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Research Article

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Overall Equipment Effectiveness Analysis to Define the Effectiveness of Yoshino I Machine: A Case Study in Manufacturing Industry

Surya Perdana, Evan Haviana, Humiras Hardi Purba

Master of Industrial Engineering Program, Mercu Buana University, Jakarta, Indonesia

Abstract This article is the research of object that engaged in printing (advertising) industry company, the product are a printed items in the form of textbooks, magazines, brochures, catalogs, and others. During production runs there are often problems occur causing inhibition of production so the results are not maximum, such problems include machines that always a lot of time wasted (downtime), breakdown time, also preparation of equipment (setup and adjustment) resulting a less productivity in the production. For this research the data used is observation result on Yoshino I machine from March to May 2015 and March to May 2016. Data processing is done by calculating the value of Overall Equipment Effectiveness (OEE) seen from Availability, Performance and Quality. After the calculation using this Overall Equipment Effectiveness method, the OEE achievement was significantly increased every month, but yet has not reached the World Class OEE standard. The OEE value becomes low on the Yoshino I machine due to less operator's knowledge about the machine (Human), Unstable glue temperature (Machine), the late material supply (Material), and the inefficient of knife change process (Method). Further improvement from individual root cause has contributed a 6% enhancement from general OEE achievement.

Keywords Availability, Performance, Quality, Overall Equipment Effectiveness

1. Introduction

In the printing industry productivity of machine becomes the most important thing in producing a high quality product. Productivity is a measuring tool for the efficiency of an activity. In a manufacturing process environment, productivity is the key to reflecting the overall performance of the production process (ie human, machine, plant, system, etc.) [1][19]. Lack of maintenance on the machine will result in a decrease in engine performance and result in reduced productivity. Total Productive Maintenance (TPM) is a maintenance system, involving new concepts to maintain the working environment and equipment used. TPM's main goal is to increase production significantly, while also improving employee work motivation and employee satisfaction [2].

In this article the industry that became the object of research is a company engaged in printing (*advertising*), the product are a printed items in the form of textbooks, magazines, brochures, catalogs, and others. During production runs there are often problems occur causing inhibition of production so the results are not maximum, such problems include machines that always a lot of time wasted (*downtime*), *breakdown* time, also preparation of equipment (*setup and adjustment*) resulting a less productivity in the production. Therefore, it is necessary to make improvements, one of them using TPM, the Total Productive Maintenance TPM function itself in Printing Operations is the efficiency of the printing press and its secondary purpose to reduce and control the variation in the printing process. Total Productive Maintenance (TPM) is used as a tool to optimize the performance of the printing press, so as to produce economic efficiency or profitability [3].

One part of TPM that can be used to measure the effectiveness of production is by using Overall Equipment Effectiveness (OEE) method. Using Overall Equipment Effectiveness enables a machine to analyze the expected performance during play and the performance measured from the machine itself and is also used to develop

current performance [4]. Overall Equipment OEE shows the relationship between availability, performance, and quality factors. Overall Equipment Effectiveness metrics can measure the effectiveness of a machine, and also identify the element of loss [5]. Overall Equipment Effectiveness is a quantitative TPM tool used to investigate and analyze production processes. Overall Equipment Effectiveness provides a metric for measuring machine efficiency in order to increase productivity through the identification of potential areas for improvement [6].

This research used a case studies conducted on yoshino machine I. Research was done through observation on the printing process, data collection obtained through direct observation, examination on low engine performance and through interviewing to employees who are responsible for the machine. Further data obtained is processed in the form of Overall Equipment Effectiveness. In addition, the analysis also conducted using the fishbond method to determine the main cause of the decline in productivity. Finally, the results of the analysis carried out improvements.

