DEVELOPMENT OF OVERALL EQUIPMENT EFFECTIVENESS (OEE) IN CASTING INDUSTRY

This report is submitted accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Hons.)

by

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I hereby, declared this report entitled “Development of Overall Equipment Effectiveness (OEE) in Casting Industry” is the results of my own research except as cited in references.

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Date : 3 June 2019

APPROVAL

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

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En Nor Akramin bin Mohamad

(Project Supervisor)

ABSTRAK

Keberkesanan Peralatan Secara Keseluruhan (OEE) dilihat sebagai cara asas untuk mengukur kecekapan prestasi. Masalahnya bermula dengan tiada pangkalan data OEE di syarikat ini. Peralatan yang digunakan semasa proses itu sentiasa mengalami kerosakan yang tidak dijangka yang menyumbang ke atas pengeluaran yang lebih tinggi dan melambatkan penghantaran. Tujuan kajian ini adalah untuk membangunkan pangkalan data OEE dalam proses pemutus. Kajian ini memberi tumpuan kepada kajian masa dan metodologi pengukuran kerja dalam membangunkan pangkalan data OEE untuk mendapatkan data masa nyata dari keseluruhan proses yang kemudiannya mengira piawai. Kajian masa dijalankan untuk mendapatkan data masa sebenar dan ia diteruskan dengan pangkalan data OEE dan data terperinci dengan menggunakan lembaran cek. Lembaran cek sedang digunakan untuk mengira OEE semasa proses tersebut. Pangkalan data OEE adalah data teoretikal sementara data kerugian terperinci adalah data di mana operasi mempunyai kerugian semasa dijalankan. Bersama-sama dengan data ini, kerugian ketersediaan, kerugian prestasi dan kerugian kualiti telah diambil kira yang berkaitan dengan tiga parameter OEE yang Ketersediaan, Prestasi dan Kualiti. Selepas peratusan OEE diperoleh, pengenalpastian kawasan penambahbaikan dikaji dan telah dianalisis dalam tahap analisis. Di samping itu, Carta Pareto digunakan dalam peringkat analisis untuk mengenal pasti masalah yang menyumbang kepada peratusan yang lebih rendah dari OEE. Masalah utama yang berlaku untuk kedua-dua mesin di kawasan mesin adalah pada unit suntikan yang pelocok selalu tersekat dan pin selalu pecah di kawasan acuan. Mengapa teknik analisis digunakan untuk mencari penyebab utama masalah untuk menganalisis kawasan penambahbaikan dan dicadangkan kepada syarikat.

ABSTRACT

Overall Equipment Effectiveness (OEE) is seen to be fundamental way of measuring performance efficiency. The problem starts with no OEE database in this company. The equipment used during the process always encountered unexpected breakdowns that contributed higher backlog of production and in delaying of the shipment. The purpose of this study is to develop OEE database in the casting process. This study focused on time study and work measurement methodology in developing OEE database to obtain real time data from the overall process which is then to compute a standard. Time study is carried out to obtain real time data and it is proceed with the OEE database and detailed loss data by using check sheet. Check sheet is being used in order to calculate the OEE during the process. The OEE database is such a theoretical data while detailed loss data is a data where the operation has the losses during run. Together with this data, the availability losses, performance losses and quality losses have taken into account that related to the three parameters of the OEE which are Availability, Performance and Quality. After the percentage of OEE is obtained, the identification of area of improvement is studied and has been analyzed in analysis stage. In addition, a Pareto Chart is used in analysis stage in order to identify which problems contributed to the lower percentage of OEE. The major problem occurred for both machines at machine area is at injection unit which is plunger always jammed and the pin always broken at mold area. Why-why analysis technique used to find the root causes of the problems in order to analyze the area of improvement and proposed to the company.

DEDICATION

Specially dedicated to my beloved father, Musazali bin Md Saleh and my lovely mother, Maimon binti Abdul Rahman and my siblings who are very concern, patient and supportive.

Last but not least, to my academic supervisor and all my friends as well who have encouraged, guided and inspired me throughout my journey to complete this study.

