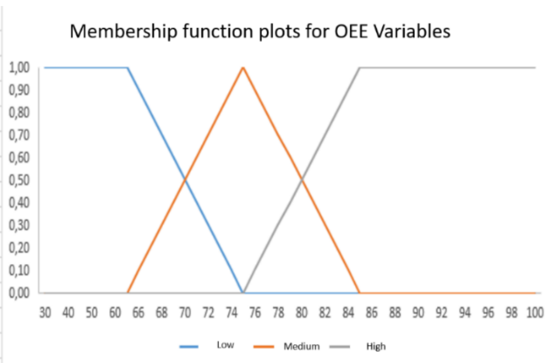

Figure 2. Triangular membership function of fuzzy set OEE

Table 6. Fuzzy rule for OEE

No	Variabel Input		Variabel Output
	Downtime Losses	Speed Losses	OEE
R1	long	frequent	Low
R2	long	moderate	Standard
R3	long	rare	Standard
R4	average	frequent	Standard
R5	average	moderate	Standard
R6	average	rare	Standard
R7	short	frequent	Standard
R8	short	moderate	Standard
R9	short	rare	high

Improvement Strategy with Goal Programming

The assumptions used in the goal programming formulation include cycle time, availability time, and target OEE values with various high, medium, and low statuses. If in cases where the decision variable with low category OEE with a target of no more than five times. The average OEE target assumes no more than five, while a high OEE is 20 times the target. The total number of targets is 30, which means 30 times or 30 days of existing OEE data. The reference level for the OEE value achieved in this case is 80%. It is assumed that the average OEE value during the measurement period for each level is 85% for the high OEE level, 75% for the medium OEE level, and 50% for the low OEE level. The case study above can be interpreted as follows, for the objective function, the target is to minimize downward or negative deviation (S1a = S1-), where X is the number of days targeted at low OEE. In this case, the target is five days (CX). Whereas Y is the number of days targeted in medium-level OEE, in this case, the target is five days (CY). The Z value is the number of days targeted at high OEE. In this case, the target is 20 days (CZ). While T, R, and S are the medium value of high, medium, and low OEE level values. In this case, OT is the level value in the case study we will achieve, while X+Y+Z = 30 is the number of days in which 30 days is the target time we want to achieve the desired level. Calculating goal programming can be done with the Lindo Application to achieve targets achieved by forecasting or production planning analysis. Thus we can formulate the constraint function as Equation 12.

$$\begin{aligned}
&\text{Objective Function: Minimize } d_1^- + d_2^- + d_3^+ \\
&(T\text{-}OT)\,Z+(R\text{-}OT)\,X+(S\text{-}OT)\,Y \geq 0 \qquad (12)\\
&X+Y+Z = 30\\
&X+d_1^- - d_1^+ = CX,\ CX = 5\\
&Y+d_2^- - d_2^+ = CY,\ CY = 5\\
&Z+d_3^- - d_3^+ = CZ,\ CZ = 20
\end{aligned}$$

Based on the results of goal programming calculations with the Lindo application to achieve an OEE above 80% as the level value in the simulation case study of the goal programming formulation, we can plan that a high OEE value is achieved in 20 days with a deviation above or below a value of 0, which means that the high OEE value must be carried out at least 20 times, not less. In comparison, medium OEE has a score of eight, which means that medium/standard OEE can be achieved a maximum of 8 times to achieve the level. Thus, medium OEE can be up to 3 times above the predetermined level. Meanwhile, low OEE can only occur twice, which means that to reach a predetermined level, low OEE can only occur two times, not more so that the deviation is reduced by three from the target. Thus, the optimal solution for planning the 80% OEE level is to achieve 20 times high OEE, eight times medium OEE, and two times low OEE. Based on planning using goal programming, management can make improvements if daily progress targets still need to be met. The company's current OEE level position was still medium level, with details of the status including six low levels, 16 medium levels, and eight high levels. According to internal targets, the company's OEE level status can be increased to a high level by comprehensively improving production factors related to the six big losses. Whether by improving in terms of humans, machines, methods and environment.

CONCLUSION

Based on the assessment conducted in this research, the most significant losses causing a decrease in engine performance so that the OEE value does not reach company standards are equipment failure Losses (wrapper head mechanics problem) with a value of 17,39% and idling and minor stop (fine tunning) with a value of 15,36% and product replacement with a value of 13,80% which makes the machine ineffective. To increase the effectiveness of the roll wrap machine, the company must carry out maintenance according to the schedule provided so that on time, the engineering division must work together with other divisions to adjust the maintenance schedule to production. Furthermore, monitoring the parts that will be used for maintenance activities so that the parts that want to use can be available on time, as well as reviewing machine operational planning by implementing a MOQ (Minimum Order Quantity) system to reduce delays and fine-tuning when the machine will run, for machine operators, it will be carried out skill matrix and operator rotation to balance the overall operator skills. The fuzzy logic could infer the status of the OEE value into a linguistic variable, which makes it easier for the operator to interpret the OEE value. Goal programming could be used as a reference for management plans and reviews in production operations.

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