PRODUCTIVITY IMPROVEMENT USING OVERALL EQUIPMENT EFFECTIVENESS IN SEMICONDUCTOR INDUSTRY

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MASTER OF MANUFACTURING ENGINEERING
(MANUFACTURING SYSTEM ENGINEERING)

2021

Faculty of Manufacturing Engineering

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A thesis submitted
in fulfillment of the requirements for the degree of
Master of Manufacturing Engineering (Manufacturing System Engineering)

Faculty of Manufacturing Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DECLARATION

I declare that this thesis entitled "Productivity Improvement Using Overall Equipment Effectiveness in Semiconductor Industry" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : USHANANTHINI A/P CHINNAPPAN

Date : 25/08/2021

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Manufacturing Engineering (Manufacturing System Engineering).

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Date : 25/08/2021

DEDICATION

TO MY BELOVED FAMILY, LECTURERS AND FRIENDS.

ABSTRACT

As manufacturing has gone global and the market are getting more competitive every manufacturing facility must improve its process to remain competitive. To maintain and develop their ability to compete in a global market, production companies as an example semiconductor industry need to be effective in producing innovative and short lead times with high quality products and designing strong and flexible manufacturing system that provide the best preconditions for operational excellence. There are many approaches have been established to support the development of production processes, but Overall Equipment Efficiency (OEE) is the best practices to monitor and improve the production process. Therefore, OEE chosen as a viable approach for this project to calculate the competence of the production testers of XYMicroelectronics Sdn.Bhd.The OEE trends show that there are some issues and problems faced by the production that cause the operating testers do not achieve the targeted productivity level. It is identified that the OEE of test department drop due to the frequent downtime of the machines. Downtime is one of the biggest culprits for bringing down a plant's OEE because it can take a huge of time out of our planned production time. This project is to identify the current performance and effectiveness of XYMicroelectronics Test Department production machines through OEE measurement. Other than that, this projects is also to identify the cause of tester downtimes during production and propose potential process improvement to increase the productivity and achieve production OEE target. Methodology planning was carried out to ensure that all the data and information collected during the data collection process was sufficient to satisfy the research objective requirements. By tracking machine performance, the OEE is used to calculate machine performance and increase the efficiency in terms of production output. At XYMicroelectronics the average value overall equipment effectiveness of the ETS 800 at Quarter 1 (Jan'20 – Mar'20) was 58.4% and Quarter 2 (Apr'20 – Jun'20) was 54.9%. During Quarter 3 (July'20 – Sept'20) efforts were made through the implementation of an effective strategy in the industry. The average value OEE of the ETS800 testing machine was increased from 54.9% to 68.8% through the implementation of proper training, planning production, 5S implementation, availability, better utilisation of resources, and raised employee morale and confidence. This implies a 13.9% increase in average OEE from before to after the implementation of continuous improvement. It is essential to reduce production losses and achieve greater competitiveness. Other than that, improvement in OEE will reduce the complex production problems into simple, accessible information that will make right decision and reduce operating expenses.

