

## Conference Paper

# Analysis of Overall Equipment Effectiveness (OEE) on Engine Power Plant Performance

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## Abstract

This research aimed to evaluate the cause of the low-value performance of the electrical energy production engine of GT21 and GT22 units and determine the way to repair so that the engine performance can be improved. This research uses descriptive quantitative approach with value analysis methods Overall Equipment Effectiveness (OEE). The result of OEE values were analyzed using six big losses method so that the occurrence of loss factors can be found and root cause analysis performance using a causal diagram/fishbone diagram and then make any improvement recommendations that can be done by using 5W1H analysis. Based on the research results, performance OEE machine GT21 units of electrical energy production get low value caused by idling and minor stoppage amounting to 99.91% and downtime losses of 0.09%, while the GT22 units due to the setup and adjustment of 16.99% and idling and minor stoppage amounted to 82.98%. The root causes of the losses derived from the operation pattern, the competence of employees, the availability of spare parts, inspection and implementation of the standard job performance test regularly. While remedial steps can be taken by installing some additional equipment and improved methods on the production machine.

**Keywords:** Overall Equipment Effectiveness (OEE), six big losses, fishbone diagram, 5W1H analysis

## 1. Introduction

The development of technology and the need for energy is getting bigger in the world, cheap energy is a leading choice for use. One form of cheap energy is in the form of electrical energy, namely the energy change of primary energy (coal, oil, water and gas) into electrical energy. Places that serve as the industry field is hydroelectric. PT. Pembangkitan Jawa Bali manages six power plants in Java, with a total capacity of 6,511 MW. One of the six power plants are generating unit Muara Tawar, operating power plants with a total capacity of 2,024 MW. This plant is a type of steam power Plant that converts the energy of the primary form of natural gas or oil (High Speed

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Diesel/HSD) into electrical energy. The machine is divided into five blocks namely: (a). Block-1: The machines combine cycle power plant gas turbines, with the type Alstom 13E2 (unit GT11, GT12 and GT13). (b). Block-2: The machines combine cycle power plant gas turbines, with the type Alstom 13E2 (Unit GT21 and GT22). (c). Block-3&4 : The open-cycle gas engine power generation turbine with a Siemens machine manufacturing GT31, GT32, GT33, GT41, GT42 and GT43). (d). Block-5: The machines combine cycle power plant gas turbines, with the type Alstom 13E2 -MXL (GT51)

The study was done by comparing the performance of the engine between the engine power plant on the block-1 operate in combine cycle power plants with the engine on the block-2 operating in open cycle. The result of the comparison of the performance of the power plant's engine, engine performance will be determined where the achievement of his performance the OEE is still low. Researchers using secondary data within the company obtained during one year i.e., data for the year 2015 and will conduct a search of the factors cause by using the methods of the six big losses of engine power. Diagram analysis method using cause and effect/Fishbone diagrams and 5W1H, this research will determine the alternative solutions of improvement that can be done so that the performance of the company's engine plant that is changing for the better as well as on the other machine.

## 2. Literature Review

### 2.1. Total productive maintenance (TPM)

Dogra (2011) stated the TPM is designed to maximize Overall Equipment Effectiveness (OEE), by involving the entire Department of planning, use, and care for the equipment, as well as involving all employees ranging from top management to the operator field. Eswaramurthi (2013) the aim of the OEE, namely identifying losses, the OEE is basically from bottom to top approach by involving all employees in order to achieve the target of OEE by eliminating six losses. Almeanazel (2010) said TPM is maximizing the effectiveness of equipment aimed at work. Almeanazel (2010) the TPM is a program for the development of fundamentals of function maintenance in an organization, involving the whole HR. TPM has three major targets as follows: Zero product defects, Zero equipment unplanned, and Zero accident.

## 2.2. OEE (Overall equipment effectiveness)

Vorne Industries Inc. (2008) described OEE is the best way to monitor and improve the effectiveness of the manufacturing process, such as: machine, cell manufacturing, assembly line. Nayak (2013) OEE are the result of calculation of factors that contribute to from a product i.e. availability, performance and quality. OEE can be used by management as a tool to measure and evaluate the productivity of the machine. Vorne Industries Inc. (2008) value or score the OEE is calculated taking into account three factors: (a). Availability, (b). Performance, (c). Quality

## 2.3. Six big losses

Wijoseno (2015) OEE measures whether the production equipment can work with high performance or low. The six big losses cause production equipment does not operate with the normal IE: (a). Breakdown, (b). Set up and adjustment, (c). Small stops, (d).Reduced speed, (e). Start-up rejects, (f). Production rejects.

