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Analysis of Total Productive Maintenance Using Overall Resource Effectiveness (ORE) Methods on Pellet Mill 3 Machine in PT. XYZ

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A B S T R A C T

Pellet Mill is a critical machine in producing animal feed in pellets and crumbles at PT XYZ. In the production process, PT XYZ has three pellet mill machines actively operating, with the highest indication of breakdown time on pellet mill machine 3. This high breakdown time affects the productivity and effectiveness of the related machines. In this research focuses on knowing the effectiveness value of the pellet mill 3 machines using the Overall Resource Effectiveness (ORE) method and determining the factors that affect the effectiveness value. From these factors, improvement recommendations are then given based on total productive maintenance (TPM) concept to maintain and increase the effective value of the pellet mill 3 machine. Based on the calculation results using the Overall Resource Effectiveness (ORE) method for the pellet mill 3 machine, the effectiveness value is 71.41%, below the Japan Institute of Plant Maintenance (JIPM) standard of 85%. The factor that causes the low ORE is power efficiency, which averages 81.71%. To increase The ORE value of the pellet mill 3 machine, the pillars of total productive maintenance applied 5S, autonomous maintenance, planned maintenance, focussed improvement, Early Equipment Management, Training and Education, Quality Maintenance, and also the safety health environment.

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1. INTRODUCTION

In the manufacturing industry, machinery and equipment play an important role in the production process. Like people, equipment quality and performance will degrade downtime, including accuracy, reliability, and production capacity. However, the performance of machinery and equipment can be improved through the implementation of a planned, regular, and controlled maintenance program. One of the commonly used approaches in maintenance is Total Productive Maintenance (Tiara, 2023). PT XYZ is one of the companies engaged in the integrated agri-food sector in Indonesia with the main business including the manufacture of animal feed. In producing animal feed by PT XYZ, a pellet mill machine is used to form the feed into pellets and crumble. PT XYZ has three pellet mill machines actively operating with the highest indication of damage time on pellet mill machine 3.

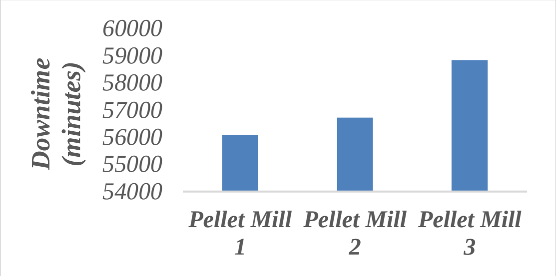

Fig. 1. Downtime of pellet mill machines
(Source: PT. XYZ)

Reported in the journal Beyene (2018) states that machine downtime is a factor that has a significant influence on low productivity and high-loss production. Downtime itself is divided into two, planned downtime and unplanned downtime. High unplanned downtime will affect the effectiveness and performance of the production machine itself. Based on the graph in Fig 1 shows that pellet mill 3 has the highest total downtime. The downtime is supported by the constraints of the pellet mill 3 machine itself in the operation process, such as often experiencing errors such as stopping due to jams in engine components, sensors that do not function properly, to damage to components in the pellet mill 3 machine itself. In addition, material delays from previous processes and obstacles in advanced processes also cause high downtime on the pellet mill machine.

Therefore, based on the exposure of these problems, it is necessary to conduct research related to the application of Total Productive Maintenance (TPM) using the Overall Resource Effectiveness (ORE) approach to the pellet mill 3 that it can help the company in analyzing downtime on the low effectiveness of the pellet mill 3 with fishbone diagram tools to improve the level of productivity of the machine and its resources.

2. LITERATURE REVIEW

2.1 Total Productive Maintenance

Total Productive Maintenance is one of the maintenance activities that include all company elements that aim to achieve zero breakdown, zero defects, and zero accidents. Total Productive Maintenance is also used to improve product quality through equipment maintenance activities and work equipment such as machinery, equipment, and other supporting tools. The main focus of Total Productive Maintenance (TPM) is to ensure that all forms of equipment and production equipment can operate in the best condition to avoid damage and delays in the production process (San,2021). According to Setiawan (2021) the concept of Total Productive Maintenance (TPM) itself is described by a house with a foundation in the form of 5S (seiri, seiton, seiso, shitsuke, seiketsu) and pillars that support the goals of Total Productive Maintenance itself. The pillars include; autonomous maintenance, planned maintenance, focused maintenance, quality maintenance, training education, office tpm, safety health environment, and early equipment management.