ABSTRAK

Oleh kerana global dan pasaran sistem pembuatan menjadi semakin kompetitif, setiap industri pembuatan mesti meningkatkan prosesnya agar tetap kompetitif. Untuk mengekalkan dan mengembangkan kemampuan mereka untuk bersaing di pasar global, syarikat produksi contoh industri semikonduktor perlu efektif dan inovatif dalam menghasilkan produk berkualiti tinggi dengan jangka masa pendek dan merancang sistem pembuatan yang kuat dan fleksibel yang memberikan prasyarat terbaik untuk kecemerlangan operasi. Terdapat banyak tindakan yang telah dibuat untuk mendukung pengembangan proses produksi, tetapi "Overall Equipment Efficiency" (OEE) adalah langkah terbaik untuk memantau dan meningkatkan proses produksi. Oleh itu, OEE dipilih sebagai pendekatan yang layak untuk projek ini untuk mengira kecekapan mesin pengeluaran XYMicroelectronics Sdn.Bhd. Trend OEE menunjukkan bahawa terdapat beberapa masalah dan masalah tersebut menyebabkan golongan operasi tidak mencapai tahap produktiviti yang disasarkan. Didapati bahawa OEE mesin di XYMicroelectronics merosot kerana sering kali mesin berhenti untuk jagka masa panjang. Waktu Henti mesin adalah salah satu penyebab terbesar untuk menjatuhkan OEE industri kerana ini memerlukan banyak masa daripada masa pengeluaran yang dirancang. Projek ini adalah untuk mengenal pasti prestasi dan keberkesanan mesin pengeluaran XYMicroelectronics melalui pengukuran OEE. Selain daripada itu, projek ini juga bertujuan untuk mengenal pasti punca masa berhenti mesin semasa pengeluaran dan mencadangkan peningkatan proses yang berpotensi untuk meningkatkan produktiviti dan mencapai sasaran OEE. Perancangan metodologi dilakukan untuk memastikan bahawa semua data dan informasi yang dikumpulkan selama proses pengumpulan data cukup untuk memenuhi persyaratan objektif penelitian. Dengan mengesan prestasi mesin, OEE digunakan untuk mengira prestasi mesin dan meningkatkan kecekapan dari segi output pengeluaran. Di XYMicroelectronics, nilai purata keseluruhan keberkesanan peralatan ETS 800 di Quarter 1 (Jan20 - Mar'20) adalah 58.4% dan Quarter 2 (Apr20 - Jun'20) 54.9%. Di Quarter 3 (20 Juli - 20 September) usaha dilakukan melalui penerapan strategi yang efektif dalam industri. Nilai rata-rata OEE mesin ujian ETS800 meningkat dari 54.9% menjadi 68.8% melalui pelaksanaan latihan yang tepat, merancang produksi, pelaksanaan 5S, ketersediaan, penggunaan sumber daya yang lebih baik, dan meningkatkan semangat dan keyakinan karyawan. Ini menunjukkan peningkatan purata OEE sebanyak 13.9% daripada sebelum pelaksanaan teknik penambahbaikan. Adalah mustahak untuk mengurangkan kerugian pengeluaran dan mencapai daya saing yang lebih besar. Selain itu, peningkatan dalam OEE akan mengurangkan masalah pengeluaran yang kompleks menjadi maklumat mudah dan mudah diakses yang akan membuat keputusan yang tepat dan mengurangkan perbelanjaan operasi.

ACKNOWLEDGEMENTS

Firstly, I would express my gratitude to God Almighty for blessing and wisdom given to me to complete this Masters. Secondly, I also wish to convey my heartfelt gratitude to my coordinator PM Dr. Nur Izan Syahriah Bt Hussein and my supervisor TS. Dr. Al Amin bin Mohamed Sultan for all the support, guidance, and willingness to spend additional time on the project discussion. Special thanks to Mrs. Xiaofen Lo, XYMicroelectronics Test Manager for guidance and support during this project. Finally, I would like to thank my parents for the prayers and support given to me always.

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LIST OF SYMBOLS AND ABBREVIATIONS

A	-	Availability
ADG	-	Automotive and Discrete Group
AM	-	Autonomous Maintenance
ASIC	-	Application-Specific Integrated Circuits
DMAIC	-	Define, Measure, Analyze, Improve and Control
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
FBD	-	Fish Bone Diagram
GPE	-	Global Process Effectiveness
HMLV	-	High-Mix-Low-Volume
IC	-	Integrated Circuit
IIoT	-	Industrial Internet of Things
IoT	-	Internet of Things
KPI	-	Key Performance Indicator
LMHV	-	Low-Mix-High-Volume
MEE	-	Machining equipment effectiveness
MES	-	Manufacturing Execution Systems
OEE	-	Overall Equipment Efficiency
OLE	-	Overall Line Effectiveness
P	-	Performance
PA	-	Pareto Analysis
PCB	-	Printed Circuit Board
PM	-	Preventive Maintenance
Q	-	Quality
RCFA	-	Root Cause Failure Analysis
ROI	-	Return of Investment
SMED	-	Single Minute Exchange of Die
SOP	-	Standard Operating Procedures
SPC	-	Statistical Process Control
TPM	-	Total Productive Maintenance

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CHAPTER 1

INTRODUCTION

1.0 Overview

This introduction chapter comprises six sections which are aimed to provide the general understanding of what, why, where, who and how this study has been carried out. First, this chapter starts with the background of the study which explains the overview of the project and then followed by the problem statement of this project. The objective, scope and significance of the study are also covered subsequently in order throughout the chapter to provide clearer information. In the final part of this chapter, an outline of the thesis and the research planning is covered.

1.1 Background of the Study

As manufacturing has gone global and the market is getting more competitive day by day over period, manufacturing facilities must constantly lookout and improve their process to remain competitive. To maintain and develop their ability to compete in a global market, manufacturing companies especially semiconductor industries need to be effective in producing innovative and short lead times with high-quality products and designing strong and flexible manufacturing systems that provide the best preconditions for operational. Many approaches have been established to support the development of production processes, as such Overall Equipment Efficiency (OEE) is the best practice to monitor and improve the production process.