## 2.4. Fishbone diagram (Ishikawa diagram)

Syukron and Kholil (2013) Ishikawa diagram or also called Fishbone diagrams, herring bone diagrams, cause and effect diagrams, is a causal diagram that shows the causes of an event or certain events. Heizer and Render (2008) stated a causal diagram is one of the tools that can help identify possible locations of quality problems and examination, also called Ishikawa diagram, or Fishbone diagram.

## 2.5. 5W1H

In the manufacturing company, the production and quality control is called 5W1H (Five Ws One H). Thi Tuyet Tran (2013) this method is used in a variety of professions and situations, not only to understand and explain almost every problem or problems but also to organize the writing of the report. 5W1H analysis method is essentially a method that is used to initiate an investigation and research on problems that occur in the production process. Concepts or methods of analysis 5W1H is certainly not only can be used in the production process but also more widely used to develop the information. 5W1H stands for 5W i.e. What, Where, When, Why, Who and the 1 H, that is, How. 5W1H method can be used as a tool to make the proposed improvement of the problems

derived from the method of Fishbone diagram to reduce defective products. (Purba, 2014)

### 3. Methods

This research is quantitative and qualitative research by doing calculations or analysis of performance calculated using OEE of each machine on a power plant block 1 and 2 for knowing the problems and solutions of low-performance machines, this research also do descriptive exploratory analysis using the causal diagram. The population in this study all engine power plants twelve units. This research took five samples on the engine power plant block 1 and 2.

Data on the machine availability production power plant derived from the production of data calculation engine in units (GWH/Giga Watt Hour). To achieve the overall equipment effectiveness (OEE), then the first step that is the focus of major losses to eliminate (the six big losses), then the analysis of the Causal (Ishikawa diagram), and the making of the recommendation or proposed improvement measures made after the known results of the calculation of the Overall Equipment Effectiveness, six big losses and the result of the root of the problem using cause and effect analysis.

### 4. Results

The six big losses of the engine unit GT21 resulting from the presence of idling and minor stoppage i.e. of 7971.63 hours or 99.91%. While the rest of the existing losses caused from a factor of downtime losses of 7.32 minutes or 0.09%.

The loss of the six big losses on the engine unit GT22 that the machine there are two sources of greatest losses i.e. the setup and adjustment of 1443.78 hours or 16.99% and also caused from idling and minor stoppage of 7049.97 hours or 82.98%. There is little the most losses on downtime losses 1.75 hours or 0.02% caused due to a breakdown in the machinery.

### 5. Discussion

The source of the biggest losses on the engine unit GT21 caused by idling and minor stoppage i.e. of 99.91%. The losses caused by the presence of reverse shutdown is a condition where the engine power plants experienced a shutdown at the request of the customer. As a single buyer of products generated by the engine manufacturer can

provide products with criteria: low cost production and the machine high responsive. So based on these conditions, the losses on the reverse side of the production machines shutdown may imply that the problem lies in the high cost production and the engine low responsive. The electric energy generation industry's production cost is also known by the term heat rate i.e. the value/price of the product revealed by the Rupiah per kWh.

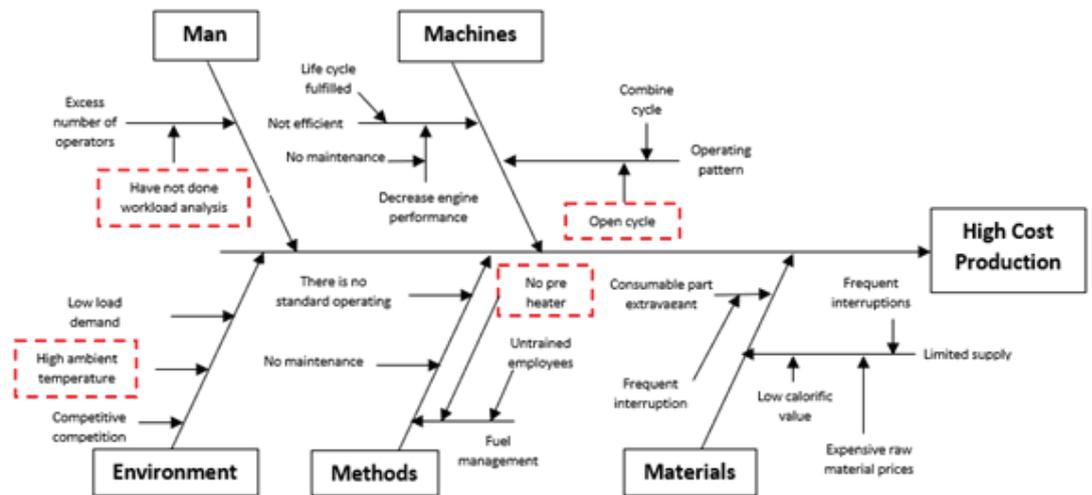


Figure 1: High cost production on the engine unit GT21. Source: Six Big Losses calculation data (2016).

