HEURISTIC
Vol. 22, No. 1, April 2025
ISSN(p) 1693-8232
ISSN(e) 2723-1585

Analysis of The Effectiveness of Wheat Transfer Machines Using Overall Equipment Effectiveness (OEE) and Root Cause Analysis (RCA) In The Jetty Operation Section of The Jetty and Silo Department At PT. XYZ

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Article history:
Received: 20 February 2025
Accepted: 2 May 2025
Published: 13 May 2025

Keywords:
Machine Effectiveness;
Overall Equipment Effectivness (OEE);
Root Cause Analysis;
Transfer Machine

ABSTRACT

PT XYZ is a wheat flour producer that faces high challenges in the effectiveness of the wheat transfer machine in the Jetty Operation Section. This study aims to analyze machine performance using the Overall Equipment Effectiveness (OEE) and Root Cause Analysis (RCA) methods. The results showed the OEE values of Hartman I, Hartman II, and Neuro machines were 93% each, which is classified as normal according to the Japan Institute of Plant Maintenance, but can still be improved. Measurement of the six big losses identified Reduced Speed Losses as the main factor, 1.93% for Hartman I and Hartman II respectively, and Idle and Minor Stoppages Losses at 1.37%. The final stage using RCA provides improvement suggestions based on human, method, material, machine, and environmental factors. These recommendations are expected to increase machine effectiveness and support smooth production in the Jetty Operation Section.

INTRODUCTION

In the manufacturing industry, the production process is a very important aspect because it determines operational efficiency, quality, and sustainability. Production is defined as an activity carried out to produce goods or services, either directly or indirectly, to meet human needs [1]. According to [2] One of the important parts of an industrial company is the production process. The production process will affect the business processes within the company. The progress of the production process is influenced by various factors, namely resources, technology, supplies of raw materials and finished goods. Meanwhile, according to [3] Production activities are the link of consumption and distribution. Production activities that produce goods and services are then consumed by consumers. Without production, economic activity will stop. The production process can be interpreted as a way, method and technique to create or increase the usefulness of a good or service by using existing resources (labor, machinery, materials and funds) and one of the important factors for a company, because making a product must go through the production process [4]. The increasing development of industrial machinery technology will encourage all industrial companies to make the best use of production factors including labor (man), materials (material), equipment and machinery (machines) and funds (money), if the company is not efficient in processing these production factors, it will hamper the company's operations [5].

According to [6] so that a production process system can continue to run, it requires maintenance activities (maintenance) of production equipment and machinery. maintenance is defined as an activity of maintaining factory facilities and making repairs, adjustments or replacements needed so that a state of production operations is as planned. One of the challenges of a manufacturing company is when there is more and more demand for the products produced. So that the increase in production processes must be carried out by manufacturing companies to meet market demand [7]. The performance of a machine can be said to be not in good condition, it has an impact on the quality of the products produced will decrease and have an impact on customer satisfaction, as a result of decreased product quality, customer satisfaction will also [8].

Wheat flour is one of the main ingredients in all processed foods which is very important and versatile. PT XYZ is an integrated and largest wheat processing plant in one location that produces golden twin cakra flour, twin cakra, blue triangle, blue key for superior products and there are also by products in the form of pellets [9]. Jetty operation is a section in the jetty and silo department that has the duty and authority to operate machines for loading and unloading wheat and pellets (bulk). The flow of the wheat distribution process from the ship is transferred with the help of the main machine called grain unloader with the help of supporting machines such as bucket conveyor, chain conveyor, separator, weigher and bucket elevator. However, in the process of transferring grain, the machine in the operation section does not escape downtime or downtime which can affect the production process. In 1 day (3 shifts) during the process of transferring wheat from the ship into the silo the machine can operate up to 101,580 hours or for 4 days non-stop. The high level of production in the jetty operation section certainly requires more attention to the machines in the jetty operation section because this machine is the beginning of the production process. It is the center of attention because of its direct impact on overall production output, causing the inability to meet daily production targets.