One of the approaches in Total Productive Maintenance (TPM) is Overall Equipment Effectiveness (OEE) which can thoroughly identify machine productivity and performance based on availability, performance efficiency, and quality rate. However, just using OEE is not enough to measure machine performance or effectiveness. That was because OEE only calculates availability, performance, and quality losses. While other losses such as machine damage, set-up and adjustment, unavailability of materials and operators are only categorized in one factor, namely the availability rate. Therefore, the OEE approach was modified into Overall Resource Effectiveness (ORE) to provide a more in-depth evaluation that considers resources related to the availability of people, materials, machines, and methods(Puspita, 2021).

2.2 Overall Resource Effectiveness (ORE)

ORE measures effectiveness using all resources, equipment, operators, technicians, production floor management, and the company's support system. ORE measurement consists of seven factors, namely readiness (R), availability of facility (A_f), changeover efficiency (C), availability of material (A_m), availability of manpower (A_{mp}), performance efficiency (P), and quality rate (Q) (Zulfatri,2020). There are more information of the seven factors of Overall Resource

Effectiveness (ORE)

1. Readiness

Readiness is the lost when the machine is not ready to operate due to planned downtime (Ramadhan,2021). In calculating Readiness (R), planned production time data is required, obtained from total time minus planned downtime. Total time is the time available. Planned downtime includes inspection and cleaning of the machine at the beginning of the machine, such as lubrication, tightening, data collection and meetings, audits, and operator training (Dawood, 2018).

$$\textit{Planned Production Time} = \textit{Total Time} - \textit{Planned Downtime} \quad (1)$$
$$\textit{Readiness}\ (\text{R}) = \frac{\textit{Planned Production Time}}{\textit{Total Time}}\ x\ 100\% \quad (2)$$

2. Availability of Facility

Availability of facilities is a loss due to damage or unavailability of equipment and machinery and related facilities (Ramadhan,2021). To calculate the availability of facilities, it is necessary to calculate the loading time obtained from the planned production time minus the facilities downtime. Facilities downtime includes machine and equipment downtime, unavailability of tools, jigs and fixtures, and unavailability of measuring instruments and related instruments (Dawood, 2018).

$$\textit{Loading Time} = \textit{Planned Production Time} - \textit{Facilities Downtime} \quad (3)$$
$$\textit{Availability of Facility}\ (A_f) = \frac{\textit{Loading Time}}{\textit{Planned Production Time}}\ x\ 100\% \quad (4)$$

3. Changeover Efficiency

Changeover efficiency is a calculation based on the total time that the system is not operating due to machine set-up and adjustment (Ramadhan,2021). To calculate changeover efficiency, operation time calculation data is obtained from loading time minus setup and adjustment. . The activities included in the set-up and adjustment are the replacement time of equipment, jigs and fixtures and minor adjustments after replacement, and replacement of machine components for different types of production on universally used machines (Dawood, 2018).

$$\textit{Operation Time} = \textit{Loading Time} - \textit{Setup and Adjustment} \quad (5)$$
$$\textit{Changeover efficiency}\ (\text{C}) = \frac{\textit{Operation Time}}{\textit{Loading Time}}\ x\ 100\% \quad (6)$$

4. Availability of Material

Availability of material is a loss due to lack or unavailability of raw materials or components (Ramadhan,2021). To calculate the availability of material, running time data obtained from operation time minus material shortages is required. Material shortage includes the unavailability of raw materials, parts, and sub assemblies, and the unavailability of work in process (WIP) inventory (Dawood, 2018).

$$\textit{Running Time} = \textit{Operation Time} - \textit{Material Shortage} \quad (7)$$
$$\textit{Availability of Material} = \frac{\textit{Running Time}}{\textit{Operation Time}}\ x\ 100\% \quad (8)$$

5. Availability of Manpower

Availability of manpower shows the comparison between actual running time and running time (Ramadhan,2021). Activities included in the unavailability of man power are leaving the workstation, being absent (leave or illness), discussing with the supervisor or team leader and work accidents (Dawood, 2018).

$$\textit{Actual Running Time} = \textit{Running Time} - \textit{Manpower absence} \quad (9)$$
$$\textit{Availability of Manpower} = \frac{\textit{Actual Running Time}}{\textit{Running Time}}\ x\ 100\% \quad (10)$$

