OVERALL EQUIPMENT EFFECTIVENESS IMPROVEMENT THROUGH SINGLE MINUTE EXCHANGE OF DIE IMPLEMENTATION: A CASE STUDY ON STAMPING MACHINE

Submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Hons.)

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DECLARATION

I hereby, declared this report entitled "Overall Equipment Effectiveness Improvement through Single Minute Exchange of Die Implementation: A Case Study on Stamping Machine" is the results of my own research except as cited in the reference

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Management).
The members of the supervisory committee are as follows:

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PROFESOR MADYA DR ZUHRIAH BINTI EBRAHIM

ABSTRAK

‘Overall Equipment Effectiveness’ (OEE) adalah kaedah pengukuran yang digunakan untuk mengukur kecekapan peralatan berdasarkan tiga komponen iaitu keberadaan, prestasi dan kualiti. Tujuan projek ini adalah untuk meningkatkan OEE mesin ‘stamping’ melalui pelaksanaan ‘Single Minute Exchange of Die’ (SMED). Proses ‘stamping’ merupakan proses utama dalam syarikat tersebut. Mesin ‘stamping’ ini menghadapi masa persediaan mesin yang panjang, dan juga kerosakan yang kerap berlaku. Masalah seperti ini boleh menyumbang kepada kerugian besar dari segi kos dan masa kepada syarikat. Tiga objektif projek ini adalah untuk; (i) mengenal pasti mesin ‘stamping’ yang mempunyai prestasi OEE yang paling rendah, (ii) melaksanakan SMED untuk meningkatkan prestasi OEE, dan (iii) mengesahkan pelaksanaan SMED yang boleh meningkatkan OEE. Dua mesin ‘stamping’ telah digunakan untuk kajian ini berdasarkan prestasi OEEnya yang rendah berbanding dengan mesin ‘stamping’ yang lain iaitu 110T (A) dan 200T. Rakaman video digunakan untuk merakam proses ‘changeover’ mesin ‘stamping’ Perbandingan OEE sebelum dan selepas pelaksanaan SMED dilakukan. Keputusan kajian menunjukkan pengurangan jumlah masa ‘changeover’ mesin ‘stamping’ 110T (A) daripada 17.08 minit ke 10.88 minit, manakala bagi mesin ‘stamping’ 200T adalah daripada 28.37 minit ke 19.71 minit. Pelaksanaan SMED telah meningkatkan OEE untuk mesin 110T (A) daripada 62% kepada 87%, manakala bagi mesin 200T peningkatan daripada 52% kepada 94%. Kesimpulannya, pelaksanaan SMED dapat meningkatkan prestasi OEE mesin kerana SMED berupaya mengurangkan masa persediaan mesin ‘stamping’.

ABSTRACT

Overall Equipment Effectiveness (OEE) is a tool use for measure the performance of the machine or equipment via availability, performance, and quality. The purpose of this project is to improve the OEE of stamping machine via implementation of Single Minute Exchanges of Die (SMED). The stamping process is the core process in the company that face long setup time, frequent breakdown occur that causes delay in running the machine. These kind of problem can contribute to big loss in term of cost and time to the company. Three objectives of this project are (i) identifying the stamping machine that has lowest OEE performance, (ii) implement the SMED for improving the OEE performance, and (iii) validate the SMED for improving the OEE. Two stamping machines with lowest OEE performance are used in this project which are 110T (A) and 200T compared with other machines. Video recording are required to record the changeover process of the stamping machine. The comparison of OEE performance between current and after SMED implementation are made. The result shows that the total changeover time of the stamping machine 110T has been reduced from 7.08 minutes to 10.88 minutes while stamping machine 200T is reduce from 28.37 minutes to 19.71 minutes. The SMED implementation has improved the OEE performance of machine 110T from 62% to 87%, while for the machine 200T OEE improved from 52% to 94%. As a conclusion, the implementation of SMED can improve OEE performance of stamping machines through the reduction of changeover time.

DEDICATION

Dedicated to

My beloved father, Mohd Fazil bin Puteh

My aprpreciated mother, Ijlalnuni binti Abd Ghani

My adored sister and brother, Maizatul Akmal, Abdul Rahim, and Abdul Hadi

For giving me moral support, encouragement and also undertandings.

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LIST OF ABBREVIATIONS

OEE	-	Overall Equipment Effectiveness
SMED	-	Single Minute Exchange of Dies
PSM	-	Projek Sarjana Muda
OE	-	Overall Effectiveness
SOP	-	Standard Operating Procedure
KPI	-	Key Indicator Performance
SME	-	Small and Medium Enterprise
VSM	-	Value Stream Mapping
TPM	-	Total Productive Maintenance

CHAPTER 1
INTRODUCTION

This chapter discussed about the project background, problem statement, objectives and scope of the project. This study focuses on improvement of Overall Equipment Effectiveness (OEE) through Single Minute Exchange of Die (SMED); a case study of stamping machine.