Reviewing the problems that exist in the jetty operation section of PT XYZ in this study using the OEE (Overall Equipment Effectiveness) method. According to [10] OEE is a comprehensive measure that identifies the level of productivity of machines/equipment and their performance. After being known for the OEE value on each machine, it can be continued to look for six big losses on the machine with the lowest OEE value, namely the Hartman I machine, BC 110-3B, SP 110-13C. The Root Cause Analysis (RCA) improvement method according to [11], The Root Cause Analysis method is a step-by-step method that leads to the discovery of faults or root causes. An RCA will investigate and trace the cause and effect of the final failure and the final effect of the failure back to the root cause.

Table 1. World Class standard of OEE value measurement according to JIPM

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

Table 1 shows the standard word class value of OEE (Overall Equipment Effectiveness) according to JIPM (Japan Institute of Plant Maintenance).

Various previous studies have used the OEE (Overall Equipment Effectiveness) method to identify and improve the efficiency of production machinery. For example, research by [12] focused on OEE. However, these studies tend to ignore the influence of specific factors such as variations in product types or work environment conditions

on OEE efficiency. Therefore, this study aims to analyze the performance and efficiency of transfer machines in the jetty operation department of jetty and sillo including grain unloader, bucket conveyor, chain conveyor, separator, weigher and bucket elevator in the process of transferring wheat into silos at PT XYZ. The expected benefit of this research is that the transfer machine can operate optimally without significant interference. In addition, this research will also propose some improvement recommendations to improve the performance and efficiency of the machine.

MATERIALS AND METHODS

The data for this research was obtained from the monthly machine report records over the course of one year and methods used in this research are Overall Equipment Effectiveness (OEE) and Root Cause Analysis (RCA). OEE is used to measure the overall performance of the machine through three main indicators, namely availability, performance efficiency, and quality rate. After the OEE value is calculated, a six big losses analysis is conducted to identify the biggest losses that affect machine performance. Next, the RCA method was applied to find the root causes of these losses, taking into account factors such as people, methods, materials, machines, and environment. This approach aims to provide improvement recommendations to increase the overall effectiveness of the machine.

RESULTS AND DISCUSSIONS

The goal of implementing TPM on this machine is to minimize the six big losses that occur in the jetty operation section. so that the effectiveness of this machine occurs optimally and this will be measured using a measuring indicator, namely OEE (overall equipment effectiveness) which is expected to increase productivity and work efficiency of the machine [13].

Table 2. Total data of production, defect amount, total running time, total planned downtime, total set up, total breakdown, total stop time, total downtime

Mesin	Total Production (Ton)	Defect Amount (Ton)	Total Running Time (Hours)	Total Planned Downtime (Hour)	Total Set Up (hour)	Total Breakdown (hours)	Total Stop Time (hours)	Total Downtime (hours)
Hartman I	27.683	0	6439	2693	40	36,92	150,89	136,67
Hartmann II	27.683	0	5.311	2693	40	36,92	150,89	136,67
Neuero	27.683	0	6.594	2693	40	36,92	150,89	136,67
BC 110-3B	27.683	0	6115	2693	40	36,92	150,89	125,40
BC 120-3B	27.683	0	6115	2693	40	36,92	150,89	132,62
BE 110-5E	27.683	0	6115	2693	40	36,92	150,89	79,70
BE 120-5E	27.683	0	6115	2693	40	36,92	150,89	124,24
BE 610-3E	27.683	0	6115	2693	40	36,92	150,89	0,13
BE 620-3E	27.683	0	6115	2693	40	36,92	150,89	0,30
WG 110	27.683	0	6115	2693	40	36,92	150,89	96,57
WG 120	27.683	0	6115	2693	40	36,92	150,89	121,67
SP 110-13C	27.683	0	6115	2693	40	36,92	150,89	125,46
SP 120-13C	27.683	0	6115	2693	40	36,92	150,89	132,62
TC 610-1R	27.683	0	6115	2693	40	36,92	150,89	134,10
TC 620-1R	27.683	0	6115	2693	40	36,92	150,89	134,10

Table 2 shows the data obtained from total production data, number of defects, total running time, total planned downtime, total set up, total breakdown, total stop time, total downtime of the transfer machine at the jetty operation.