6. Performance Efficiency

Performance efficiency means measuring the total time that operators use efficiently. Earrned time data is required to calculate performance efficiency, which is obtained from cycle time multiplied by the amount of production or quantity produced (Dawood, 2018).

$$\textit{Earned Time} = \textit{Cycle Time (/unit)}\ x\ \textit{Quantity Produced} \quad (11)$$
$$\textit{Performance Efficiency}\ (\text{P}) = \frac{\textit{Earned Time}}{\textit{Actual Running Time}}\ x\ 100\% \quad (12)$$

7. Quality Rate

Quality rate is the quality level of products produced by the company, which is the ratio between the quality of parts accepted and the quality of parts produced (Dawood, 2018).

$$\textit{Quantity of Parts Accepted} = \textit{Quantity Produced} - \textit{Quantity Rejected} \quad (13)$$
$$\textit{Quality Rate (Q)} = \frac{\textit{Quality Parts Accepted}}{\textit{Quantity Parts Produced}}\ x\ 100\% \quad (14)$$

8. Overall Resource Effectiveness

After obtaining the value of each factor, then the calculation of Overall Resource Effectiveness (ORE) is carried out by multiplying the seven factors, as in the following formula:

$$\text{ORE} = \textit{Readiness (R)}\ x\ \textit{Availability of Facility}\ (A_f)\ x\ \textit{Changeover Efficiency (C)}\ x\ \textit{Availability of Materil}\ (A_m)\ x\ \textit{Availability of Manpower}\ (A_{mp})\ x\ \textit{Performance Efficiency (P)}\ x\ \textit{Quality Rate (Q)}\ \text{x}\ 100\% \quad (15)$$

3. RESEARCH METHOD

This study uses the Overall Reource Effectiveness (ORE) method to find the effectiveness value of the pellet mill 3 machine with details that can be seen in Fig 2.

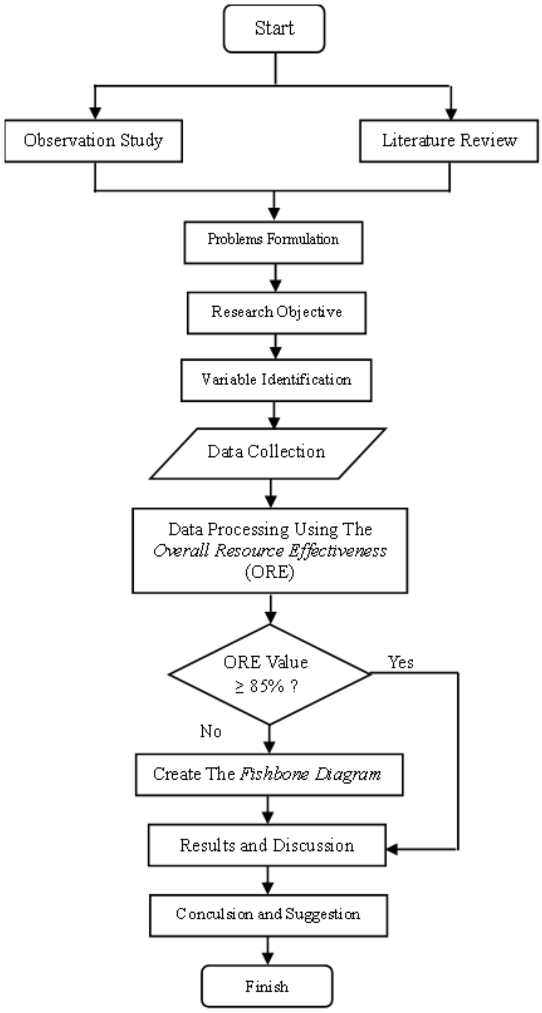

Fig. 2. Research stages

Based on Figure 2, an outline of the research will be carried out by looking for the effectiveness value of the pellet mill 3 machine with Overall Resource Effectiveness (ORE) which is carried out by calculating the seven factors including readiness, availability of facilities, changeover efficiency, availability of materials, availability of manpower, performance efficiency, and quality rate. After that, the average ORE value can be determined whether it is below or above the 85% standard. Then the factors that affect the value will be analyzed using a fishbone diagram. After knowing the cause, improvement proposals will be given based on the pillars of the application of total productive maintenance.