1.1 Project Background

In the middle of the 20th century, lean has been known as a concept of efficient manufacturing that rise the Toyota Production System. It is depends on the principles of defining value from the customer's viewpoint, and continuous improvement on the way in which value is delivered. The wasteful resources or that does not contribute to the goal value need to be eliminated. The first step in lean concept is to understand what value is and what is activities or resources that are necessary to create the value. The waste can easy to identify if the value is understood. There are two concept of activities used in lean which are value added and non-value added activities. The value added is described as the work or task that give a benefit to the company. Meanwhile, the non-value added is the unnecessary work that does not give any benefits to the company. Thus, the non-value added time should be eliminated. The non-value added activities may decrease the company's productivity. This is the problem that faced by many company. Eliminate the non-value added activities can reduce the lead time and reduce operating cost of the company.

Some of the method or tools in lean can be used for eliminating the waste. It depends on the problem that faced by the company. One of the tool that popular and widely used is the Overall Equipment Effectiveness (OEE). OEE can be considered as one of useful tool. It used to measure the machine's productivity by considering the machine availability, performance, and quality (Charaf and Ding, 2015). The OEE identify the percentage of manufacturing time. If the OEE score of 100%, it means that the company is manufacturing 100% quality of product, 100% performance, and 100% availability. OEE is one of the best tool for eliminating waste. Thus, it also can determine the losses, benchmarking progress, and improve the manufacturing equipment productivity.

Besides, Single Minutes Exchange of Dies (SMED) also one of the method in lean that can be used for reducing waste in manufacturing process. It provides a faster and effective way of converting a manufacturing process from running the current product to running next product (Yash and Nagendra, 2012). SMED is known with the changeover concept that had been develop by Shigeo Shingo. The faster changeover in SMED is the crucial for reducing the production lot sizes and thereby improving flow. In addition, the SMED also can help eliminate or reduce the non-value added operation. Basically, the non-value added activities that can be identified by implementation of SMED is waiting time. For example, instead of waiting a stamping machine to finish the current part, the operator can prepare the die close to the machine earlier before the current part finish. That is why the implementation of SMED is important in order to reduce the changeover time.

1.2 Problem Statement

The aim of this project is to improve the OEE of stamping machine through implementation of SMED. In this project, the stamping machine is chosen as the scope of this study among the processes of the production. This is because the stamping process is the bottleneck that provide a long setup time, unexpected breakdown or problem and some of delay before the machine need to run. Although the time of these problem happened are short, but it contributing to a big loss when the company ignored this kind of problem. To identify the problem the Overall Effectiveness (OE) data are collected from the company. The data contained the information about the production of each machine that being used.

The OEE is the new tool for the company. Currently, the company used Overall Effectiveness (OE) tool to determine the productivity of the machine. The company already know about the OEE functionality, but they does not know detailed about OEE which it can give a big impact to the production productivity of the company.

1.3 Project Objectives

The objectives of the study are as follows:

i) To identify the machines that has lowest Overall Equipment Effectiveness (OEE) in stamping process.

ii) To implement the Single Minute Exchange of Die (SMED) for improving the OEE performance of stamping machine.

iii) To validate the SMED application for improving OEE at stamping machine.

1.4 Project Scopes

The scopes of study are as follows:

i) This study focuses on machine productivity measure based on SMED) and OEE.

ii) The case study is based on the lowest OEE performance, which is focused on stamping process.

iii) Two stamping machines had been chosen for the lowest OEE performance (i.e. stamping 200T and 110T (A).

1.5 Company Background

Founded in 1992, The Company began as a small scale of metal and plastic manufacturer supplying automotive components to Proton Sdn Bhd in the same year. As a pioneer in the industry, today the company has evolved into one of the leading and biggest supplier to Malaysia automotive industries especially Proton and Perodua. The company's achievement began in the year 1994 with expansion to a bungalow factory at a section 24 Shah Alam totally as metal divisions with areas of 10,000 sqft. Since then, the company has continued to expand with another three manufacturing facilities.

The company had also embraced the power of integration, value added, teamwork and globalization to enhance the company development in order to realize the company's mission to become the leading of original design manufacturer of automotive component. The nature of business that the company had involved are the manufacture of plastic part, fluid transfer system, electro mechanical component, mechanical component, metal part and appearance part. The facilities of the company are only focusing on metal stamping process, painting process, bending process and assembly. As a corporate body, the company wants to be known as a leading original design manufacturer of automotive components, which focused on innovation and competitiveness.

1.6 Expected outcomes

The expected outcomes of this project is better of Overall Equipment Effectiveness (OEE) performance through application of Single Minutes Exchange of Die (SMED).

