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PRODUCTIVITY ANALYSIS IN THE MANUFACTURE OF DIE PLATE PRODUCTS USING THE OVERALL EQUIPMENT EFFECTIVENESS (OEE) METHOD AT PT. XYZ

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Abstract

The effectiveness possessed by manufacturing machines is a parameter used to determine the performance of a company's manufacturing process. Effectiveness can be shown in the form of percentages as effective as a manufacturing process is carried out. Effectiveness can be a reference for companies in the implementation of production by evaluating charts of production that are considered less effective and do not meet standards. The factors that affect the effectiveness of a production machine can be seen in the availability or capability, quality, and performance where in this article the overall equipment effectiveness (OEE) method which has a production period of one month is used to get the effectiveness of the production process carried out. The results obtained in this study were 88.53% in the first week of proposition, 94.63% in the second week of production, and 91.58% in the third and last week of production.

Keywords: Effectiveness; Quality; Performance, OEE

Abstrak

Efektifitas yang dimiliki oleh mesin-mesin manufaktur menjadi parameter yang digunakan untuk menentukan kinerja dari proses manufaktur suatu perusahaan. Efektivitas dapat ditunjukkan dalam bentuk persentase efektif suatu proses manufaktur yang dilakukan. Efektifitas dapat menjadi acuan oleh perusahaan dalam pelaksanaan produksi dengan mengevaluasi bagan-bagan dari produksi yang dianggap kurang efektif dan tidak memenuhi standar. Faktor yang mempengaruhi dari efektivitasnya suatu mesin produksi terlihat pada ketersediaan atau kemampuan, kualitas, dan performa yang dimana pada tulisan ini menggunakan metode overall equipment effectiveness (OEE) yang memiliki periode produksi selama satu bulan untuk mendapatkan keefektivitasan proses produksi yang dilakukan. Hasil yang didapatkan pada penelitian ini adalah 88,53% pada produksi minggu pertama, 94,63% produksi minggu kedua, dan 91,58% produksi minggu ketiga dan juga minggu terakhir.

Kata kunci: Efektifitas; Kualitas ; Performa, OEE

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1.0 INTRODUCTION

Manufacturing is a process that converts raw *materials* or parts into a product using tools, human labor, machinery, and chemical processes on a large production scale. Manufacturing production provides added value to raw materials which are then sold to consumers through the distribution network. [1] Manufacturing also does not always include raw materials into finished goods, sometimes manufacturing also processes into semi-finished goods and/or semi-finished goods into finished goods. A company can carry out an efficient manufacturing so that it can make a variety of goods with many units at a low cost. [2]

There are various types of manufacturing itself. Based on the Technique, Manufacturing can be divided into 3 namely:

1. *Make to Stock*
   This type of manufacturing produces finished goods based on estimated demand. A manufacturing company will estimate how many units of finished goods will be sold in a certain period of time, then it is planned in advance to manufacture the finished goods so that they become inventory or *stock* goods and distributed. [2]
2. *Make to Order*
   This type of manufacturing is the opposite of *Make to Stock* where this manufacturing is done directly with customers to find out their wants and needs for the manufactured product. The manufacturing process usually begins after the contract has been signed. In addition, manufacturing companies will also make prototypes based on the specifications provided by customers until they meet the required or desired specifications. [2]
3. *Make to Assemble*
   This type of manufacturing is a type of manufacturing that involves the manufacturing process of product components and when an order is placed from a customer for the product, the assembly process is carried out on the components that were previously manufactured. This type of manufacturing relies on market estimates of the products owned by the company. The process of shipping products can be faster, however, there is also a risk if the market does not match the predictions. [2]

Computer Numerical Control (CNC) is one of the core components in a precision manufacturing process [4-7]. The CNC machining process begins with designing objects using *Computer Aided Design* (CAD)-based software, then is passed into the manufacturing process using *Computer Aided Manufacturing* (CAM)-based software, which is an application technology that uses computer and machine software to facilitate and automate the manufacturing process. *Computer Aided Manufacturing* (CAM) is often used in conjunction with *Computer-Aided Design* (CAD). Software in the form of joint integration between CAD and CAM is referred to as CAD/CAM software as an example of Mastercam. In addition to material requirements, *modern Computer Aided Manufacturing (*CAM) systems include real-time control and robotics. Simulation of the cutting/forming process of the workpiece in CAD/CAM software can be simulated.[3]