Calculation of Overall Equipment Effectiveness (OEE) and Six Big Losses Machine

Data processing is carried out using the Overall Equipment Effectiveness (OEE) method which is based on three factors, namely availability, performance efficiency, and quality rate. In creating this overall equipment effectiveness, the first step is to focus on eliminating the six big losses, including Equipment failure, Stop and Adjusment, idling and stoppages, reduce speed, rework and scrap [14].

Table 3. Calculation of availability, performance efficiency and quality rate

Mesin	Loading Time (Hour)	Operation Time (Hour)	Total Production (Ton)	Ideal Cycle Time (Ton)	Defect Amount (Ton)	Availability	Performance Efficiency	Quality Rate
Hartman I	1963	1826	27.683	0,0660	0	93%	100%	100%
Hartmann II	1963	1826	27.683	0,0660	0	93%	100%	100%
Neuero	1963	1826	27.683	0,0660	0	93%	100%	100%
BC 110-3B	1963	1838	27.683	0,0664	0	94%	100%	100%
BC 120-3B	1963	1830	27.683	0,0661	0	93%	100%	100%
BE 110-5E	1963	1883	27.683	0,0680	0	96%	100%	100%
BE 120-5E	1963	1839	27.683	0,0664	0	94%	100%	100%
BE 610-3E	1963	1963	27.683	0,0709	0	100%	100%	100%
BE 620-3E	1963	1963	27.683	0,0709	0	100%	100%	100%
WG 110	1963	1866	27.683	0,0674	0	95%	100%	100%
WG 120	1963	1841	27.683	0,0665	0	94%	100%	100%
SP 110-13C	1963	1838	27.683	0,0664	0	94%	100%	100%
SP 120-13C	1963	1830	27.683	0,0661	0	93%	100%	100%
TC 610-1R	1963	1829	27.683	0,0661	0	93%	100%	100%
TC 620-1R	1963	1829	27.683	0,0661	0	93%	100%	100%

After obtaining the availability value, performance efficiency, and quality rate, the performance efficiency value of 100% for all machines can be seen in table 3. For availability, there are several machines that have an availability value of 93%, namely the top machine Hartamnn I Hartmann II and Neuro, then the OEE value measurement can be carried out on each machine in the jettty operation section. The results of the OEE calculation can be seen in Table 4.

Table 4. Machine OEE Calculation in the Jetty operation Section and OEE Classification According to JIPM (Japan Institute of Plan Maintenance)

Factor of OEE	StandardWorld Class	Hartman II	Neuero	Hartman I	BC 110-3B	BE 120-5E	WG 120	SP 110-13C	SP 120-13C	TC 610-1R	TC 620-1R	WG 110	BE 110-5E	BE 610-3E	BE 620-3E
Availability	90%	93%	93%	93%	94%	94%	94%	94%	93%	93%	93%	95%	96%	100%	100%
Performance Efficiency	95%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Quality Rate	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
OEE	100% 85%	93%	93%	93%	94%	94%	94%	94%	93%	93%	93%	95%	96%	100%	100%

Factor of OEE	Standar dWorld Class	Hart man n II	Ne ue ro	Har tma n I	BC 110-3B	BE 120-5E	W G 12 0	SP 110-13C	SP 120-13C	TC 610-1R	TC 620-1R	W G 110	BE 110 -5E	BE 610-3E	BE 620-3E
OEE	60%														
	40%														