Figure 1: Yoshino machinery

2. Literature Review

Total Productive Maintenance (TPM) will be successful if the entire organization seeks to work together to maintain and improve the performance of a machine. As a first step it is important to measure machine performance or make small changes. There are 6 major losses from Total Productivity Maintenance that are link with Overall Equipment Effectiveness metric as a tool to measure the three factors: Availability, Performance, and Quality. Overall Equipment Effectiveness allows organizations to measure and monitor performance with simple and easy-to-understand metrics. Overall Equipment Effectiveness provides a measurement tool for the success of Total Productive Maintenance (TPM) and a framework for identifying enhanced possibilities [7]. In large industries the loss / wastage takes place on the floor of the manufacturing plant. These wastes are caused by operators, personal maintenance, processes, tooling problems and unavailability of components in time etc. [8]. The benefits to be gained for the organization afterwards to implement TPM is to ensure better quality for the product, reduce equipment damage, reduce total production costs, create a motivated work environment, and improve employee work attitude [9].

Overall Equipment Effectiveness (OEE) is a process-oriented method, which is not only time of machine availability (planned time/turn) but also efficiency (real efficiency / nominal efficiency) and quality (good product number / overall production) [10] . Overall Equipment Effectiveness is one element that measures equipment performance, but can measure the performance of OEE throughout the manufacturing process [11]. Achieving the value of Overall Equipment Effectiveness is influenced by various factors namely Availability, Performance, and Quality [12]. Availability is a ratio that describes the utilization of the time available for the operation of machinery or equipment. Performance is a ratio that describes the ability of the peratan in producing goods. Quality is a ratio that describes the ability of the parts in producing the goods. Quality is a ratio that describes the ability of equipment to produce goods [13]. Improving efficiency and effectiveness, the more productive is the organization. Overall equipment effectiveness is a measure of such performance, which shows the current production status with the least amount of calculations. It also helps measure losses and

corrective actions can be taken to reduce them. Effective utilization of Humans, Machines, Materials and Methods will result in higher productivity [14]. Stop Time is defined as the time duration at which the system fails and is unable to perform the basic activity and is known by the term outage duration. To achieve an effective reduction in downtime, the value of Overall Equipment Effectiveness should be regulated so that losses can be altogether removed, increasing the profitability of the company [15].

3. Methodology

The data used in this research is observation result on Yoshino I machine from March to May 2015 and March to May 2016. Data processing is done by calculating the value of Overall Equipment Effectiveness (OEE) seen from Availability, Performance and Quality. Overall Equipment Effectiveness (OEE) analysis is derived from the calculation of availability, production effectiveness, and quality level compared to the TPM standard to determine the level of machine effectiveness. The ideal JIMP Standard for TPM Index, is [16]:

1. Availability (AV) ≥ 90%
2. Production Effectiveness (PE) ≥ 95%
3. Quality Level (RQ) ≥ 99%
4. The overall effectiveness of equipment and machinery, (OEE) ≥ 85%

(Ideal OEE: (0.90 x 0.95 x 0.99) x100% = 85%)

To calculate Overall Equipment Effectiveness (OEE) the following formula as below [17]: (i) Availability calculation is a ratio showing the utilization of the time available for the operation of the machine or equipment. The required data is downtime and loading time, using the following calculation formula:

$$\text{Availability} = \frac{\text{Operating Time}}{\text{Planned Production}} \text{ X } 100\% \quad (1)$$

(ii) Performance calculation is the ratio that shows the ability of the equipment in producing goods. The required data is the total production, cycle time, and operation time, using the formula of calculation as follows:

$$\text{Performance} = \frac{\text{(Total Product: Operating Time)}}{\text{Ideal Run Rate}} \text{ X } 100\% \quad (2)$$

(iii) Calculation of *quality* is the ratio that shows the ability of the equipment to produce goods in accordance with the standards specified. The required data is the total production and the number of defects, using the formula of calculation as follows:

$$\text{Quality} = \frac{\text{Good Output}}{\text{Actual Output}} \text{ X } 100\% \quad (3)$$

(iv) Calculation of overall equipment effectiveness (OEE), obtained from the multiplication of the three categories. So the formula used for calculation as follows:

OEE =Availability (%) x Performance (%)x Quality (%) (4)

Fishbone diagram is a visual tool to identify, explore, and graphically describe in detail all the causes associated with a problem. The basic concept of a fishbone diagram is a fundamental problem placed on the right side of the diagram or on the head of the skeleton of the fishbone. The cause of the problem is described in the fins and the thorns [18].

