

# Increasing Production Capacity of Oil Country Tubular Goods Pipe Using Oee Methods

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## ABSTRACT

The effectiveness of production equipment is very important to pay attention to maintain competition, coupling pipe threading process there has been an imbalance in the threading process time resulting in decreased output due to the number of rejected products which is decreasing in production capacity. To overcome the problem, the data was processed using mixed methods with a sequential explanatory approach, and the overall equipment effectiveness measurement method to analyze the calculation of availability, performance, and quality rate. To determine the root cause of the problem using fishbone diagram analysis and six big losses. The results of the study stated that the overall equipment effectiveness was below the world-class standard, which was below 85% with a difference of 49.74% being the factor causing the failure to achieve the coupling pipe production capacity. The low overall equipment effectiveness is influenced by the engine performance which is a total average of 42.61%, due to failed products and reworked products and the breakdown time for 460 minutes impacting in losses on the engine productivity. This findings pursue the company to monitor, and implement the overall machine effectiveness system to optimize the capacity production.

**Keywords:** Capacity, Fishbone Diagram, OEE, Production.

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## I. INTRODUCTION

The competition demands of an oil country tubular goods pipe is very high, so that the machine effectiveness is important consideration in a production process (Nusraningrum & Arifin, 2018; Ridwansyah *et al.*, 2019). The machine must be produced on time, and meet the quality. It means that the equipment becomes the main and very important in this process (Kristono, 2018). At the production stage of the coupling pipe threading process, there are problems when the threading process is less than the maximum, the number of rejects caused by factors causing a decrease in quality which results in a decrease in production, as evidenced by the following data.

The Production Output Report 2021 shows the failure to achieve production targets due to products that fail to produce. The problem is suspected that the machine did not operate optimally and experienced an imbalance in the production process so that there was a buildup of pipes which resulted in the production capacity target not being achieved, Nusraningrum and Senjaya (2019) mention that the problem arises from the presence of inappropriate capacity settings, maintenance schedules the machine is not optimal, the competence and lack of knowledge of machine operators, technical problems in the machine itself and the

unavailability of spare parts. The problems are caused by the engine experiencing a speed change that is not following the engine's ability due to the engine experiencing heat and falling to operate (Febriyanti & Fatma, 2018; Nurdin *et al.*, 2018).

To find out the root cause of the problem by measuring

the level of effectiveness and efficiency of machines and equipment using Overall Equipment Effectiveness (OEE) to reduce machine problems and optimize productivity so that production capacity can be achieved (Syahputra *et al.*, 2020) stated the importance of implementing OEE for the manufacturing industry to see the effectiveness of production machines. The OEE can identify the causes and losses caused and determine how to improve so that engine performance can increase and help to increase productivity, research result (Corrales *et al.*, 2020; Nusraningrum & Daman, 2020; Nusraningrum & Setyaningrum, 2019; Ridwansyah *et al.*, 2019; Nusraningrum & Senjaya, 2018; Nusraningrum & Arifin, 2018).

The purpose of this study is to increase the capacity of the coupling pipe with the OEE measurement method and analyze the factors causing the decrease in capacity, and the loss factors caused and provide suggestions for improvement.

## II. LITERATURE REVIEW

### A. Capacity

Capacity is a measure of the productive capacity of a facility per unit of time usually expressed in terms of the volume of output per certain period (Sumayang, 2003). Capacity planning requires two stages; the first stage is future demand, forecasted by traditional methods such as statistical concepts, and the second stage of forecasting is to determine the capacity and increase in size for each additional capacity. The capacity is an output level in a

certain period and is the highest possible output quantity during that period and capacity can be adjusted to fluctuating sales levels and poured into the production schedule and if the lack of capacity causes failure to meet targets (Nusraningrum & Arifin, 2018; Nusraningrum & Senjaya, 2019; Ridwansyah *et al.*, 2019; Setiabudi *et al.*, 2018). Capacity is the level of an enterprise's ability to produce a good or service supported by the availability of facilities in the form of labor and equipment, and is usually expressed in the amount of output that can be produced for the period a certain time (Rani, 2019; Adhiputra, 2021; Nasution *et al.*, 2018)