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Every effort has been made to fulfill this Final Year Project and I apologize to anyone whose rights have been inadvertently overlooked and will be happy to rectify any errors or omissions.

Thank you.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

UTeM	- Universiti Teknikal Malaysia Melaka
OEE	- Overall Equipment Effectiveness
PDC	- Pressure Die Casting
TPM	- Total Productive Maintenance
TMU	- Time Measurement Units
MOST	- Maynard's Operation Sequencing Techniques

CHAPTER 1
INTRODUCTION

The research, which focuses on implementing the general effectiveness of equipment (OEE) in a casting sector, is presented in the first section of this section. The context of the study is the process of computing the OEE. The issue statement is submitted according to the goals and scope of the project. It also clarifies the significance of the project and the project organization. The overview of this project is described at the end of this chapter.

1.1 Background of Study

Schmenner (2014) stated that efficiency and effectiveness must be implemented in today's competitive market in order to be more efficient in any industry. At this stage, the success of total sales is increasing and leads to greater profit. Any inefficiency demand, unknown losses must be identified and eradicated in any manufacturing setting. Empirical industry research required altering its performance measurements or they should use appropriate and accurate measures. For determination in companies, the concept of overall equipment efficiency (OEE) is crucial. OEE is essential because it determines whether the company's manufacturing lines are outstanding, moderate or poor. In terms of its efficiency, OEE tracks the real output of a machine under optimal circumstances. The OEE has the cumulative impact of the three variables: availability, results and quality in its easiest form.

The main causes of the industry's production facilities not achieving a high OEE percentage in this evaluation of the three factors are generally the six big losses, which are machine breakdowns, set-up and machine adjustments, small stopovers, reduced speed, start-up rejections and rejected production. These losses generated during the process have helped to decrease machine effectiveness and material use, product quality and time

consumption in the entire process. Time study method is used to determine the percentage of OEE. In order to calculate the time to finish a product process, time studies are used. The time study is also about measuring the job.

The aim of this research is to discuss the Overall Equipment Effectiveness (OEE) in manufacturing sector by using the time-study technique for the manufacturing phase, the technique used to calculate the OEE proportion from the timetable down and down is at Dormakaba Production Malaysia Sdn. Bhd. The focus of the time study is on time to carry out the activity. Akansel *et al.* (2017) found that the following the proper collection of time information, an enterprise is in a position to use its procedures to its real potential. Pressure Die Casting process is the field of the working research. In order to gather the information, an observation should then be made. The information will be used for the assessment of the OEE. In this way, it is possible to establish the proportion of OEE and determine the conditions of a specific region whether it is good, moderate or bad.

1.2 Problem Statement

This manufacturing industry recently has created OEE for its production line, but due to the absence of time to collect the information the development has not been completed. As a result, this manufacturing industry has sought assistance in implementing OEE in its sector. In this project, the method of pressure die casting (PDC), which contributes to a delay of manufacturing and delivery, was selected as the topic of analysis among the manufacturing procedures.

There are also problems in the machine, including the excessive time it takes for the mold to be mounted almost two hours. In the event of an unforeseen breakdown, preventive maintenance was only carried out once in 2 weeks. This creates the delay and contributes to great loss when accumulated, and the complete loss in the efficiency of the method needs to be quantified.

1.3 Objectives

The objectives of this study are:

i. To identify the problems occurred at the production line.

ii. To develop OEE database using time study.

iii. To analyze the area of improvement in the Pressure Die Casting process.

1.4 Scopes

This study will be focused on Overall Equipment Effectiveness (OEE) calculation. To ensure the objectives are achieved, some of the important elements must be considered:

i. This study is basically conducted at Dormakaba Production Malaysia Sdn. Bhd. in PDC process only.

ii. This study in mainly focused on the development of OEE in PDC process.

iii. The execution of this study covers two machines which are PDC 2 and PDC 4 instead of five machines in total.

iv. This study only covers the identification of the area of improvement.

1.5 Project Significant

The significant of the project are as follows:

i. To implement the OEE for the manufacturing industry and it will be useful.

ii. To calculate standard time by using direct time study.

iii. The results in the percentage of OEE will able to be improved.

iv. Non-valued added can be eliminated and the productivity can be improved.