4. RESULT AND DISCUSSION

4.1 Overall Resource Effectiveness (ORE)

In the calculation of Overall Resource Effectiveness (ORE) to calculate the effectiveness of pellet mill 3 and its resources, the following seven factors are calculated:

A. Readiness

The results of the readiness calculation on pellet mill machine 3 for the period January to December 2022 are shows in Table 1.

Table 1. Readiness

Month	Total Time	Planned Downtime	Planned Production Time	Readiness
Jan	30240	1095	29145	96.38%
Feb	34560	570	33990	98.35%
Mar	38880	655	38225	98.32%
Apr	40320	675	39645	98.33%
Mei	24480	185	24295	99.24%
Jun	30240	390	29850	98.71%
Jul	30240	895	29345	97.04%
Ags	31680	515	31165	98.37%
Sept	31680	405	31275	98.72%
Okt	30240	465	29775	98.46%
Nov	33120	430	32690	98.70%
Des	34560	670	33890	98.06%
Average of Readiness				**98,22%**

(Source: processed data, 2023)

In the calculation of readiness with an average of 98,22%, the pellet mill 3 machine has a very good value because the value is above the readiness standard of 90%. The highest readiness value is in May at 99,24% while the lowest in January was 96,38%. The readiness factor with an excellent average score of 98.22% is due to the planned dowtime being appropriate and running according to what was planned. However, other factors and unplanned downtime also have an impact on the effectiveness of the associated machines.

B. Availability of Facility

The results of the availability of facility calculation on pellet mill machine 3 between January to December 2022 are shown in Table 2.

Table 2. Availability of facility

Month	Planned Production Time	Facilities Downtime	Loading Time	Availability of Facility
Jan	29145	700	28445	97.60%
Feb	33990	1840	32150	94.59%
Mar	38225	730	37495	98.09%
Apr	39645	1705	37940	95.70%
Mei	24295	1475	22820	93.93%
Jun	29850	1575	28275	94.72%
Jul	29345	990	28355	96.63%
Ags	31165	1195	29970	96.17%
Sept	31275	2075	29200	93.37%
Okt	29775	1220	28555	95.90%
Nov	32690	2530	30160	92.26%
Des	33890	1610	32280	95.25%
Average of Availability of Facility				**95,35%**

(Source: processed data, 2023)

Based on Table 2, the availability of facility value with an average of 95.35% on the pellet mill 3 machine shows a very good value because it is above the 90% availability of facility standard. The highest availability of facility value is in March at 98,09% while the lowest is in November at 92,62%.

C. Changeover Efficiency

The results of the changeover efficiency calculation on pellet mill 3 between January to December 2022 are shown in Table 3.

Table 3. Changeover efficiency

Month	Loading Time	Set Up and Adjustment	Operation Time	Changeover Efficiency
Jan	28445	890	27555	96.87%
Feb	32150	1160	30990	96.39%
Mar	37495	1525	35970	95.93%
Apr	37940	1135	36805	97.01%
Mei	22820	1170	21650	94.87%
Jun	28275	875	27400	96.91%
Jul	28355	815	27540	97.13%
Ags	29970	1590	28380	94.69%
Sept	29200	1215	27985	95.84%
Okt	28555	1060	27495	96.29%
Nov	30160	805	29355	97.33%
Des	32280	1105	31175	96.58%
Average of Changeover Efficiency				**96,32%**

(Source : processed data, 2023)

Based on table 3, the changeover efficiency value with an average of 96.32% on pellet mill 3 machines is very good because it is above the 90% standard. The highest changeover efficiency value is in November which amounted to 97.33% while the lowest in August which amounted to 94.69%.

D. Availability of Material

Calculation on pellet mill machine 3 between January to December 2022 are shows in Table 4.

Table 4. Availability of material

Month	Operation Time	Material Shortages	Running Time	Availability of Material
Jan	27555	1750	25805	93.65%
Feb	30990	1405	29585	95.47%
Mar	35970	1760	34210	95.11%
Apr	36805	1450	35355	96.06%
Mei	21650	660	20990	96.95%
Jun	27400	335	27065	98.78%
Jul	27540	240	27300	99.13%
Ags	28380	1235	27145	95.65%
Sept	27985	1000	26985	96.43%
Okt	27495	525	26970	98.09%
Nov	29355	755	28600	97.43%
Des	31175	90	31085	99.71%
Average of Availability of Material				**96,87%**

(Source: processed data, 2023)

Based on Table 4, the availability of material value of the pellet mill 3 machine with an average of 96.87% is said to be good because it is above the 90% standard. The highest availability of material value is in December at 99.71%, while the lowest is in January at 93.65%.

