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Calculation of Overall Equipment Effectiveness Total Productive Maintenance in Improving Productivity of Casting Machines

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Abstract:- In a production process not only about input, process and output. Its include about maintenance of production machines. The maintenance of a production machines is highly recommended, because it will be related with the performance of the machine in production.The same things works for die casting machines in one of biggest industry of manufacturing in Indonesia where the engine or machines is still not operate with normally due downtime happend. Because of it all, using the help of the Overall Equipment Effectiveness (OEE) method for Six Big Loses on this machines we got the big one problem is reduced speed loss which is up to 65%.

Keyword:- *Overall Equipment Effectiveness (OEE), Six Big Loses, Die Casting Machines.*

I. INTRODUCTION

In manufacturing or non-manufacturing industry, maintain is needed for machinery or equipment, work as a tools of production. Maintenance management is the maintene through a process of planning, organizing, and controlling operation about industrial facilities.

In the development thing, there's a new concept of maintenance managaement, which aims to maintain productivity optimization as Total Productive Maintenance (TPM).

Total Productive Maintenance (TPM) is a development of ideas from total productive maintenance which is a method for keep or maintain machine and equipment so the machine can run well when operated.

One of the output from *Total* ProduvtiveMaintenace (TPM) method is *Overall Equipmet Effectiveness (OEE).*

*Overall Equipment Effectiveness (OEE),*is a ability for identify of root cause and another factor of causes, so it can make us focus with the main factor of damage in machine or equipment.

Effort to improve the manufacturing industry can be seen in term of equipment by increasing the effectivenesEffeectiveness is a measure that states how far the target (quantity, quality, and time) has been achieved, the higher the effectiveness (Andras, 2007). High effectiveness values can be achieved if in the production process the company can reduce the value of losses, one of which is caused by a decrease in the performance of the production machine.

This research will focus on die-casting machines, where used to produce one of motorcycle spare part.Based on data collected about the effectiveness of die casting machines, it shows that this machine has not fully worked effectively.This is shown by the data downtime, data decreasing engine speed and product defect data.For this reason, author do a study of the research engine to measure the effectiveness of die casting machines using the Overall Equipment Effectiveness (OEE) method, and analyze the causes of six big losses of die casting machines using Fishbhone diagrams, and the authors could suggest improvements to improve effectiveness die casting machine.

II. RESEARCH METHOD

This research consists of several stages of data processing, the stages of calculating the effectiveness of die casting machines using the Overall Equipment Effectiveness (OEE) method, and the stages of analyzing the factors causing Six Big Losses of die casting machines using the Fishbhone diagram.

- *Overall Equipment Effectiveness (OEE)*

OEE is a method that is used as a metric in implementing TPM programs to maintain equipment in ideal conditions by removing Six Big Losses equipment.OEE measurement is based on the measurement of three main ratios, namely (1) Availability ratio, (2) Performance ratio, and (3) Quality ratio. To get an OEE value, the value of the three main ratios must be known in advance.The Availability ratio is a constellation that describes the use of time available for the operation of machinery or equipment. Nakajima (1988) states that availability is the ratio of operation time, by eliminating equipment downtime, to loading time.The formula for used to measure the availability ratio is:

$$Avaibility = \frac{Operation\ time}{loading\ time} = \frac{loading\ time - down\ time}{loading\ time} \quad \text{.....(1)}$$

Performance ratio describes the ability of equipment to produce goods. This ratio is the result of operating speed rate and net operating rate. The equipment operating speed rate refers to the difference between the ideal speed (based on the design of the equipment) and the actual operating

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speed. Operating rate measures the maintenance of a speed during a certain period.In other words, it measures whether an operation remains stable in a period as long as the equipment operates at a low speed. The formula for measuring this ratio is:

$$Performance\ rate = \frac{Processed\ amount\ x\ theoretical\ cycle\ time}{operation\ time} \text{.....(2)}$$

Quality ratio describes the ability of equipment to produce products that comply with standards. The formula used to measure this ratio is:

$$Quality\ Rate = \frac{processed\ amount - defect\ amount}{Processed\ amount} \text{....(3)}$$

OEE value is obtained by multiplying the three main ratios. Mathematically the formula for measuring OEE values is as follows:

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

➢ *Six Big Losses*

There are six disadvantages as cause low performance of machines and equipment, namely equipment failure (breakdown losses), setup and adjustment losses, idling and minor stoppage losses, reduced speed losses, process defect losses, reduced yield losses (Saiful, et al, 2014). Breakdown losses are damage to the engine or equipment that suddenly experiences unwanted damage and consequently will cause the engine to not operate properly. To calculate the Breakdown Losses (BL) formula is used :

$$BL = \frac{Total\ breakdown\ time}{loading\ time} x100 \text{.....(5)}$$

Setup and Adjustment Losses (SAL) are losses due to installation and adjustment (Saiful, et al, 2014). to calculate setup and adjustment losses the formula is used:

$$SAL = \frac{Total\ setup\ and\ adjustment\ losses}{loading\ time} x100\% \text{...(6)}$$

Idle and Minor Stoppage Losses (IMSL) are caused by events such as short engine stops, engine congestion, and idle time of the engine (Saiful, et al., 2014). To calculate the idle and minor stoppages losses, the formula is used:

$$IMSL = \frac{Nonproductive\ time}{loading\ time} x100\% \text{.....(7)}$$

RSL Reduced Speed Losses is a loss because the engine does not work optimally (decrease in speed of operation) occurs the actual speed of machine operation or smaller equipment designed (Saiful, et al. 2014). To calculate the reduced speed losses used the formula:

$$RSL = \frac{Actual\ Processing\ time - Ideal\ processing\ time}{loading\ time} x100\%$$

Process Defect Losses are defective products that are produced will result in material losses reducing the amount of production, production waste increasing and increasing costs for rework (Limantoro& Felecia, 2013). To calculate the defect losses process, the formula is used:

$$Process\ defect\ losses = \frac{Idle\ cycle\ time\ X\ Total\ process\ defect}{loading\ time} x100\%$$

Reduced Yield Losses are losses incurred during the time needed by the machine to produce new products with the expected product quality.Losses that arise depend on factors such as unstable operating conditions, improper handling and installation of equipment or operators do not understand the production activities carried out (Limo & Felecia, 2013). For reduced yield losses the formula is used:

$$Reduced\ yield\ losses = \frac{Nonproductive\ time}{loading\ time} x100\%$$

➢ *Fishbone Diagram*

Fishbone diagram is a method for analyzing the causes of a problem or condition. This diagram is also called the cause-effect diagram. The inventor was Professor Kaoru Ishikawa, a Japanese scientist who was also an alumni of the chemical engineering University of Tokyo, in 1943. So it is also called the Ishikhawa diagram.Fishbone diagram or cause and effect diagram can be used to:

- Identify the root causes of a problem
- Get ideas that can provide solutions for solving a problem
- Assist in search and further investigation of facts

III. RESULT AND CONCLUSION

From the OEE calculation on the Die Casting machine, researchers took a sample of 5 months for data collection from July 2018 to November 2018. For Overall Equipment Effectiveness the results of multiplication of the three elements are availability, performance rate, and quality rate. Before getting the OEE value, the calculation of these three elements is carried out every month, the calculation results can be seen in the picture below:

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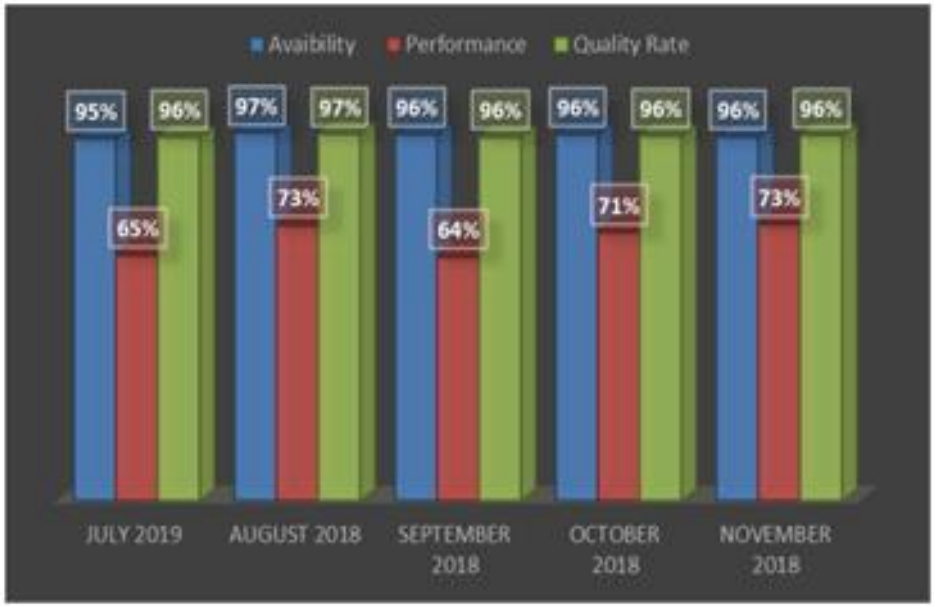