### B. Overall Equipment Effectiveness (OEE)

The Overall Equipment Effectiveness is the total measurement of performance related to the availability of the productivity and quality process (Nusraningrum & Arifin, 2018; Nusraningrum & Senjaya, 2019; Ridwansyah *et al.*, 2019; Firmansyah, 2016). Some argue that OEE is a strong measurement for repair performance by eliminating six major losses to equipment (Farahani *et al.*, 2020), and show how capable equipment or machines are in producing quality products compared to what they should be (Hudori, 2018). Ekawati and Husni (2018) argue that OEE is a calculation method to determine the effectiveness of a process that is being implemented, and identifies a truly productive production time presentation. As a well-known measurement method, OEE can fully reflect the equipment conditions on the production site, and it is widely used in the manufacturing industry to analyze equipment efficiency (Fei *et al.*, 2018), Nisbantorito *et al.*, (2018) saying OEE is a key measurement in indicating how many products the equipment is turning out, how much of the time equipment is actually working, and what percentage of the output is the good product, and Ravjibhai (2017) saying OEE highlights the actual *Hidden Capacity* in an organization, it measures both efficiency and effectiveness with the equipment.

### C. Six Big Losses

Six Big Losses is part of Overall Equipment Effectiveness to find out the losses caused by the production machine (Napitupulu *et al.*, 2020; Nusraningrum & Arifin, 2018; Nusraningrum & Senjaya, 2019; Ridwansyah *et al.*, 2019). Six big losses consist of three main parameters that affect the Overall Equipment Effectiveness value to determine the factors that cause the Overall Equipment Effectiveness value to be below standard namely downtime losses, speed losses, and defects losses (Dewanti & Putra, 2019; Pramesti, 2018; Rahayu *et al.*, 2020). Saharani and Sukanta (2020) argue that the purpose of the six major losses is to find out the value of the Overall Equipment Effectiveness which is not optimal and also this calculation is to determine the biggest factor that causes the machine not to work optimally, Kustiawan (2019) saying with the six big losses can be analyzing the main root cause of the existing problems. Six big losses need to be applied for the treatment machine so that the machine avoids improper maintenance targets that will cause losses for the company (Vernando & Mulyadi, 2020; Prabowo *et al.*, 2018), and according to Wiyatno *et al.* (2019) with the indication of six big losses this is a long-term systematic program planning with the aim of minimizing losses can be implemented so that it will

directly affect the important elements of the company, such as productivity increase due to reduced loss, quality too increased impact of reduced equipment breakdown so the cost also decreases due to decreasing numbers product damage.

### D. Fishbone Diagram

The cause-and-effect is often referred to as a *Fishbone Diagram* because it looks like a fish skeleton, or an Ishikawa Diagram (Hispratin & Musfiroh, 2020). A fishbone diagram is used to show the causal factors and quality characteristics effect to identify and categorize the causes of the problem which are also a conversion of lines and symbols designed to represent the relationship between effects and causes (Nusraningrum & Arifin, 2018; Nusraningrum & Senjaya, 2019; Ridwansyah *et al.*, 2019). Fishbone diagram to find the root of the problem and analysis then make the right decisions and find solutions to problems (Rifaldi, 2020; Ekawati & Husni, 2018; Suparno & Bahroni, 2019) and Beatrix *et al.* (2020) say the fishbone diagram is one of the seven tools in a quality control system. Therefore, it can analyze the root causes of the six big losses.

## III. METHODS

This study uses a mixed method with a sequential explanatory approach to describe the object or samples (Sugiyono, 2014). The sampling method is purposive sampling, namely the data on the coupling pipe output report for the period January-April 2022. The data analysis is use Overall Equipment Effectiveness (OEE), the six big losses, and to determine the causal factors using a fishbone diagram.

## IV. RESULTS AND DISCUSSION

Based on the breakdown time recapitulation data above, it can be seen that the machine that has the highest breakdown value among the other main machine is the CNC machine and shows that the CNC machine is the machine that has the highest frequency of wasted time among other machines in the coupling pipe manufacturing process.

The Availability rate of CNC Machine for the January-April 2022 period above is generated the average of the Availability Rate is 87,27% where Availability Rate value in each period as in January is 89,89%, the Availability Rate value in Februari 2022 is 92,58% and the Availability Rate value in March 2022 is equal to 90,79% is the ideal value because it is still above the standard set by company, which is 80%, but there is still a low Availability rate value, which is 75,57% in April 2022. The influencing factor is the operating time with a total of 7595 minutes. Breakdown time of 2035 minutes with a total of 2455 minutes of downtime is wasted time without producing a product.