From Table 4 above, it can be seen the calculation of the OEE value of the machine in the jetty operation section which has an average value above the ideal value of 90% which according to the OEE Classification at the Japan Institute of Plan Maintenance, this value is included in the good category or the machine is optimal when used, but it can still be improved again for the machine to be maximized again, namely on the machine. Production is considered reasonable but still shows there is a large space for the company to grow, and the company's competitiveness is reduced. The second stage after getting the OEE value of each machine in the jetty operation section is to measure the six big losses. Six big losses are six factors that affect the OEE value. The value of six big loss for each machine at the jetty operation section station that is not ideal is calculated to determine the most dominant factor and affects the OEE value, so the Hartman I machine, Hartmann II machine and neuro machine are chosen because the machine is the initial or main machine for the wheat transfer system. Then. It is recommended to use six big losses to identify six losses on the machine. The six big losses are represented by downtime loss (breakdown loss, set up, and adjustment loss), speed loss (idling and minor stoppages loss and reduced speed loss), and defect loss (rework loss and scrap loss) [14].

Table 5. Calculation of six big losses of Hartmann I, Hartmann II and Neuro machines

Six Big Losses	Hartmann I	Hartmann II	Neuero
Breakdown Losses	0,019%	0,070%	0,019%
Set Up & Adjustment Losses	0,020%	0,020%	0,022%
Idle and Minor Stoppages Losses	1,372%	1,372%	1,372%
Reduced Speed Losses	1,930%	1,936%	1,936%
Rework Losses	0	0	0
Scrap Losses	0	0	0
Total	3,341%	3,398%	3,349%

From the results of the calculation of the percentage of six big losses in table 5, the highest percentage factor for Hartman I machines is Reduced Speed Losses of 1.930%, Idle and Minor Stoppages Losses of 1.372% Hartmann II machines with a value of Reduced Speed Losses of 1.936%, Idle and Minor Stoppages Losses of 1.372% and Neuro machines are Reduced Speed Losses of 1.936%, Idle and Minor Stoppages Losses of 1.372%. In order for researchers to propose improvements to each machine, it is analyzed using root cause analysis.

Root Cause Analysis

To find out the problems that affect the effectiveness of the machine, Root Cause Analysis is conducted. The benefit of Root Cause Analysis is to show the causal relationship or factors that affect the level of efficiency by brainstorming. The influencing factors are people, methods, materials, machines, and the environment [15].

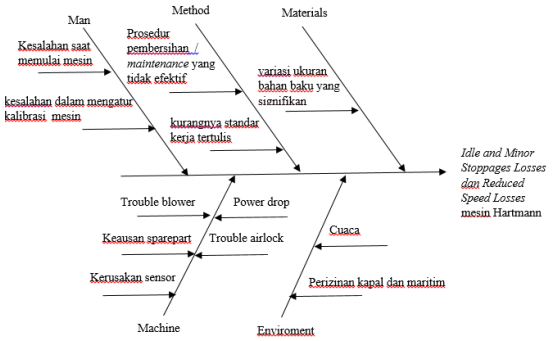

Figure 1. Root Cause Analysis of the Hartmann I

In Figure 1 Root Cause Analysis of the Hartmann I machine the first man includes errors when starting the machine, errors in setting the machine calibration the second method includes ineffective cleaning or maintenance procedures. Third materials include significant variations in the size of raw materials. The fourth machine includes blower Trouble, spare part wear, sensor damage, power drop, airlock trouble, and the fifth Enviroment includes Weather, ship and maritime licensing.

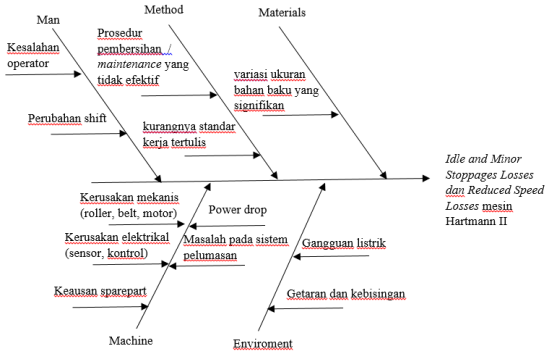

Figure 2. Root Cause Analysis of the Hartman II

In Figure 2 Root Cause Analysis of the Hartmann II machine the first man includes operator error and shift changes, the second method includes ineffective cleaning or maintenance procedures and lack of written standards. Third materials include significant variations in the size of raw materials. The fourth machine includes mechanical damage (rollers, belts, and motors), wear and tear of spare parts, power drops, and problems with the lubrication system and the fifth Enviroment includes electrical interference, vibration and noise.