The cause of the occurrence of high production values on the engine production unit of GT21: (a). The Material used in the production process is fuels and Consumable Parts. (b). The process of Feeding the incoming gas on production machine with declining value calories causes the value/price of the product (Rp/kWh) resulting in a higher rate. (c). Environmental factors in the form of a high ambient temperature (26-34 ° C). (d). The human factor due to haven't been doing an adjustment between the requirement and the number of workers assigned to operate and maintain production equipment. (e). Engine production units have as unit construction GT21 power plant open cycle. The cause of the occurrence of low response to the engine production unit GT21; There is no test the readiness of the production machine regularly, employees who are not competent, engine failure at start up and the decrease in engine performance. The source of the biggest losses on the engine unit GT21 caused by idling and minor stoppage of 82.98% IE and Setup and adjustment of 16.99%. Idling and minor stoppage losses caused by the presence of reverse shutdown.

The cause of the occurrence of high cost production on the engine production unit GT22: absence of pre-heater used to raise the temperature of the gas (fuel) into the input of the machine production, high ambient temperature (26-34 ° C), the number of workers and competence, open cycle operation pattern. The cause of the occurrence

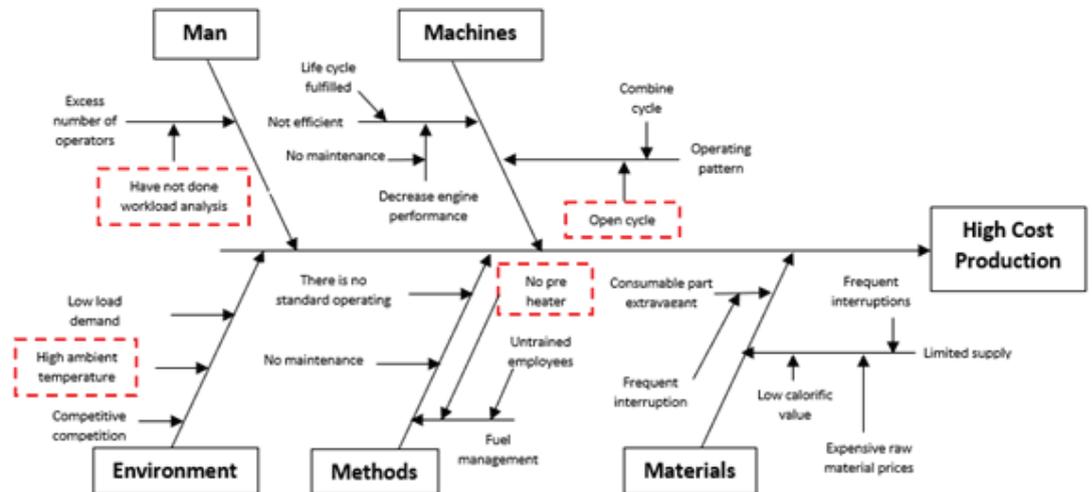


Figure 2: Fishbone Diagram High Cost Production Unit GT22. Source: Six Big Losses calculation data (2016).

of low response to the engine production unit GT22: machine parts not available due has not been produced by the manufacturer, the competence of employees is low, and no running test machine. Causes of occurrence of losses due to plan an outage on the engine unit GT22 stems from factors incompetent technicians and no updated standard of work.

Based on the analysis of the causes by using the diagram for further analysis is done using the 5W1H in order to get improvement the performance of the engine production can be increased. The engine production unit and unit GT21 and GT22 has roots in the same problems associated with the high cost of production and low response.

## 6. Conclusion

The factors of the six big losses affecting low achievement of OEE performance production machine unit GT21 because idling and minor stoppage with a value of 7971.63 hours or 99.91% and downtime losses of 7.32 minutes or 0.09%. While on the engine unit GT22 because setup and adjustment factors to the value of 1443.78 hours or 16.99% and also caused from idling and minor stoppage of 7049.97 hours or 82.98%. The root of the problem on the engine production unit and the GT22 GT21 resulting from several sources including: the influence of the operating machine, pattern of lack of competence of employees and production technicians, the availability of spare parts which are not optimal, the standard documents job used to the inspection work is not appropriate/not yet updates and performance test is not done on a regular basis at the time of production machine in standby condition. Engine performance improvement by

making the design and installation of the equipment of pre-heater fuel (gas), the addition of inlet Air inlet air side unplug chilling combustion (air intake filter), the addition of heat exchanger device on a cooling system generator, the addition/change pattern HRSG equipment operation, renewal of the standard documents job for inspection and doing a Work Load Analysis as the basis for the determination of the number and competence of employees.

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