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# Evaluating total productive maintenance using overall equipment effectiveness: fundamental study

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**ABSTRACT**
Nowadays, consumers expect manufacturers to provide excellent quality, reliable delivery and competitive pricing. This demands that the manufacturer's machines and processes are highly reliable. In order to possess highly reliable machines to make sure smooth manufacturing process, many organizations have implemented Total Productive Maintenance (TPM) as the enabling tool to maximize the effectiveness of equipment by setting and maintaining the optimum relationship between people and their machines. Overall Equipment Effectiveness (OEE) is used as a measure when evaluating the result of TPM. This paper intends to find out the relationship between TPM implementation and OEE result. Comparison between before and after the implementation of TPM is carried out to see the difference that TPM can bring to an organization. Elements that constitute the OEE equation will be analyzed in order to identify which one that affects OEE result. After identifying, improvement will be made on that element so that OEE result will be improved ultimately. The approach used in this paper is case study and the instruments used to collect data are observation and interview. Microsoft Excel is used to analyze data obtained and calculate OEE. Hence, TPM is a useful tool in helping firm to achieve optimal manufacturing process. By being able to achieve this level of maintenance, an organization will be able to reap competitive advantages brought by TPM, thus, producing quality products that manage to satisfy customers and subsequently generating greater profits.



## Introduction

Having recognized by some world-class Japanese companies over twenty-five years ago, effective application of modern technology can only be achieved through people – starting with the operators and maintainers of that technology – and not through systems alone. Hence the emergence of Total Productive Maintenance (TPM) as the enabling tool to maximize the effectiveness of equipment by setting and maintaining the optimum relationship between people and their machines. According to [1], TPM is a program that addresses equipment maintenance through a comprehensive productive-maintenance delivery system covering the entire life of the equipment and involving all employees from production and maintenance personnel to top management. Besides that, TPM is a methodology and philosophy of strategic equipment management focused on the goal of building product quality by maximizing equipment effectiveness. At many companies where maintenance is viewed as an operational expense to be minimized and not as an investment in increased process reliability, the maintenance practices decrease their competitiveness by reducing throughput, increasing inventory, and leading to poor due-date performance. [2]. By the late 1990's, TPM was well entrenched as a continuous improvement methodology across a wide range of industries.

## Research Background

Automotive industry Malaysia is a booming industry which encompasses areas of activities from car manufacturing to dealing auto business with foreign countries. Automotive industry Malaysia is one of principal producers and exporters of vehicle parts, components and accessories, which are widely accepted to most of leading countries of world. Leading automotive manufacturing companies like Mercedes, Suzuki, Ford, General Motors, Mazda, Nissan and Mitsubishi are using Malaysian automotive products and accessories because of their high quality and competitive prices. The goal of TPM is to bring competitive advantages to organizations, improve quality of the products, and reduce the cost production of the line [3]. It is vital to study the state of TPM implementation by examining the measure of Overall Equipment Effectiveness (OEE) in companies like those located in developing countries such as Malaysia.

## Problem Statement

Modern manufacturing requires that to be successful organizations must be supported by both effective and efficient maintenance. One approach to improving the performance of maintenance activities is to implement and develop a total productive maintenance (TPM) strategy. TPM implementation in an organization can ensure higher productivity, better quality, fewer breakdowns, lower costs, reliable deliveries, motivating working environments, enhanced safety and improved morale of the employees [4]. Measurement is an important requirement of continuous improvement process. It is necessary to establish appropriate metrics for measurement purposes. From generic perspective, TPM can be defined in terms of Overall Equipment Effectiveness (OEE) which in turn can be considered a combination of the operation maintenance, equipment management and available resources [5]. The goal of TPM is to maximize equipment effectiveness, and the OEE is used as a

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measure. Hence, this paper will focus on the aspect implementation of TPM to OEE. This paper will study the relationship between TPM implementation and machine performance (OEE) in automotive industry. Study on OEE figures will also be conducted as OEE is the indication of machine performance. Comparison of result between before and after the use of TPM will be carried out too in order to identify the element with lowest value that affect rate of OEE in TPM implementation. It is to believe that by improving the element, OEE rate will increase, production rate of the factory will increase and thus, bringing higher sales and revenue to organization.

**Research Objective**

- To investigate the relationship between TPM implementation and machine performance (OEE).
- To identify element that affects machine performance (OEE).
- To propose suggestions in order to improve machine performance (OEE).