A Total Productive Maintenance (TPM) idea was mooted by a person named Nakajima (1988) to give a quantitative metric, namely the OEE, for calculating the

productivity of individual equipment in a production plant. OEE is the maintenance of a Key Performance Indicator (KPI) that measures the strengths level of productivity. The three significant parameters that constitute the OEE product are availability, output rate, and quality rate. The key contribution affecting the efficiency of the machines is the six big losses such as breakdowns, setup and changes, minor stops, reduced speed, start-up rejects, and output rejects.

Figure 1.1 Tester platform at XYMicroelectronics Sdn.Bhd.

Therefore, OEE was chosen as a viable approach for this project to calculate the competence of the production testers of XYMicroelectronics Sdn.Bhd. Figure 1.1 shows the tester platform of XYMicroelectronics where this project conducted. The OEE outcome will be used to assess the current performance of the plant and from there it will be beneficial to seek the enhancement factor. XYMicroelectronics Sdn.Bhd. is a Franco-Italian multinational electronics and semiconductor company that is headquartered in Geneva, Switzerland. This

industry consists of around 4000 employees and this site built in 1974 by Thomson which is currently operating as an assembly plant. The goal of this organisation is to achieve innovative product manufacturing to the market with constant delivery supply at the right time, while being cost-competitive, the right level of quality and the appropriate level of support.

The research will be performed at XYMicroelectronics Sdn.Bhd. and within the test department which will include real-time data collection and analysis. The performance rate of the tester, availability of the tester, and the product's quality rate are termed to be crucial parameters for optimizing the OEE of the production. Other than that, the data collection for this project will be easy as the test department's product amount and total time elapsed on each production are computerized which is automatically recorded by the system at the production.

1.2 Problem Statement

OEE is a best practice method of determining the actual effective percentage of expected production time. According to Oliveira et al. (2019), OEE is considered not only to be one of the most significant measurements used by manufacturing industries to track efficiency and quality, but also to indicate and inspire performance improvements. Furthermore, the introduction of an efficient method for improving efficiency and contributing to the development of industry sectors is very important. Oliveira et al. (2019) stated that there are several obstacles pushing organizations to integrate various efficiency changes to meet the demands of ever-changing consumer demand.

A data collection is done at one of the test departments in XYMicroelectronics to identify the problem related to production machines that caused the OEE to drop. Based on collected data as in Table 1.1 and a graph is plotted as shown in Figure 1.2 at one of the test

departments and the OEE trends show that there are some issues and problems faced by the production that causes the operating testers to do not achieve the targeted productivity level. From the table and the trend, this company failed to achieve the targeted OEE at Quarter 1 which is from month January 2020 to March 2020 and for Quarter 2 from the month April 2020 to Jun 2020.

Table 1.1 Data of OEE for 10 testers collected from one of the Test Department at XYMicroelectonics.

Tester Type	**ETS-800**
Number of Tester	10
Quarter1 2020 (Jan - Mar)	58.4%
Quarter2 2020 (Apr – Jun)	54.9%
Jan'20	54.2%
Feb'20	62.3%
Mar'20	58.7%
Apr'20	58.7%
May'20	56.0%
Jun'20	50.1%
Quarter1 2020 Target	64.0%
Quarter2 2020 Target	***64.5%***

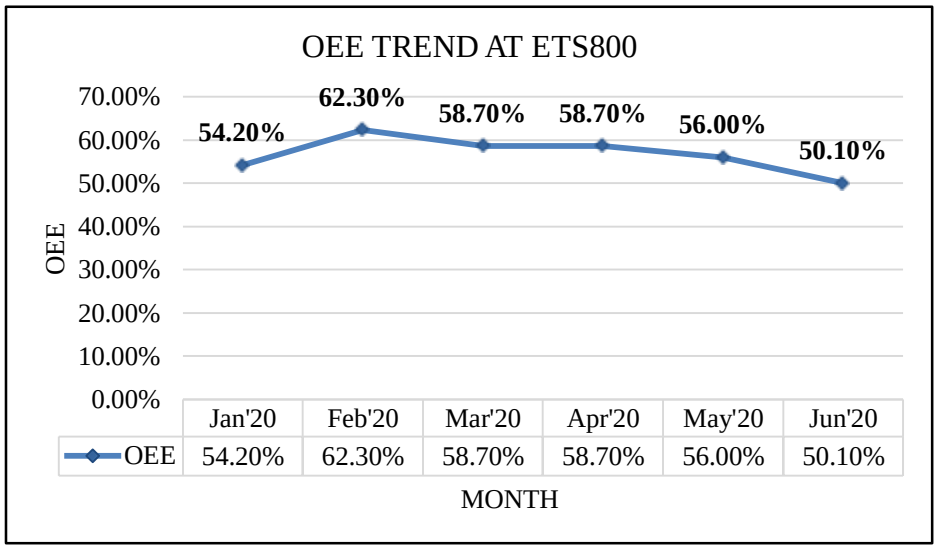

Figure 1.2 OEE trend of ETS800 tester at one of the test department.