1.7 Thesis organization

Chapter 1 discusses project background, problem statement, project objectives, project scopes and expected outcome.

Chapter 2 presents a literature review that describes the concepts, theories and the previous studies. The benefit of Overall Equipment Effectiveness (OEE) and Single Minutes Exchange of Die (SMED) were also explained.

Chapter 3 explains the method and process used to execute the project. The flow charts are used to illustrate the overall flow of the study.

Chapter 4 presents the result and discussion. It consist the result of machine with the lowest OEE and the implementation of SMED for improving the OEE performance.

Chapter 5 consists the overall elaboration focused on the achievement of the project.

CHAPTER 2
LITERATURE REVIEW

This chapter explains the research undertaken previously by previous researcher. First section is about the productivity measurement. Second section focused on the Overall Equipment Effectiveness. Meanwhile, third section is about lean manufacturing. The last section focused on Single Minute Exchange of Dies (SMED).

2.1 Productivity Measurement

Productivity describes different type measures of the efficiency of production. A productivity measures is expressed as the ratio of output to input used in a production process. The productivity measurement is the evaluation of both output and input resources of a production system. The productivity measurement is one of the finest way for improve the productivity. Nowadays, the productivity measurement give a high impact to the manufacturing industry in term of overall performance. It became the important factor for the manufacturing industry to improve their productivity (Matebu and Shibabaw, 2015). The target of the productivity measurement is improvement of productivity which involves a combination of increased effectiveness and a better use of available resources (Goshu *et al.,* 2017). Rawat *et al.* (2018) described that by converting the inputs to total outputs was one of the important factor to get a good efficiency productivity.

2.2 Overall Equipment Effectiveness (OEE)

OEE is a standard metrics developed by Seiichi Nakajima in 1960s that used to measure the performance of the equipment in a factory by taking an extensive view of all aspects of production. OEE is a really effective tool that can be used to identify the performance of improvement process (Castro and Araujo, 2012). Nowadays, many manufacturing industries recognize that their endurance in the business world rely upon on obtaining competitive OEE (Esa and Yusof, 2016). Some of the manufacturers use the OEE as a Key Performance Indicator (KPI) as a motivation for change. OEE make a current status of production with least calculations for the performance measure. It also help to measure losses and corrective action can be taken to reduce it (Relkar and Nandurkar, 2012). OEE provides the manufactures with the best measure of machine utilization and help them focus on improvement based on the three factors in OEE.

Many methods can be used to calculate the OEE which are Nakajima approach, event method approach, and good units transferred method. Nakajima approach is used in determined the OEE of the machines. To determine the OEE there are three factors need to be considered which are (i) Availability, (ii) Performance, and (iii) Quality (Mohammadi 2011). In this regard, OEE is calculated by multiplying the three elements of availability, performance, and quality as shown in equation 2.1;

$$OEE = Availability \times Performance \times Quality \qquad \text{Equation 2.1}$$

The availability can be defined by using the equation 2.2;

$$Availability = \frac{Operating\ time}{Schedule\ time} \qquad \text{Equation 2.2}$$

For equation 2.3, the excluded time refers to the time that is not going to be accounted for a machine's working time. The total time refers to the total time in working shift.

$$Schedule\ Time = Total\ Time - Excluded\ Time \qquad \text{Equation 2.3}$$

For equation 2.4, the operating time refers to the total time for which the machine actually working. Meanwhile, the downtime refers to the unplanned interruptions.

$$Operating\ Time = Schedule\ Time - Downtime \qquad \text{Equation 2.4}$$

For equation 2.5, the performance of OEE can be calculated by using the following equation;

$$Performance = \frac{Total\ Units\ Produced \times Ideal\ Cycle\ Time}{Operating\ Time} \qquad \text{Equation 2.5}$$

Finally, the quality element was defined using the classical definition by using the equation 2.6;

$$Quality = \frac{Number\ of\ Good\ Units\ Produced}{Total\ Units\ Produced} \qquad \text{Equation 2.6}$$

2.2.1 Advantages of Overall Equipment Effectiveness (OEE)

The Overall Equipment Effectiveness (OEE) provides an extensive view of the ways the machine was operating. It also goes deeper than this as it makes an organization to check on individual items of equipment and make sure that the maximum benefits are being obtained from the equipment. The OEE also can observe the number of parameters, which the shift or the specific part numbers that involved. This means that all different types of aspect of the performance can observe instead of having to rely on verbal data from operators (Raguram, 2014).