Fig 1:- Graph of OEE Element Comparation

From the fig, it can be seen that Performance has a relatively lower value with an average value of 69%, and the quality rate value has a higher relative value with an average value of 96%, and for the value of availability it has an average value of 96% . With this, it can be seen that the performance value has a smaller value than the two elements, which of course will affect the OEE value on die casting machines tend to not match the values set by the world class.

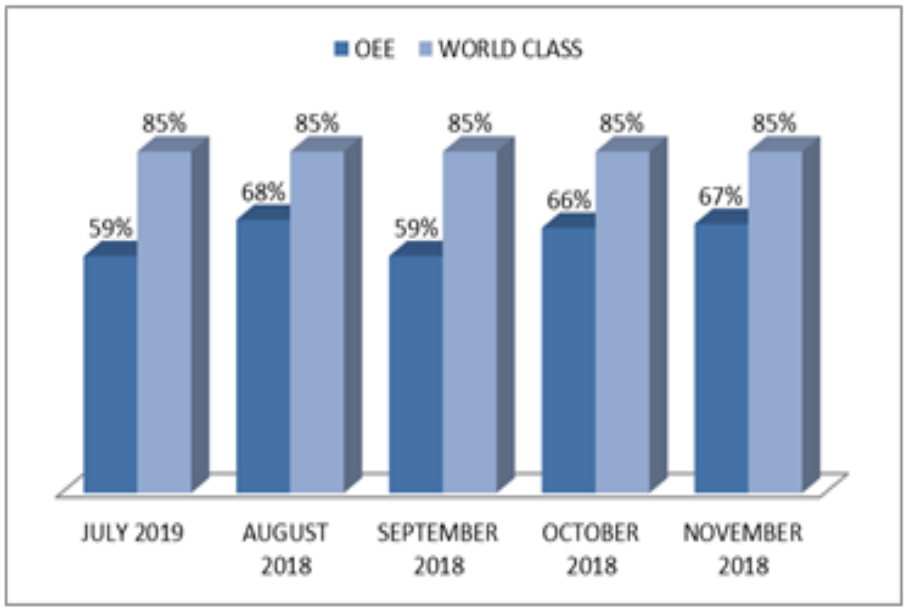

Fig 2:- OEE calculation Chart

From the graph above, it can be seen that the achievement of all OEE elements is still below the world class. However, the most striking value in the calculation is the value of performance that is still very far below the world class. Which results in an OEE average that is still far from world class standards. So that it can be concluded that the performance rate value that causes the overall equipment effectiveness value becomes nonstandard.

After the OEE calculation is done, then the next step is to calculate the proportion or percentage of each six big losess. Percentage of sig big losess can be seen in the picture below:

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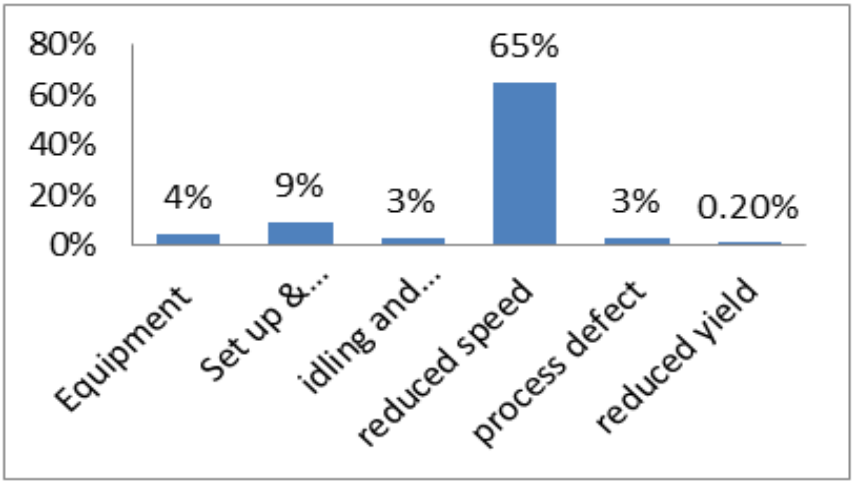

Fig 3:- Six Big Losess Calculation Chart

From the Pareto chart above, it is concluded that the loss due to Performance loss to the low OEE value. Therefore this analysis will focus on reducing speed by using a graph of causality (fishbone) to find out more clearly the root of the problem.