It is identified that the OEE of the test department drops due to the frequent downtime of the machines. Downtime is one of the main culprits in bringing down the OEE of a factory because it can take a massive amount of time out of our scheduled production time. It is also one of the most difficult factors to repair, as there can be so many problems that could affect it, such as equipment breakdowns, unplanned maintenance, setup or changeover, and material shortages. It was very clear that the operators had wasted a lot of time, but not in terms of intention. There were many and several different forms of all the steps the operators had to take to run the machine. Other than downtime, speed loss is also one of the factors causing the OEE to drop and affect the productivity of the test department. These losses occur when the equipment stops for a short time because operators had to stop the machine to fix a temporary problem such as component jams due to operator efficiency. Hence, OEE was chosen as a proper measurement to identify the root causes that impede the test department productivity.

1.3 The Objectives of the Study

The primary objectives of this studies are as following:

a) To identify current performance and effectiveness of XYMicroelectronics Test Department production machines through OEE measurement.

b) To identify the cause of tester downtimes during production.

c) To implement potential process improvement to increase productivity and achieve the production OEE target.

1.4 Scope of the Study

The study was carried out to improve the productivity of manufacturing thorough OEE and the limitations of the study are outlined as follows. First, it is important to identify a suitable industry to carry out this project. The organization should be open-minded and

adopt the changes made throughout this project. This study is set in XYMicroelectronics Sdn.Bhd which involves the principles of efficiency, availability, and effectiveness of production machine. The study is narrowed down to only one the test departments in XYMicroelectronics and the focus is only on ETS800 testers. From the overall OEE of XYMicroelectronics testers, it is found that this area has the highest machine downtime and speed loss cases compare to another department. The study is observed from the operators start to operate the testers until unloading the tested product to understand the equipment losses and operator efficiency.

1.5 Significant of the Study

OEE is one of the best measures of efficiency in the manufacturing industries which play an important role in improving the quality and performance of a product. OEE is also a powerful KPI focusing on equipment availability, performance efficiency and quality rate. This OEE project will reduce breakdowns, increase the rate of performance and quality, and thereby improve the machine's productive capacity. It is essential to reduce production losses and achieve greater competitiveness. It is because improving an OEE system identifies operator downtime reasons and highlight the lengthy changeovers or the set-up times. By using this information, it will be helpful for the management to allocate resources and to identify where are the extra capacity or any new hires needed. Other than that, improvement in OEE will reduce the complex production problems into simple, accessible information that will make the right decision and reduce operating expenses. The product amount and total time elapsed on each production are computerized which is automatically recorded by the system at the production. It will be a challenging project because, while OEE can provide operational measures with a structured process, the data must be collected at the correct time

from the right place and then presented in the correct format before making any decisions in the right locations.

1.6 Thesis Outline

This study is consisting of five (5) chapters based on the objectives stated previously and the content of each chapter are summarized as follows. Chapter 1 begins with the introduction of the project which made up of the background of the study, problem statement, and objectives of the study. The scope and significance of the study concerning OEE improvement are also explained at the end of this chapter. Research plan is attached in Figure 1.3 to assist and monitor the progress of the project.

The next chapter briefly discusses the research from other researchers and theories related to the project. This chapter begins with an overview of the effectiveness, productivity, and efficiency of OEE. The chapter continued with the definition of OEE, the benefit of OEE, factors of OEE, OEE calculation, an example of OEE measurement, and losses in the industry which will be explained more on planned versus unplanned downtime losses. For a clearer understanding, the chapter derived in detail on six big losses and. Later, this chapter presents the application of OEE and compile the issues and challenges faced by OEE from various literature studies. A brief explanation shown on the data collection, TPM and Root Cause Failure Analysis (RCFA) for OEE and in the last part of this chapter the summary of all literature studies related to OEE is also presented.

Chapter 3 is made up of methodology, to ensure that all the data and information obtained during the data collection phase were suitable to meet the requirement of the study objectives. This chapter is the outlines how the methodology was planned and executed. Then, data collection method, calculation method, approaches to data analysis practiced by