4. Result and Discussion

Value of Overall Equipment Effectiveness (OEE) data from March to May 2015:

Data Value Overall Equipment Effectiveness (OEE) is obtained from archive data of progress job which is the samples only taken from 3 months data due to lowest result was achieved in this period (table #1).

Table 1: Overall Equipment Effectiveness year 2015

No	Items	March (%)	April (%)	May (%)
1	Availability Rate	74,60%	59,08%	54,69%
2	Performance Rate	61,62%	100,00%	100,00%
3	Quality Rate	99,99%	99,99%	99,99%
4	OEE	45,97%	59,08%	54,69%

Refer to above data, the values are still under required standard based on comparison to previous analysis with the same processes. Which is the result can reach 96%, refer to below table#2. [1].

Table 2: OEE value from previous research on year 2014

Date Performed	Quality (Q) and Performance (P)			Availability (A)	OEE			
	Expected output	Actual output	Rejects		Q	P	A	OEE
101014	6000	7840	25	832	100	100	96	**96 %**

Problem Analysis

From the calculation of *Overall Equipment Effectiveness* (OEE), there are some parameters that cause the low value of *Overall Equipment Effectiveness* (OEE) such as: material, machine, human, and method. The following diagram fishbone can show the main cause of low OEE machine Yoshino I C.22:

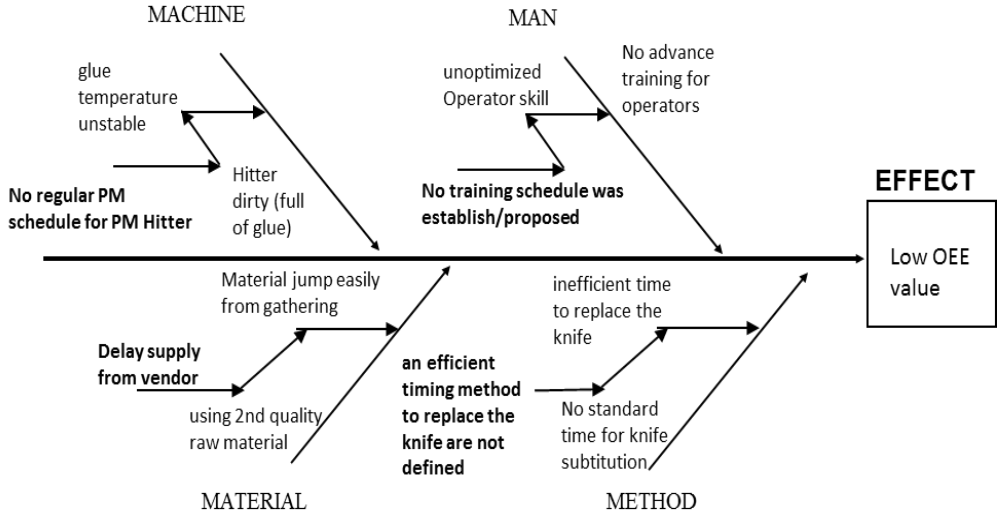

Figure 2: Fishbone diagram

a. Machine

After *Brainstorming* was done by Yoshino I team, there is a lack of scheduling has not been done on the treatment of a *hitter* that causes dirty *hitters* and make the temperature of the glue unstable. The proposal to repair this hitter is to coordinate with *maintenance* team to establish new *preventive maintenance* schedule, its purpose to make the temperature stable. The glue temperature that should be 160 °C but due to the hitter issue its can reach 170 °C which can cause the gluing process resulting in the form of imperfect book.