The OEE help measure the capability of the equipment or lines that had been used. The constraint or bottleneck equipment can be run more effectively by implementing the OEE (Puvanasvaran *et al.*, 2012). A good managing of OEE make customer satisfaction can be met due to the good time delivery and service quality. After that, the OEE measure can reflect with the equipment the being used for a process. For example, it can obtain a result where the equipment is losing time (Esa and Yusof, 2016; Hedman *et al.*, 2016)

2.2.2 Overall Equipment Effectiveness (OEE) Limitations

Overall Equipment Effectiveness (OEE) is still in critical parts of measuring the performance of the production. In manufacturing, the OEE is a method that widely used in measuring the performance. The comparison of machine in term of capacity, produced product, and cost of production may give an effect to inappropriately prioritize problematic equipment of OEE. This becomes the weakness and challenges in implementing the OEE (Wudhikarn, 2013).

In that respect are some limitations of the original OEE equation for the mining industry application. For the mining industry, the OEE that needs to be looked at is the quality parameters. It becomes unrelated in a mining context as per its original definition (Lanke *et al.*, 2016).

2.3 Lean Manufacturing

Lean manufacturing is a concept that oriented for getting the shortest cycle time of an operation by eliminating waste. It has been proved by the Toyota Production System. The purpose of lean is to eliminate the waste and increasing the value added work. The advantages of this technique are lower cost, increase the quality, and shorter the lead times. The Toyota industry in Japanese had implemented the lean manufacturing to improve the economy in Japanese after the World War II. They turned out with an idea by making a continuous progressive way of producing what the customer needs. This is what the lean means to the Japan earlier that 1970's (Puvanasvaran, 2014).

Lean manufacturing has become one of the most important developments in the 21st century. Many companies around the world have taken up about the lean manufacturing development to gain and maintain a position in a global market (Munteanu and Ștefănigă, 2018). The target of lean manufacturing is not only focused on the big company. Some of the Small and Medium Enterprise (SME) also implements the lean to improve the productivity of an organization. According to the Hu *et al.* (2015) there is a lack of research on implementation of lean for SMEs in developing countries. The lack of

understanding and difficulty of lean manufacturing in the Middle East and Gulf countries make the lean implementation of SMEs become difficult. Therefore, it increases the concern of the implementation of lean in SMEs (Al-najem, 2014).

Nowadays, the combination of lean manufacturing is currently discussed in literature. According to Dombrowski *et al.* (2017) industry 4.0 can be defined as intelligent and digital networking, equipment and objects the business management process and value creating networks.. Other literature state that industry 4.0 as a completion of lean (Kolberg and Zühlke, 2015).

2.3.1 Type of Waste

Neha *et al.* (2013) stated that waste referred to any human activity that absorbs resources but creates no value. The focus of lean thinking is the elimination of waste whenever it exists. There are several types of waste which are rework, over-processing, motions, overproduction, waiting, transportation, skills and excessive inventory. The rework process may occur when an error of defect product passed onto the next operation. This will cause a loss for the organization. As a result, the product need to be manufactured again or rework whereas the customer will rightfully only pay once for the goods or service. Thus, to make the process efficient and least wasteful way, doing everything right for the first time is the better way.

In a health care industry, the existence of over-processing is defined when the patients do the not value work or caused by rules that are not aligned with patient's need. For example, filling out multiple forms at every clinic visit. Then, normally in a hospital or a health care the employees will make many movement. They move from room to room, floor to floor, or building to building more than necessary. This kind of activity is reflected to the waste in term of motion (Rubin, 2018).

Over-production occur when the production over the demand (Douglas, 2013). The over-production has the most negative impact toward success. It can occur any time when the part or products are produced more than customer willing to purchase. The

overproduction will lead to the generation of other lean manufacturing waste which are waiting, inventory and motion. It will give a very large effect to the time consuming and resources.

Waiting is referred to the employee or customer waiting for information or service delivery (Andrés-López *et al.*, 2015). This is due to when the overhead cost continuously increase during the time the products wait to be transformed. No value is being produced when the product waits. Instead the cost of overhead operations continues to grow, which strips potential profit from the sale. Next, any transportation will cost money. The unnecessary transport of a product or material is a wasteful activity. This is due to the long distance between many types of stages of production process (Grzelczak and Werner-lewandowska, 2016). The transportation leads to increase the waste of motion because resources are required to move without generate the value.

Nowadays, the company like to handle unnecessary stocks that will lead to waste in term of inventory. This type of waste will results to the other waste which are waiting, correcting, and over processing (Pieńkowski, 2014). If the product stay for an entire time in the inventory, it will affect the profit margin of the company because the overhead must be paid to maintain the product in inventory.

Skills or non-utilized talent is the waste that not specific in the manufacturing process. This type of waste occur when in manufacturing environment the management fails to make sure that all the employee skills is being utilized. The management of an industry must have an ability to utilize the critical thinking and continuous improvement feedback from employees. If the management does not cooperate with the employees on continuous improvement, it is considered a manufacturing waste (Narses, 2015)

2.3.2 Lean Principles

There are five fundamental principles of lean manufacturing that need to be followed step by step to gain the maximum advantage of lean success (Aziz and Hafez, 2013).