The ideal world-class standard for analysis in this study is 80%-90% (Rimawan & Raif, 2016; Herwindo *et al.*, 2016). The Availability rate meet global standards, namely 84,35%, but the lowest availability rate was 77,30% in February. It means that company is still able to improve the capacity (Indrawanti & Bernik, 2020) where the higher the availability rate value, the better the capacity.

TABLE I: MACHINE BREAKDOWN

Machine Working Time (Minutes)	480	480	480	480
Total of Machines	1	1	1	1
Period	CNC	MPI	Forklift	Phosphating
Januari	768	150	4	45
February	460	0	0	60
March	750	0	0	28
April	2035	0	60	137
Total (Minutes)	4013	150	64	270
Accumulation (%)	0,1	3.2	7,5	0,6

Source : Data Processing, 2022.

TABLE II: PRODUCTION TIME

Period	CNC	MPI	Forklift	Phosphating
Januari	9600	9450	9596	9555
February	9120	9120	9120	9060
March	10560	10560	10560	10532
April	10080	10080	10020	9943
Total (Minutes)	39360	39210	39296	39090

Source : Data Processing, 2022.

TABLE III: CNC MACHINE

Period	Production Time (Minutes)	Set Up & Adj. (Minutes)	Planned Downtime (minutes)	Output (MTon)	Reject & Rework (MTon)
Januari	9600	200	30	552	32
February	9120	190	30	1026	24
March	10560	220	30	2699	105
April	10080	420	30	1623	39

Source : Data Processing, 2022.

TABLE IV: AVAILABILITY RATE OF CNC MACHINE

Period	Operation Time (Minutes)	Loading Time (Minutes)	Availability Rate (%)
January	8602	9570	89,80
February	8440	9090	92,85
Maret	9560	10530	90,79
April	7595	10050	75,57
Average (%)			87,27

Source : Data Processing, 2022.

TABLE V: PERFORMANCE RATE OF CNC MACHINE

Period	Output (Mton)	Ideal Cycle Time (Minutes)	Operation Time (Minutes)	Performance Rate (%)
January	552	2,5	8602	16,04
February	1026	2,5	8440	30,39
Maret	2699	2,5	9560	70,58
April	1623	2,5	7595	53,61
Average (%)				42,61

Source : Data Processing, 2022.

Table V shows an Overall average of 42,61%, this value is still very far from the ideal value of the company's standard of 97%, and the value of the performance rate is influenced by the output value produced in January 2022 still low, namely as much as 552 metric tons with an Ideal Cycle Time of 2,5 minutes is the the target time that the company has set and if from the calculation of the operation time it is 8602 minutes it is a long time.

The value is below the world-class standard value (Rimawan & Raif, 2016), and there is an imbalance of output produced with operating time, and ideal cycle time (Febriyanti & Fatma, 2018) which the low production yield compared to the time available.

TABLE VI: QUALITY RATE OF CNC MACHINE

Period	Output (Mton)	Reject & Rework (MTons)	Quality Rate (%)
January	552	32	94,20
February	1026	24	97,66
Maret	2699	105	96,10
April	1623	39	97,59
Average (%)			96,39

Source : Data Processing, 2022.

TABLE VII: OEE RATE OF CNC MACHINE

Period	Availability (%)	Performance (%)	Quality Rate (%)	OEE Rate (%)
January	89,89	16,04	94,20	13,58
February	92,85	30,39	97,66	26,67
Maret	90,79	70,58	96,10	61,38
April	75,57	53,42	97,59	39,39
Average (%)	87,27	42,61	96,39	35,26

Source : Data Processing, 2022.

Table VI Calculation of the Quality Rate of CNC Machines, the total average value of the Quality Rate as a whole is 96,39% where this value is greater than the company standard set which is 92,00%, but there is still a Quality Rate produced is low, namely, in January 2022, which is 94,20% when compared of the calculation result in February 2022, March 2022 and April 2022 were affected by low output of 552 metric tons with a total of 32 metric tons of rework and reject caused by a machine breakdown in January 2022 of 768 minutes (Hudori, 2018). Where the occurrence of product failures and damage problems when the machine is operated.