**Significance of the Study**

This study is intended to figure out the contributions of TPM in manufacturing industry. By observing the production process, element that causes low OEE value will be identified, therefore, suggesting resolutions for the challenge encountered. A holistic implementation of TPM will provide and promise high machine performance, moving towards to achieve zero breakdowns, to achieve zero defects, and to achieve improved throughputs which ultimately, bringing high production rate. Besides that, benefits that come along include cultivating sense of ownership of equipment among operators, developing cross functional teams to improve individual employee and employer performance, increasing the life of equipment and plant. This study can also be a future reference for others in the automotive industry as the suggestions made maybe the guidelines for others as well.

**Literature Review**

TPM is a methodology and philosophy of strategic equipment management focused on the goal of building product quality by maximizing equipment effectiveness. It embraces the concept of continuous improvement and total participation by all employees and by all departments. (Society of Manufacturing Engineers 1995 p. ix). Emphasizing the role of teamwork, small group activities and the participation of all employees in the TPM process by the Japanese approach, the Western approach focuses on the equipment while understanding that operator involvement and participation is required [7]. TPM experts such as [8] and [9] all agree that a common feature of either the Japanese or Western style approach to TPM is to strive for the three goals of zero defects, zero accidents and zero breakdowns. The aim of TPM activities is to improve the Productivity, Quality costs, Cost of products, Delivery and movement of products, Safety of operations and Morale of those involved (PQCDSM).

TPM now comprises of eight different sections which have come to be known as pillars. Each pillar has its own areas of responsibility. They are autonomous maintenance, focused improvement, planned maintenance, quality maintenance, education and training, safety, health and environment, office TPM, and development management. Overall Equipment Effectiveness (OEE) is the TPM metric for measuring equipment effectiveness or productivity. Variations for calculating OEE are in use, however, most are consistent in identifying three major elements of OEE, which are availability, performance efficiency, and quality rate. TPM has the standards of 90 per cent availability, 95 per cent performance efficiency and 99 per cent rate of quality [10]. An overall 85 per cent benchmark OEE is considered as world-class performance [11] and [1].

Automotive industry Malaysia is a booming industry which encompasses areas of activities from car manufacturing to dealing auto business with foreign countries. Automotive industry Malaysia is one of principal producers and exporters of vehicle parts, components and accessories, which are widely accepted to most of leading countries of world. Some of the benefits gained from the implementation of TPM are can ensure higher productivity, better quality, fewer breakdowns, lower costs, reliable deliveries, motivating working environments, enhanced safety and improved morale of the employees [4].

According to [12], there are a few factors affecting successful TPM implementation, which are to approach TPM realistically, accept that TPM will take a long time to spread across the company and change existing maintenance culture and be determined to keep going, to name a few. Since there are successful factors, sure there will be barriers during implementation. Some of the barriers include underestimating the task, lack of management consensus, and underestimating the importance of knowledge.

| | | | |
|---|---|---|---|
| OEE | = | Availability (A) × Performance Efficiency (P) × Rate of Quality (Q) | (3.1) |
| where | | | |
| Availability (A) | = | Operating Time / Planned Production Time | (3.2) |
| Operating Time | = | Planned Production Time – Down Time | (3.3) |
| Planned Production Time | = | Shift Length – Breaks | (3.4) |
| Performance Efficiency (P) | = | Ideal Cycle Time / (Operating Time / Total Pieces) | (3.5) |
| Ideal Cycle Time | = | Shift Length / Scheduled Number of Products | (3.6) |
| Quality Rate (Q) | = | Good Pieces / Total Pieces | (3.7) |
| Good Pieces | = | Total Pieces – Reject Pieces | (3.8) |

Due to this is a case study, so non-probability sampling is used in collecting data as the data that is going to be collected is just from one organization only. Non-probability sampling is one in which each element of the population does not have an equal probability of selection. When choosing type of non-probability sampling, purposive or judgmental sampling is chosen as the method of choosing samples. The reason of choosing purposive sampling is the subject to be studied is fixed, which the machines in the production line. The research sample in this case study is the machines available in Manufacturing Operation and Engineering Department.

The instruments that are going to be used in this case study are observation, and interview. Observation is carried out by observing closely the activities of machines and data is recorded. Interview will be conducted on the person in charge of Manufacturing Operation and Engineering Department in order to understand more about the implementation history of TPM in company. The independent variable in this case study is the implementation of TPM while the dependent variable is machine performance (OEE). Microsoft Excel in analyzing data and when calculating OEE. Besides that, graphic method will be used in order to show a clearer picture of implementation of TPM to OEE and to identify element that affects OEE the most.

**Conclusion**

Definition of TPM and OEE has been given in this proposal. Besides that, other information such as background, problem statement, scope, significance and etcetera are mentioned too. Research methodology in showing how the

research is carried out and how data is collected is presented in this paper. Literature review is shared in order to show the significance of this study by providing past researches. Those past researches have shown that there is no other study being done in this area, thus, creating a need to study this area.

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