Figure 1. CNC Machine

The specifications of Computer *Numerical Control* (CNC):

1. Manufactured: YCM
2. Model: MV66A
3. Min - Max Height Under Spindle: 680 - 120 mm
4. Machine Weight: 5,000kg
5. Traverses XYZ: 660 x 510 x 560 mm
6. Spindle Speed: 8,000 rpm
7. Spindle Motor Power:11kW (15kw)
8. Rapid Feed rates: 30m Min
9. Additional Equipment: High Pressure Coolant System
10. Taper: BT40
11. Table Size: 840 x 560 mm

2.0 METHODOLOGY

Overall Equipment Effectiveness (OEE) can be expressed as a ratio or percentage of field results and divided by the maximum results under the best conditions [8]. This effectiveness is used as a benchmark for the performance of a manufacturing process that occurs in the company. This OEE method aims to reduce or eliminate a term called *six big losses* which is the main cause of the decrease in efficiency owned by a manufacturing process [8-10]. Of the six causes of losses, they are recategorized into 3 main causes, which are as follows:

1. *Downtime Losses*
   This type of loss is found when the resulting production is nil and the manufacturing system does not produce anything, the time that is not used for production. Basically, these *downtime* losses are divided into two, namely:
   a) *Breakdown loss* or loss of damage caused by failures that occur in machine parts so that it is necessary to stop the production process for repair or replacement of parts with new parts.

b) These losses are measured by calculating the time spent fixing the problem that occurred.
c) *Setup and Adjustment time* or preparation and adjustment time, these time losses are caused by changes in the operating conditions of the machine, such as at the beginning of production or the change of work shifts or changes in the product to be manufactured.

2. *Speed Losses*
These types of losses are losses that are generally caused by a reduction in the speed of production when compared to the theoretical speed of production or the initial speed of production. These types of losses are generally caused by machines that are stopped, stuck, and idle. Many companies consider this to be the most costly losses than others

3. *Defect or Quality Losses*
This type of loss is a loss that is generally caused by a reduction in production quality in the form of defective goods and goods that do not meet standards (*reject*). These losses cause a decrease in production capacity as a result of a decrease in production output that reduces what should be produced (1).

This method consists of three aspects, namely availability, performance, and quality with the following calculation formula:

$$OEE = availability \times performance \times quality \quad (1)$$

Further explanation of the three aspects is as follows:

1. *Availability*
Availability is the ability of a machine or plant to operate according to a certain schedule or the availability of a plant to operate, which is the ratio between *the actual operation time* and the loading *time*. The formula that is generally used is as follows:

$$availability = \frac{loadingtime - downtime}{loadingtime} \times 100\% \quad (2)$$

Operation time is the time of the machine in a ready-to-use state obtained by reducing *loading time* with unexpected *down time*. *Loading time* is the reduction of available time with *planned machine* downtime

2. *Performance*
Performance is the ratio of the actual operating speed of the equipment to the ideal speed based on the design capacity. In *performance efficiency*, there are three factors that need to be known, namely *ideal cycle time*, *processed amount*, and *operating time*. The formula for commonly used performance is as follows:

$$performance = \frac{theoreticalcycletime \times processedamount}{operatingtime} \times 100\% \quad (3)$$

3. *Quality*
Product quality is a ratio that shows the ability of equipment to produce products that are in accordance with specified quality standards. The ratio used is between the amount of production (*actual product*) minus the defective or *rejected* production results so as to get *the value of the good product*. The determination formula that is generally used is as follows:

$$Quality = \frac{goodproduct}{actualproduct} \times 100\% \quad (4)$$

3.0 RESULTS AND DISCUSSION

The production process is carried out by direct observation and also analysis of production data obtained during one month of the production period. The analysis was carried out on the results of direct observation and production data using *the overall equipment effectiveness* method. This analysis is divided into 4 stages, namely:

1. *Availability*
At this stage, the observation and recording of data in the machine's ability to carry out the production obtained. The data required for these stages are the time available for machine use, planned *downtime*, and unplanned *downtime*. The results of the data and analysis obtained can be seen in the table below:

Table 1. Availabilty of Production Processing

Period of Production (Week)	Unexpected of Downtime (hours)	Loading Time (hours)	Operating of Time (hours)	Availability (%)
1	1	47.5	46.5	97.89
2	0.25	47.5	47.25	99.47
3	0.5	47.5	47	98.95
4	1	47.5	46.5	97.89
Average				98.55

The availability *value* is obtained using Formula 2 Based on Table 1, it shows that the lowest *availability* value is located in the production period of weeks 1 and 4, which is 97.89% and *the most effective availability is located in the week 2 period with* an availability value of 99.47%. The average of each period is 98.55%.