E. Availability of manpower

The Results of the availability of manpower calculation on pellet mill machine 3 between January to December 2022 are shown in Table 5.

Table 5. Availability of Manpower

Month	Running Time	Manpower Absence	Actual Running Time	Availability of Manpower
Jan	25805	0	25805	100%
Feb	29585	0	29585	100%
Mar	34210	0	34210	100%
Apr	35355	0	35355	100%
Mei	20990	0	20990	100%
Jun	27065	0	27065	100%
Jul	27300	0	27300	100%
Ags	27145	0	27145	100%
Sept	26985	0	26985	100%
Okt	26970	0	26970	100%
Nov	28600	0	28600	100%
Des	31085	0	31085	100%
Average of Availability of Manpower				**100%**

(Source: processed data, 2023)

Based on Table 5, the availability value of manpower on the pellet mill 3 machine shows a perfect value of 100%. This can occur because there is no downtime caused by operator absence or manpower absence.

F. Performance Efficiency

Cycle time of pellet mill 3 shows the time required to produce each ton which is 2.86 minutes/ton. The Results of the Performance Efficiency calculation on pellet mill machine 3 between January to December 2022 are shown in Table 6.

Table 6. Performance efficiency

Month	Quantity Produced	Earned Time	Actual Running Time	Performance Efficiency
Jan	7339.22	20969.19	25805	*81.26%*
Feb	8665.31	24758.02	29585	*83.68%*
Mar	10353.81	29582.31	34210	*86.47%*
Apr	9190.43	26258.37	35355	*74.27%*
Mei	4582.83	13093.80	20990	*62.38%*
Jun	8558.77	24453.63	27065	*90.35%*
Jul	7538.78	21539.38	27300	*78.90%*
Ags	8710.64	24887.53	27145	*91.68%*
Sept	8220.45	23486.99	26985	*87.04%*
Okt	8064.46	23041.32	26970	*85.43%*
Nov	7572.27	21635.05	28600	*75.65%*
Des	9070.62	25916.05	31085	*83.37%*
Average of Performance Efficiency				**81,71%**

(Source: processed data, 2023)

Based on Table 6, the performance efficiency value of the pellet mill 3 machine has an average of 82.62% which is below the standard value of performance efficiency of 95%. The lowest performance efficiency value is in May which is 62.38% and the highest is in August.which is 91.68%.

G. Quality Rate

The Results of the availability of material calculation on pellet mill machine 3 between January to December 2022 are shows in Table

Table 7. Quality rate

Month	Operation Time	Material Shortages	Running Time	Availability of Material
Jan	27555	1750	25805	93.65%
Feb	30990	1405	29585	95.47%
Mar	35970	1760	34210	95.11%
Apr	36805	1450	35355	96.06%
Mei	21650	660	20990	96.95%
Jun	27400	335	27065	98.78%
Jul	27540	240	27300	99.13%
Ags	28380	1235	27145	95.65%
Sept	27985	1000	26985	96.43%
Okt	27495	525	26970	98.09%
Nov	29355	755	28600	97.43%
Des	31175	90	31085	99.71%
Average of Quality Rate				**98,22%**

(Source : processed data, 2023)

Based on table 7, the quality rate value of the pellet mill 3 machine shows a value of 100% which means that no defects or process deviations are found in the production results by the pellet mill 3 machine. In this case, the pellet mill 3 machine has achieved one of the goals of total productive maintenance, namely zero defects

H. Overall Resource Effectiveness (ORE)

After calculating for each factor, the next step is to calculate the overall resource effectiveness value by multiplying all the factors. The results of the Overall Resource

Effectiveness calculation on pellet mill machine 3 between January to December 2022 are shown in Table 8.