If measured by world-class standard values in this study, namely 80%-90% (Rimawan & Raif, 2016), so the average quality rate of CNC machines is the period January 2022-April 2022 are meet the standard.

The total average OEE value of CNC machines is 35,26% due to the low OEE value produced in January 2022, which is 13,58% influenced by the calculations results. Performance rate namely the output value produced in January 2022 is still low at 552 metric tons with an Ideal Cycle time of 2,5 minutes and the resulting calculation of operation time is 8602 minutes which is a long time and the breakdown of CNC machines in January 2022 is 768 minutes.

The OEE value does not meet world-class (Rimawan & Raif, 2016), the OEE obtained is 35,26% which is still less than 40% (Nakajima, 1988), machine production is considered to have a low score, but the company can easily make continuous improvements through direct measurement for example by tracing the root causes of downtime and addressing the sources (Suliantoro *et al.*, 2017). There is still the possibility to increase the value of the performance rate by analyzing and improving the idling and minor stoppages losses dan reduced speed losses on the engine (Nusraningrum & Arifin, 2018; Dermawan & Suhardi, 2017).

TABLE VIII: SIX BIG LOSSES

Period	Breakdown Losses (%)	Set Up & Adj. Losses (%)	Idling & Minor Stoppages Losses (%)	Reduced Speed Losses (%)	Rework Losses (%)	Reject Losses (%)
Januari	8,03	2,09	10,11	14,42	0,44	0,39
February	5,06	2,09	7,15	28,22	0,52	0,14
March	7,12	2,09	9,21	64,08	2,49	0,00
April	20,25	4,18	24,43	40,37	0,97	0,00
Average (%)	10,11	2,61	12,73	36,77	1,11	0,13

Source : Data Processing, 2022.

A. Reduce Speed Losses

Reduce speed losses the highest and dominant 36,77% is the available time (Loading Time) which turns out to be wasted and id also a loss that effects the low-performance value every month. This loss will hamper the production cycle time because the machine moves very slowly from a predetermined time, where this loss is caused because the machine or equipment has decreased in speed (Nusraningrum & Arifin, 2018; Herwindo *et al.*, 2016; Suliantoro *et al.*, 2017). The factors that cause reduced speed losses are operators who do not understand how to set machines, dirty machines that are rarely cleaned, and the age factor of machines with poorly maintained conditions.

B. Idling & Minor Stoppages Losses

Losses with the total average generated is 12,73% with the highest percentage value in April 2022, which is 24,43% this loss can be by a momentary engine stop, congestion, and idle time of the engine (Nusraningrum & Arifin, 2018; Suliantoro *et al.*, 2017). The factor of idling time and minor stoppages is the operator not capable of the machine settings and the vibrations from the machine itself.

C. Breakdown Losses

Losses amounted to 10,11%, with the highest percentage value in April 2022 this loss is a loss caused by a failure of the machine not operating and needs to be repaired or replaced, no output to make delivery times delayed or not according to a predetermined schedule (Nusraningrum & Arifin, 2018; Suliantoro *et al.*, 2017).

D. Setup & Adjustments Losses

With a total average of 2,61% and the highest percentage value in April 2022, namely, 4,18% loss of setup and installation of setup time including adjustment time caused the production time target tp not be achieved and the operator did not skill how to set the machine, and the procedure is long or complicated (Nusraningrum & Arifin, 2018; Suliantoro *et al.*, 2017).

E. Rework Losses

Losses which is 1.11% with the highest percentage value in March 2022, which is 2.49% this loss is a loss caused by a defective product, but the product can still be reworked, this loss can cause the company to suffer losses because they have to repeat the production process from the beginning which will suffer a loss from the production cost of 5%. This loss is caused by the machine having a breakdown or the pipe material is not good, usually when the operator's inspection is not focused or negligent.

F. Reject Losses

Losses with an average value of 0.13% with the highest percentage value occurring in January 2022, namely 0.39%, losses caused by unused materials or raw material waste, causing the output to be not on target and lots of places to store materials or waste from rejected products. This loss is due to the machine factor suddenly not operating.