Further improvement are implemented by established a new PM checklist for maintenance to regularly control the internal parts of the Yoshino machine.

Date :

PM by :
Verified by :
Frequency :

Yhosino I Machine Preventive Maintenance Checklist

Nr	Items Description	Good	Bad	Align or Clean	Replaced	Total cut (knife)	Remarks
1	Check the cover feeder.						
2	Check the Grinding knifes.						
3	Check and clean Cresing Unit.						
4	Check glue roller						
5	Check glue drum						
6	Check and clean Knife trimmer.						
7	Check the Clamper						
8	Check the stacker						
9	**Check and clean the hitter.**						

Note : All findings must have corrective actions.

Figure 3: New revision on PM checksheet with additional hitter check and clean point

b. Method

After *Brainstorming* was done by the Yoshino I team, there is a weakness which is time calculation of the blade replacement is not defined that causes an inefficient time standard. The proposed improvement is to perform an efficient knife replacement time and set the standardization of a knife change process in a Yoshino machine. Further investigation showed the knife replacement was required after 500K ~600K cut, a check sheet to regularly control the changed was released by maintenance.

Date :

PM by :
Verified by :
Frequency :

Yhosino I Machine Preventive Maintenance Checklist

Nr	Items Description	Good	Bad	Align or Clean	Replaced	Total cut (knife)	Remarks
1	Check the cover feeder.						
2	Check the Grinding knifes.						
3	Check and clean Cresing Unit.						
4	Check glue roller						
5	Check glue drum						
6	**Check and clean Knife trimmer.**					**Cutting Qty**	
7	Check the Clamper						
8	Check the stacker						
9	Check and clean the hitter.						

Note : All findings must have corrective actions.

Figure 4: New revision on PM checksheet for knife replacement control

c. Human

After *Brainstorming* conducted by team Yoshino I, there is a lack of no *training* schedule or and it has not been submitted, which causes the knowledge of the operator of Yoshino I machine not maximum. Proposed improvement is to make the training of machine knowledge and Yoshino I graphics from vendor, training is specified only for operators, also Established new standard for operators recruiting program. Further data collection on the improvement effectiveness showed as below chart reject quantity product has reduced compare to previous year data.

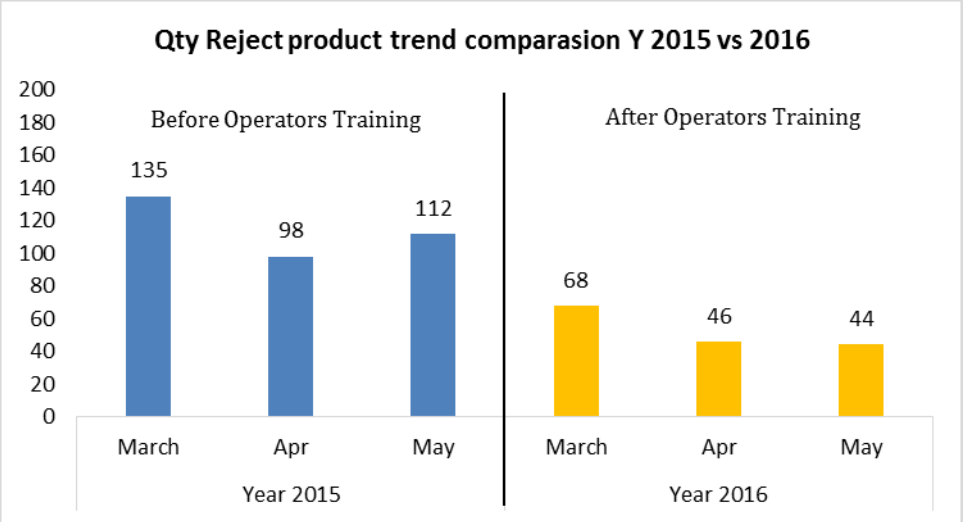

Figure 5: Reject Product trend 2015 and 2016

d. Material

After Brainstorming was done by team Yoshino I, there is a weakness on material supply by vendor, the delay has caused production using a second option by picking a quality materials (KW) so that the material jump easily. Proposed improvement is to make agreements with related vendors on compliance with raw materials or

to add vendors with minimum quality to match the previous product. Action has been made by increasing the raw incoming visual check and test by QC department to tighten control the material product quality.