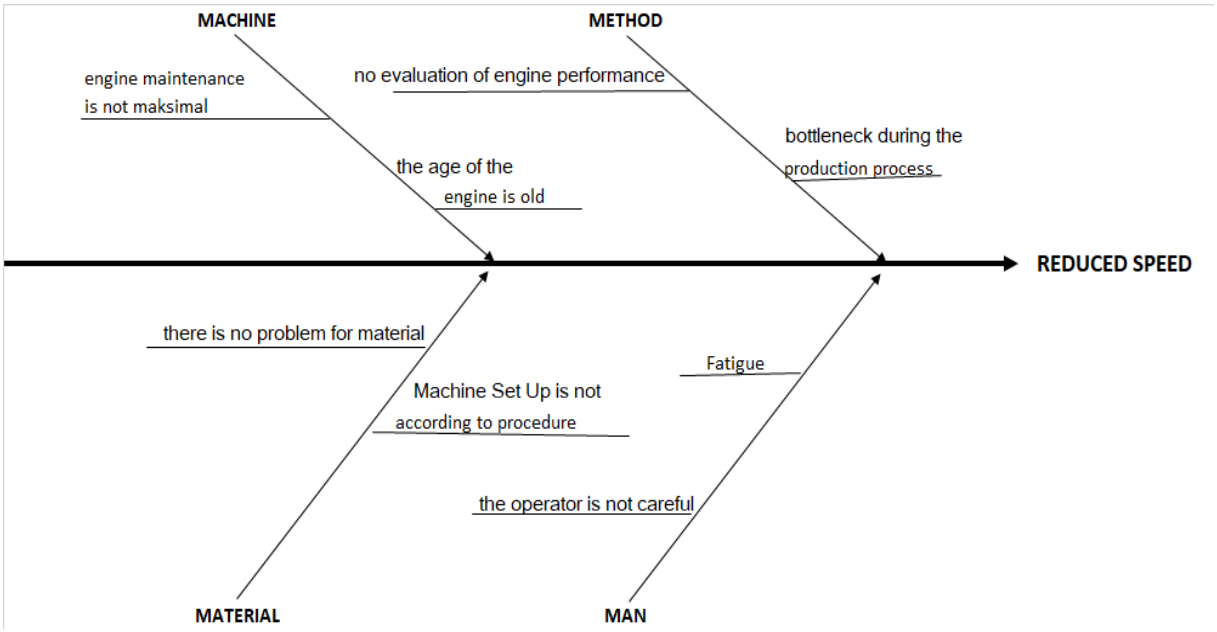

Fig 4:- FisboneDiagran Reduced Speed

In the Fig above shows that cause and effect of several factors that can affect the height of reduced speed. It can be seen from the fishbone diagram that dominates the cause, namely, the lack of training in the carway in machine operation and preventive maintenance has not been running continuously on the machine. Which causes the engine to damage the engine often so that the engine cannot process properly.

IV. CONCLUSION

Based on research conducted in July 2018 to November 2018, the company has not implemented Total Productive Maintenance in its production process activities, so researchers are interested in calculating OEE values and getting an OEE value of 64%, this value is still far from world class standards.

Based on the analysis using the Pareto diagram for the six big losses that affect the OEE value, is the performance loss, namely reduced speed losess with an average percentage value of 65%. From the results of the analysis it can be concluded that the main cause that affects the low OEE value is Reduced Speed Losess.In addition, researchers analyzed using fishbone diagrams to find out which factors were very influential by looking at several factors, namely from Machine, Method, Material, and Man. Of the four factors which have an effect on reduced speed losess, preventive maintenance is not performed optimally on the machine and the operator is less skilled in using the machine, so that the machine often has trouble and inhibits production activities.

SUGGESTIONS

After the researchers conducted data processing, analysis and concluded the whole study, the following researchers will give some suggestions that should be done so that the problems that occur are not repeated:

- It is expected that the company can carry out preventive continuously so that the engine can run optimaly.
- Make scheduling preventive maintenance processes for each machine. In order to minimize the occurrence of excessive breakdown
- Conduct training for employees so that employees can use and understand the procedures for using the machine properly and correctly, if the employee cannot use or operate the machine properly, this will cause damage to the machine and make the line stop production process so that the engine performance decreases.

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