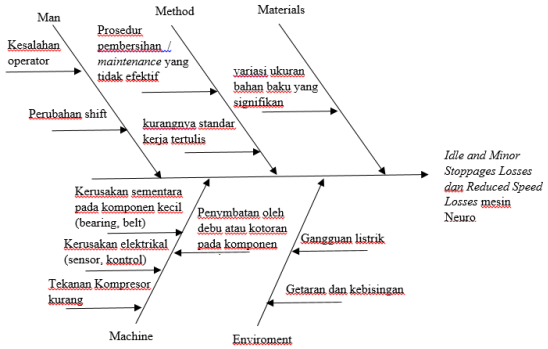

Figure 3. Root Cause Analysis of the Neuro

In Figure 3 Root Cause Analysis of the Hartmann II machine the first man includes operator error and shift changes, the second method includes ineffective cleaning or maintenance procedures and lack of written standards. Third materials include significant variations in the size of raw materials. The fourth machine includes temporary damage to

small components (bearings and belts), electrical damage (sensors and controls), and insufficient compressor pressure, the fifth Enviroment includes electrical interference, vibration and noise.

From the results of the root cause analysis above, recommendations are made to reduce the value of losses due to Idle and Minor Stoppages Losses Reduced Speed Losses on Hartmann I, Hartmann II, Neuro machines. Will be explained in the following points:

1. *Man*
   a. Provide direction and training on the machines to be operated and the importance of complying with applicable SOP rules to increase the sense of responsibility in each operator.
   b. Provide direction or instructions for the next shift to avoid machine damage or hinder the production process to be carried out.
2. *Method*
   a. Provide regular and scheduled maintenance training to operators
   b. Using spare parts with good quality and according to the required standards
3. *Materials*
   a. More attention should be paid to each type of wheat, because for hard wheat types there is more accumulation that disrupts the production process.
4. *Machine*
   a. Perform regular engine inspections and collect data on any problems with the engine to prepare for proper and efficient component replacement.
5. *Enviroment*
   a. Keeping the work environment clean and dry, Cleaning tools and operator premises after the production process is complete to keep the environment comfortable for operators.

CONCLUSION

Based on data processing and analysis of the results that have been carried out by researchers, it can be concluded as follows. The OEE value for the average of each wheat distribution machine in the jetty operation section of the jetty and silo department has a value above 85%. This condition indicates that the production is included in the world class category because it can be used as a long-term goal and has excellent competitiveness. Meanwhile, for machines that have a value below 95% and can still be improved again, namely the Hartmann I machine with an OEE value of 93%, this condition can be said to be reasonable but still indicates that there is a large space for the company to develop, and the company's competitiveness is reduced. Meanwhile, there are also several machines that can be optimized besides Hartman I, namely the Hartman II machine with an OEE value of 93%, and the Neuro machine with a value of 93%. The dominant factor affecting the OEE value on the three machines with the lowest value, namely the Hartmann I, Hartman II and Neuro machines, can be optimized or considered by the company is the Idle and Minor Stoppages Losses factor with a value between 0.372% and Reduced Speed Losses with a value between 1.930% - 1.936%. Then improvements can be made by following the suggestions of the results of root cause analysis including man, method, materials, machine and environment. The limitation of this research is that the scope studied is only in the jetty operation section, not researching all existing sections. For further research, it can be considered to use or add the MTBF

(Mean Time Between Failures) method to determine the reliability of the transfer machine in the jetty section.

ACKNOWLEDGMENT

The authors would like to thank the entire Jetty Operation Section team for their support, cooperation, and information provided during this research process. My gratitude also goes to my partner who has provided assistance, encouragement, and moral support so that this research can be completed properly. Hopefully the kindness and contributions that have been given will be rewarded.

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