1.6 Organization of Report

Table 1.1 demonstrates the organisation of the study. The table is based on sections covering the project background, issue statement, goals, scope and project. The

literature review in Chapter 2, the methodology in Chapter 3, and outcome and discussion in Chapter 4 and the conclusions and suggestion in Chapter 5.

Table 1.1: The Organization of Report

Topic	Subtopic	Explanation
Chapter 1	Project Background	Elaborate the project background where the topic is covered
	Problem Statement	Describe the problem occurs that lead to the project
	Objectives	Describe what are need to be achieved in this project
	Scopes	Involved the limitation of the project, the area of the project is being conducted and the method used to complete the project
	Project Significant	Explaining about the importance of the project and whether the project can be contributed for the betterment of industry
Chapter 2	Literature Review	Review the previous studies or projects that have been done from the source to be referred
Chapter 3	Methodology	Explain the exact method used to accomplish the aim of project and provide the sufficient detail

Chapter 4	Result and Discussion - Company Profile - OEE Technique - Direct Time Study Technique - OEE Analysis	A detail explanation of the results achieved and discussed the results Describe about the company profile and the details of the related production processes Elaborate in detail the OEE and Direct Time Study techniques
Chapter 5	Conclusion and Recommendation	Conclude the achievement of the project State whether the project is successful or not Identify the recommendation for the future works

1.7 Summary

Chapter 1 comprises of seven sub capitulations that form the basis of the project, the declaration of issue, goals, scope, project importance, organization of the project, and a summary. The background of the project shows the significance in the sector and the variables engaged in the OEE calculation of general machinery effectiveness (OEE). The next subchapter is the issue declaration. A powerful issue declaration based on the actual situation in the sector is essential to take a closer look at this project. At the end of the project, then, there are four primary goals to achieve. For the project's scope, the priorities for project development, the limitation, the area and the project's methodology are described. The main point of this project is the significant project. Finally, every chapter is provided by the sector with an overview.

CHAPTER 2

LITERATURE REVIEW

The main idea of this section is to gain knowledge of the OEE notion by examining the lean production principles that cover OEE variables. Furthermore, this section discusses how and when OEE operates in the manufacturing sector. Moreover, the notion of moment and standard time is given in this section.

2.1 Overall Equipment Effectiveness (OEE)

Akansel *et al.* (2017) stated that the Overall Equipment Effectiveness (OEE) classic or general definition is the result of availability, performance, and quality. Overall Equipment Effectiveness (OEE) is one of the metrics for managing a production business successfully. In order to manage sustainability, OEE is also essential. Nakajima created the OEE measuring tool in 1998 using the notion of Total Productive Maintenance (TPM). Williamson R.M. (2006) indicated that the OEE is defined as the overall efficiency measure of equipment to be used by the equipment. Bulent Dal *et al.* (2000) also indicated that the OEE will be used at some stage to track and track the development of improved machinery efficiency. Ericsson J. (1997) argued that the cost of manufacturing loss, whether direct or indirect, contributed to the greater part of the overall cost of manufacturing. Nakajima (1988) argued that such concealed expenses can be disclosed only by OEE as a measuring tool. Szwedzka et al. (2015) evaluated OEE in six large losses that primarily depend on accessibility, efficiency and quality parameters as illustrated in Figure 2.1.