2. *Quality*
In this stage, the CNC production result, namely *die plate*, is observed the number of products that have *defects* and are rejected as acceptable production results. The data needed in this stage is *total product produced* and *defective product produced*. The results of the data and analysis of the *quality* stages can be seen in the Table 2.
The quality value was obtained by calculating using formula 4 It can be seen in Table 2, there was a decrease in quality in the production period of week 1. The cause of this decline is due to failures in product manufacturing that reach twice such as

improper settings and errors in *design*. The average quality score obtained for one month was 96.77%.

Table 2. Quality of Production Processing

Quality Rate				
Period of Production (Week)	Quantity of Product (Pcs)	Defect of Product (Pcs)	Percentages	Quality (%)
1	31	2	6.45	93.5
2	31	0	0.00	100
3	31	1	3.23	96.77
4	31	1	3.23	96.77
Average				96.77

3. *Performance*

At this stage, the performance of the production process is analyzed. The data needed for this stage is in the form of *ideal cycle time*, production quantity, and *operating time*. The results of data acquisition and analysis can be seen in the following Table 3.

Table 3. Performance of Production Processing

Performance				
Period of Production (Week)	Quantity of Product (Pcs)	Cycle Time Ideal (Hours/Pcs)	Operating of Time (hours)	Performance (%)
1	31	1.45	46.5	96.67
2	31	1.45	47.25	95.13
3	31	1.45	47	95.64
4	31	1.45	46.5	96.67
Average				96.03

In the production process, *the ideal cycle time* is made standard by PT. XYZ is 1.25 pcs/hour so to get the performance value, calculations can be carried out using the Formula 4 as shown in Table 3, production experienced the lowest performance in weeks 1 and 4. The thing that affects the decrease in performance is seen in the lower operation time compared to others, it is caused by unplanned *downtime* due to errors during operation and damage to one part of the equipment. The average performance of each period is 96.03%.

4. *Overall Equipment Effectiveness*

The results of the analysis of the overall equipment effectiveness in the production process at PT. XYZ are presented in the following Table 4.

Table 4. Overall Equipment Effectiveness (OEE)

Period of Production (Week)	Overall Equipment Effectiveness (OEE)
1	88.53
2	94.63
3	91.58
4	91.58
Average	91.58

As seen in Table 4, the OEE value obtained for the production process at PT. XYZ is at an average value of 91.58%. The lowest OEE value was located in week 1 with a yield of 88.53%. The most optimal performance in the production process was in week 2 with a figure of 94.63%. With the results in table 4 that this production process has a fairly good efficiency, it is marked by the value obtained is a normal value in terms of production. However, there is still a need for improvement efforts and performance improvement by reducing *downtime* and *speed losses*.

4.0 CONCLUSION

The conclusions obtained OEE on PT. XYZ are:

1. The effectiveness of the equipment as a whole for 1 period of one month in the production process carried out at PT. XYZ has a fluctuating value. The average of the OEE score obtained was 91.58%. In week 1, an effectiveness of 88.53% was obtained, an effectiveness value of 94.63% was obtained in week 2, an effectiveness of 91.58% was obtained in week 3, and an effectiveness of 91.58% was obtained in week 4. Each effectiveness in the period shows that the production process is effective in carrying out the production process. However, the production process can be improved. This increase will affect the production process significantly and will improve the quality of the products made.
2. In the production process there are several things that affect the level to effectiveness such as things where these factors such as the lack of precision of the operator in preparing the machining process, lack of precision in designing, machines that start or are used continuously which allow overhit to occur and there are also unexpected obstacles such as damage to the machining parts. The less effective part in carrying out production lies in the quality or goods that are defective. The average quality of each week in the production process is 96.77%. This factor is a part that needs to be considered because of the lack of precision in operating the machine and there are unexpected damages that cause the operational time to stop when operating but it is good enough for the machining process.

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