Table 8. Overall resource effectiveness value of Pellet Mill 3

Month	R	Af	C	Am	Amp	P	Q	ORE (%)
January	96.38%	97.60%	96.87%	93.65%	100.00%	81.26%	100.00%	69.34%
February	98.35%	94.59%	96.39%	95.47%	100.00%	83.68%	100.00%	71.64%
March	98.32%	98.09%	95.93%	95.11%	100.00%	86.47%	100.00%	76.09%
April	98.33%	95.70%	97.01%	96.06%	100.00%	74.27%	100.00%	65.12%
May	99.24%	93.93%	94.87%	96.95%	100.00%	62.38%	100.00%	53.49%
June	98.71%	94.72%	96.91%	98.78%	100.00%	90.35%	100.00%	80.87%
July	97.04%	96.63%	97.13%	99.13%	100.00%	78.90%	100.00%	71.23%
August	98.37%	96.17%	94.69%	95.65%	100.00%	91.68%	100.00%	78.56%
September	98.72%	93.37%	95.84%	96.43%	100.00%	87.04%	100.00%	74.14%
October	98.46%	95.90%	96.29%	98.09%	100.00%	85.43%	100.00%	76.19%
November	98.70%	92.26%	97.33%	97.43%	100.00%	75.65%	100.00%	65.32%
December	98.06%	95.25%	96.58%	99.71%	100.00%	83.37%	100.00%	74.99%
Average	**98.22%**	**95.35%**	**96.32%**	**96.87%**	**100%**	**81.71%**	**100%**	**71.41%**

(Source: processed data, 2023)

Based on the results of the seven factors calculated in the Overall Resource Effectiveness (ORE) method, namely readiness, availability of facilities, changeover efficiency, availability of materials, availability of manpower, performance efficiency, and quality rate, it is found that the average ORE value on the pellet mill 3 machine is 71.41%. Based on these seven factors, performance efficiency is the only factor that causes the low Overall Resource Effectiveness (ORE) value. This figure is below the standard ORE provision in the Japan Institute of Plant Maintenance (JIPM) which is 85%. The lowest ORE value is in May which is 53,49% and the highest is in June which is 80,87% but still below the ORE standard of 85% This can happen because in May the pellet mill 3 machine did not work optimally due to damage to engine components and the duration of working time was less compared to other months. Less production time also leads to less production quantity. With the average ORE value in 2022 of 71.41% based on the JIPM value grouping, the pellet mill 3 machine is still considered good and has indications of development or improvement to get a better value and increase the ORE value by.

4.2 Fishbone Diagram

Based on the calculation of machine effectiveness using the Overall Resource Effectiveness (ORE) method, it is found that the performance efficiency factor is the factor causing the low Overall Resource Effectiveness value of the pellet mill 3 machine. Therefore, a fishbone diagram was constructed to analyze the cause of the low performance efficiency value so that researchers can make appropriate suggestions for improvement.

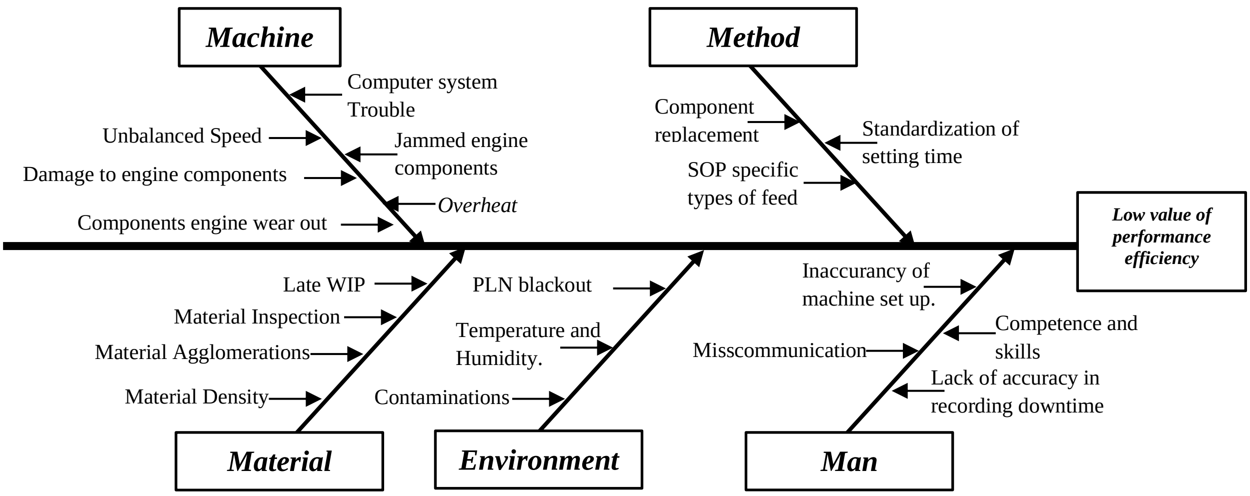

Fig. 3. Fishbone diagram
(Source : processed data, 2023)

Making fishbone in Figure 3 shows that 5 causal factors including people, machines, methods, materials and environment influence the low of performance efficiency value of pellet mill 3.