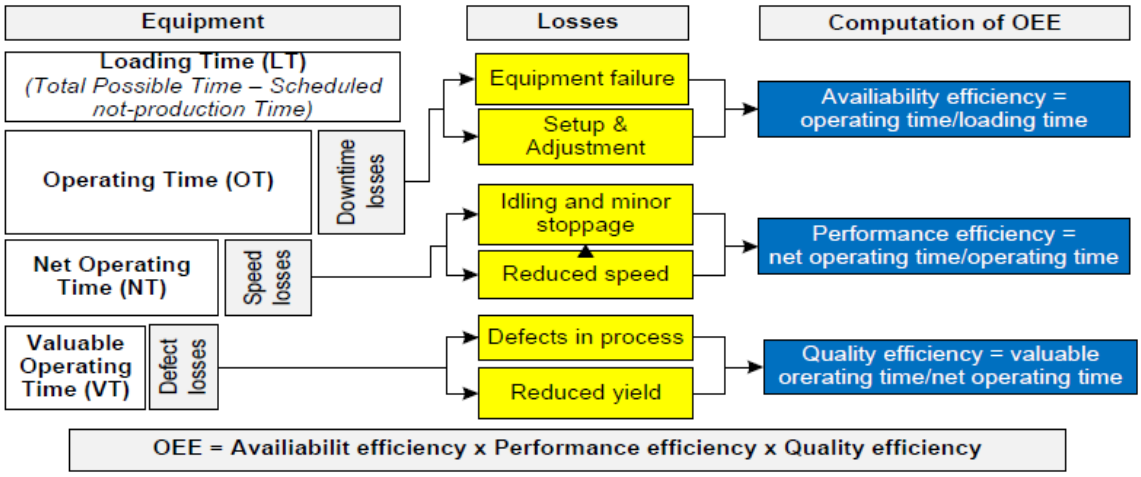

Figure 2.1: Six Big Losses

OEE has a generic model of its own. This model demonstrates how the OEE calculation is determined and how the OEE percentage contributes. The significant losses in production line have been dedicated to every factor in OEE. The significant losses in manufacturing can sometimes be eliminated or enhanced to increase the effectiveness of the production line. One of the biggest losses is changing moment and set-up time. It cannot be eliminated because the machine has a time to start the machine when manufacturing runs down. The losses can be decreased in order to enhance productivity, like changing time and installation time. In terms of availability, efficiency and quality, Figure 2.2 demonstrates the overall model of the OEE.

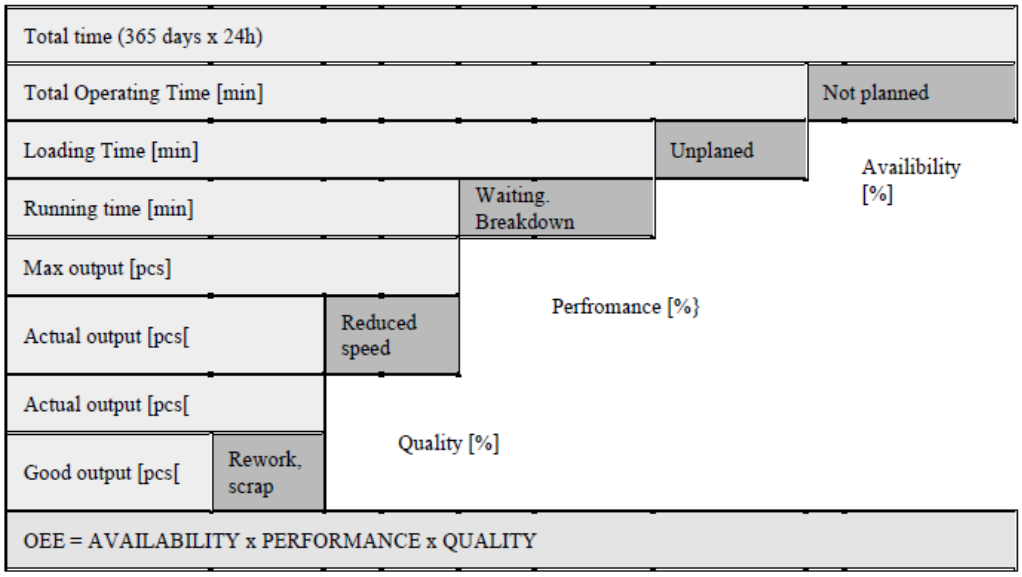

Figure 2.2: General Model of OEE

2.2 Overall Equipment Effectiveness Factors

Lahri and Pathak (2015) found that OEE is an indicator of performance for monitoring the effectiveness of the casting die process. OEE is a management tool for measuring and evaluating the productivity of plant floors, especially in the manufacture of door closures. OEE is classified into three parameters which are Availability, Performance and Quality as shown in Figure 2.3. These measuring parameters help to measure the efficiency and efficiency of the plant. These parameters also categorized the main losses in productivity that occurs in the production process. In addition, OEE also enhances manufacturers ' quality, consistency, sustainability and productivity to enhance their manufacturing line. Almeanazel (2010) provided the percentage of OEE in the world class manufacturing is 85% and the world class measurement for each parameter is shown in Table 2.1.