Data processing

Data processing is by determining the value of Availability, Performance, and Quality of Overall Equipment Effectiveness method after improvement was made based on above action plan from fishbone analysis result.

OEE value measurement

Once the value of Availability, Performance, and Quality is obtained, and then next is to calculate the value of Overall Equipment Effectiveness (OEE). Here are the results of OEE value measurements on Yoshino machines March, April, and May 2016 as below chart, showed an increased trend:

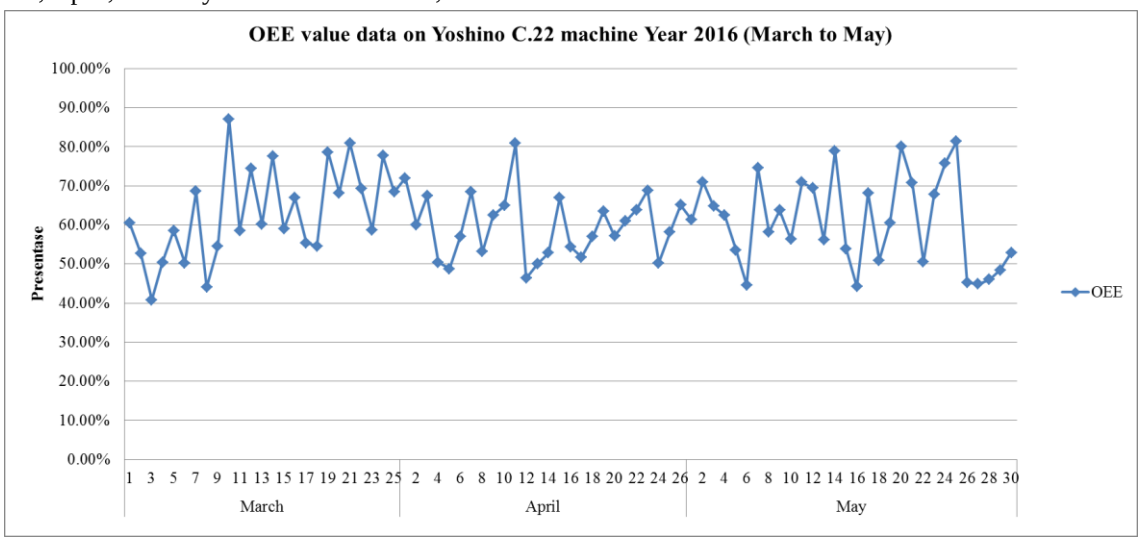

Figure 6: OEE value data average of Yoshino Machine on year 2016

The OEE value data is not showing an ascending trend as shown above, the chart showed us a stable OEE trend on Year 2016. But by monthly average and overall comparison it has improved (see table 3).

Table 3: OEE value comparison between year 2015 vs 2016

Year	March	April	May	Average
2015	45.97%	59.08%	54.69%	53%
2016	60.14%	57.92%	59.92%	59%

This table is a comparison from 3 months OEE data summary between year 2015 and 2016, and shown that year 2016 is higher and better.

5. Conclusion

The low of OEE value obtained on the Yoshino Machine has causes the machine's productivity decrease, the following main four factors such as less operator knowledge about the machine (Human), unstable glue temperature (Machine), late vendor supply (Material), and inefficient knife replacement time (Method). After done the improvement referring to above root causes and further calculation using the Overall Equipment Effectiveness (OEE) method, the general achievement of OEE has increased around 6% (refer to Table 3), although not yet reached the World Class OEE standard.

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