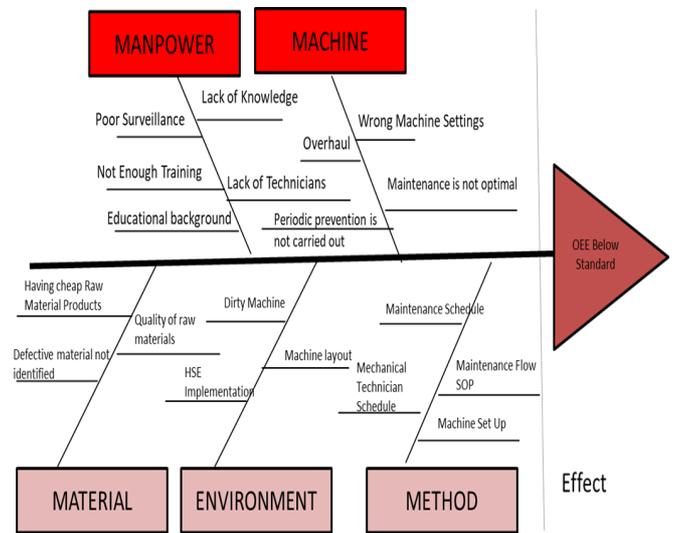


Fig. 1. Cause and Effect Analysis (Fishbone Diagram).

The root findings of the identified problems that caused the unachievable OEE and the decrease of pipe capacity performance are there is no preventive maintenance. This problem should be underlined by the stakeholder, in order to fulfill the company target and continuous improvement.

The causal analysis describes:

- 1) Machine. Installation should be carried out effectively and efficiently and requires resetting and which is then tested with measuring or calibration instruments according to company standards, the length of time in setting the machine is also identified the cause. Each machine has an age value for each unit, the older the machine, the performance level the machine will decrease. The machine need to rejuvenate since the machine has been performed for 10 years.
- 2) Environment. The existence of pieces of a product resulting from the initial setup process of the machine and pieces of a product resulting from the adjustment process of the machine is caused by the insert setting not being appropriate.
- 3) Human / Employee. Factors that cause insert settings are not appropriate are because the operator does not have the knowledge of the form, part, and function of

the insert, and the operator does not have the skill how to set the insert.

- 4) Method. Preventive maintenance does not exist, and when maintenance occurred another problems arised, namely damaged spare parts, and the length of time in delivery.
- 5) Material. Lack of inspection of raw materials and not being identified causes defects and makes the engine stop / idle. Raw materials of spare parts are of less quality can also affect the machine breakdown. From the observations made in purchasing spare parts, choosing cheap products, and waiting for pivoting spare parts.

The ineffectiveness of machines whose use exceeds the economic life, causes various kinds of damage (Fajrah & Noviard, 2018). This condition also triggers a high level of machine downtime which worsens the condition of the machine (Dermawan & Suhardi, 2017), due to sticky material, usually due to rain which causes a decrease in temperature. Then engine failure include the shape of the mold construction being not good, so the mold gets hot and dirty easily, there are errors when setting up the machine, making the machine clogged and sudden disturbances in the machine or equipment (Haradito *et al.*, 2019; Febriyanti & Fatma, 2018) and reinforced by the results of research from Hamda (2018), machines that often experience breakdowns are not changed regularly, there are residual raw materials attached to the machine, machine maintenance is not carried out regularly, the engine is overheating. The low OEE is caused by machine breakdown that is not carried out corrective and preventive maintenance effectively and the unavailability of spare parts (Daman & Nusraningrum, 2020; Nusraningrum & Setyaningrum, 2019; Ridwasyah *et al.*, 2019; Nusraningrum & Senjaya, 2018; Nusraningrum & Arifin, 2018).

## V. CONCLUSION

The study found that the OEE of CNC machines is below standard, and the full capacity of the machine is not achieved. The factors in decreasing's machine capacity are the technicians, where there is no strict supervision and lack of skill from operators in setting up machines, the age of machines is more than ten years old, and there is no preventive maintenance system. These can be analyzed from the losses due to the machine stopping production and unloading time. However, the managerial implications of increasing the capacity of the Oil Country Tubular Goods pipe can be done by strictly supervision, recurrent training, developing a total productive maintenance system, and rejuvenation of machinery and equipment by reinvesting.

For future research in the same field, it is necessary to implement and further observe the recommended actions and conduct analysis by simulating the level of loss based on unit costs.

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