Figure 2.3: Three Parameters of OEE

Table 2.1: World Class Measurement for Three Parameters

Parameters	OEE world class
Availability	90%
Performance	95%
Quality	99%

2.2.1 Availability

Availability can be defined as the performance during the possible loading time of the machines or workers. The production time excludes the planned downtime such as breaks, meetings, cleaning, etc. The machines can be defined when the machines stop for repairs or changes. Sometimes the downtime is called the downtime. Almeanazel (2010) has claimed that the production of the formula of this supply provides the real accessibility of the equipment. In general equipment effectiveness (OEE) the value derived from a formula is also used to evaluate equipment effectiveness. The availability is calculated as described in the following formula:

$$\text{Availability} = \frac{\text{Total time} - \text{Total downtime}}{\text{Total time}} \times 100\% \qquad \text{Equation 2.1}$$

Alex *et al.* (2014) investigated the time when the machine was planned, planned or assigned to run is included in the availability. The availability examines the machines themselves and concentrates more on the absorption of variable costs.

2.2.2 Performance Efficiency

P. Nelson Raja (2007) stated that the working time is known first in order to calculate the device's performance effectiveness. This is because the working time is required to achieve the proportion of effectiveness. Working time is defined as exclude the planned and unplanted downtime and set-up times for the entire working time of a shift device. The velocity loss occurred during manufacturing is the performance efficiency. The loss of velocity takes into account all variables that reduce the optimum velocity of the equipment. Ngadiman *et al.* (2013) recognized that how much time waste is generated during the process is the proportion of results. Alex *et al.* (2014) calculated performance efficiency as shown in Equation 2.2:

$$\text{Performance} = \frac{\text{Actual Output (units)} \times \text{Theoretical Cycle Time}}{\text{Operating Time}} \qquad \text{Equation 2.2}$$

2.2.3 Quality Rate

Maran *et al.* (2012) stated that from a manufacturing perspective, the quality rate in OEE is measured by the percentage of good products produced (specification compliance) or sometimes referred to as yield. Moreover, the quality rate can be described as quality loss. Sharma *et al.* (2017) described quality loss as variables during the production of parts not meeting the quality standards, including products for scraping and processing. The quality rate is also measured as the amount of components that comply with the manufacturing requirements in total. Alex *et al.* (2014) expressed quality rate as shown in Equation 2.3:

$$\text{Quality} = \frac{\text{Actual output (units)} - \text{Defect amount (units)}}{\text{Actual output (units)}} \quad \text{Equation 2.3}$$

2.3 Major Equipment Losses

Perumal Puvanasvaran and Y.S. Teoh (2013) claimed that the improvement programs depend not only on the OEE but also on clarifying the losses during production to be more efficient. Losses can be called resource-related activities but do not create values. Losses can be divided into three types, which are the frequency of occurrence, the causes and the type. Nakajima has identified six types of losses associated with equipment called Six Big Losses. They are losses of breakdown, loss of setup and adjustment, idling (minor stoppages), loss of speed (production capacity), quality defects and rework and loss of start- up yield, losses of downtime used to determine the real value of the machine's availability. Three categories of the Six Big Losses were classified. The losses for break-down, set-up and adjustment are in the same class, as time losses during idling, small stops and decreased velocity in the category of velocity losses. Alex *et al.* (2014) identified the losses in quality and decreased yield in category quality. The OEE loss category (Downtime, Speed and Quality) is listed below in Table 2.2 with the six main loss categories and examples of events that could occur in a machine manufacturing process that reduces productivity. These loss categories help to reduce the overall simple equipment OEE value. Chronic and sporadic manufacturing process disturbances as shown