1. Machine Factor
   The machine factor is caused by unbalanced speed between Pellet Mill 3 and other machines, damage to pellet mill machine components such as cracks or breaks in die components, broken V-belts, and wear of components due to improper lubrication. Motor overheating due to overlubrication and also computer system problems.
2. Method Factor
   The method factor is caused by the fact that the guidebook used for component replacement has not been updated according to the characteristics of the related components, and there are no SOPs related to certain types of feed.
3. Material Factor
   The material factor is caused by material

delays or work in process (WIP), poor material inspection, different material density levels, material clumping in the cooler, and pellet mill door.

4. Human Factor
   The human factor is caused by SOP deviations such as less careful machine setup, lack of communication with other machine operators, differences in operator competence and skills, and less careful of downtime recording.
5. Environmental factors
   Environmental factors are caused by PLN failures and unavailability of generators capable of powering all production machines, temperature and humidity levels in the pellet machine area, and contamination such as dust and other particles.

4.2 TPM Recomendations

The improvement recommendations are made based on the pillars of Total Productive Maintenance (TPM) concepts, as follows:

a. 5S (*seiro, seiton, seiso, seiketsu, shitsuke*)

Seiri means that each worker or operator must be able to identify and separate items not needed in the pellet mill 3 machine work area and implement a clear and organized storage system. Seiton means that each worker or operator must place or return equipment and machine components according to the placement location, especially providing a sign in the form of a label that indicates the correct storage location. Seiso means that each operator must pay attention to the daily cleaning and maintenance schedule. Seiketsu means setting clear operational standards for routine maintenance through a checklist of maintenance activities. And Shitsuke means all workers or operators must familiarize themselves with the culture of maintaining cleanliness and order in the work area, and also motivate fellow workers to carry out 5s habituation personally and in the work area.

b. Autonomous Maintenance (Jishu Hozen)

The autonomous maintenance pillar in this case requires all operators to be responsible for small maintenance of machinery and equipment starting from cleaning, lubrication, checking the condition of machine components during pre-production and production processes. In addition, the company must also provide SOP for machine settings at the beginning of production with timeliness to ensure that each operator always checks the state of the machine by the SOP so that the machine will not experience damage in the middle of the operation process.

c. Planned Maintenance

This pillar shows the need for regular replacement of components before they are damaged. So technicians must implement preventive and predictive maintenance with the right duration depending on the characteristics of the machine and its components. The timing of component replacement and how the characteristics and age of the components must also be recorded to implement predictive maintenance optimally.

d. Focussed Improvement (Kobetsu Kaizen)

In this case, the company must be ready to make improvements focusing on factors affecting the ORE value. Including Equipment Improve, Operator and Technician Involvement, and also Process Improvement.

e. Early Equipment Management

In this pillar, the company must focus on the initial planning and design of equipment that has potential damage problems in the pellet mill 3 machine. This can be done with equipment planning, design, development, and initial testing of the sensitivity of machine components. This can certainly help the implementation of predictive maintenance properly.

f. Training and Educations

In this pillar, the company must always upgrade the ability of each worker or operator by providing training on the importance of total productive maintenance to the correct operation of the machine to support machine productivity. In addition, training on the maintenance of components and the machine itself is also important, especially in the initial repair action when a discrepancy occurs. Even in terms of communication between operators or management must also be considered by the company to support the company's production process.

5. CONCLUSION

The effectiveness value of the pellet mill 3 machine using the Overall Resource Effectiveness (ORE) method is 71.41%, which is lower than the standard ORE value formulated by the Japan Institute of Plant Maintenance (JIPM), which is 85%. This value shows that the Pellet Mill 3 machine is considered to be good, but there are some indications of improvement or development (improvement) to increase its effectiveness value. Because human, material, machine, method and environmental factors on the fishbone diagram influence the low of the performance efficiency value of the Pellet Mill 3 machine. By applying the principle of Total Productive Maintenance, it is expected that PT XYZ will be able to increase the efficiency of the Ore Pellet Mill 3 to 85% of the standard, or even better. In future research, it is hoped that machine repair priorities can be found using the FMEA or RCA method. In addition, the age replacement method can be used to provide a good proposal for component replacement scheduling.

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