YIELD IMPROVEMENTS IN SEMICONDUCTOR MANUFACTURING USING TRIZ METHODOLOGY

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA
2018

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

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2018

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Sesi Pengajian: **2017/2018 Semester 2**

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I hereby, declared this report entitled “Yield Improvements In Semiconductor Manufacturing Using TRIZ Methodology” is the result of my own research except as cited in references.

Signature : ……

Author’s Name : SEE LI XIN

Date :

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee are as follow:

……

(PROFESSOR DR. CHONG KUAN ENG)

ABSTRAK

Dalam persekitaran yang kompetitif ini, setiap pengilang perlu meningkatkan prestasi. Banyak syarikat dikehendaki memohon banyak program mengenai peningkatan produktiviti supaya dapat bertahan di dunia nyata. Syarikat yang dapat memenuhi keperluan pelanggan dengan kualiti yang lebih baik dapat melebihi pesaingnya. Kajian ini adalah mengenai peningkatan hasil dalam pembuatan semikonduktor menggunakan metodologi TRIZ. Kajian ini dijalankan di sebuah syarikat semikonduktor yang terletak di Melaka. Syarikat sekarang sedang menghadapi masalah pengeluaran yang rendah. Syarikat kes telah mengenalpasti bahawa proses kesesakan itu berada dalam kawasan ujian. Mesin di kawasan ujian telah menyumbang Overall Equipment Effectiveness (OEE) yang rendah. Syarikat kes ini ingin meningkatkan OEE mesin dengan meningkatkan hasil kualiti. Oleh itu, syarikat itu merancang untuk meningkatkan parameter kualiti di jabatan ujian dan dengan itu dapat meningkatkan OEE mesin. Oleh itu, keluaran syarikat dapat ditingkatkan. Kajian ini akan memberi tumpuan kepada parameter kualiti di jabatan ujian. Tujuan projek ini adalah untuk meningkatkan OEE dengan meningkatkan kualiti mesin. Untuk memenuhi objektif, tiga jenis menolak yg tertinggi telah dikenal pasti menggunakan carta Pareto. Selepas itu, punca utama kritikal telah dikenal pasti untuk jenis menolak menggunakan Ishikwa rajah. Kaedah Theory of Inventive Problem Solving (TRIZ) digunakan untuk mencadangkan penyelesaian yang boleh dilaksanakan. Terdapat lima penyelesaian yang dicadangkan kepada syarikat kes dan tiga daripada penyelesaian telah dijalankan untuk diuji kerana kekangan masa. Hasilnya meningkat sekitar 0.5% berdasarkan data yang diperolehi. Peningkatan ini boleh memberikan keuntungan sebanyak RM 500,000. Oleh itu, peningkatan hasil boleh memberikan keuntungan kepada syarikat kes itu.

ABSTRACT

In this full of competitive environment, every manufacturer has to increase the performance. Many companies are required to apply a lot of programs regarding the increasing of the productivity so can survive in the real world. A company which can fulfil the customer need with the better quality may exceed its competitors. This study is about yield improvement in semiconductor manufacturing using TRIZ methodology. This study is carried out at a semiconductor company which is located at the Melaka. The company is currently facing the low throughput. The case company had identified that the bottleneck process is in the testing area. The machine in the testing area had contributed the low Overall Equipment Effectiveness (OEE). The case company desire to improve the OEE of the machine by improving the quality yield. So, the company plans to improve the quality parameter in the testing department and therefore can increase the OEE of the machine. Therefore the throughput of the company can be improved. This study will focus on the quality parameter in the testing department. The aim of the project is to improve the OEE by improving the quality of the machine. To fulfil the objectives, the top three significant reject types were identified using the Pareto chart. After that, the critical root causes were identified for the significant reject types using Ishikawa diagram. Theory of Inventive Problem Solving (TRIZ) methodology was used to propose the feasible solution. There are five solution that proposed to the case company and three of the solutions were carried the pilot run due to time constraint. The yield was improved around 0.5% based on the data obtained. The increment can earn a profit of about RM 500,000. So, the yield improvement can give the profit to the case company.

DEDICATION

I would like to dedicate my thesis to my beloved family members, supervisor and friends.
Thank you for the unconditional loves, understandings and supports.
Love you all forever.

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TABLE OF CONTENT

APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

A	-	Availability
ABS	-	Antilock Braking System
ATV	-	Anti-Theft Vehicle
C&E	-	Cause & Effect Diagram
CCS	-	Chip Card & Security
CECA	-	Cause and Effect Chain Analysis
CM	-	Corrective Maintenance
CTE	-	Cycle Time Effectiveness
DMAIC	-	Define, Measure, Analyse, Improve, Control
E	-	Expectation
FMEA	-	Failure Mode and Effect Analysis
FYP 1	-	Final Year Project 1
FYP 2	-	Final Year Project 2
ICs	-	Integrated Circuits
IPC	-	Industrial Power Control
JIPM	-	Japan Institute of Plant Maintenance
LED	-	Light Emitting Diode
MP	-	Maintenance Prevention
OEE	-	Overall Equipment Effectiveness
OTE	-	Overall Throughput Effectiveness
P	-	Performance
PC	-	Personal Computer
PE	-	Performance Efficiency
PM	-	Preventive Maintenance
PMM	-	Power Management & Multimarket
Q	-	Quality
QIs	-	Quality Improvements
RQ	-	Rate of Quality
SEMI	-	Semiconductor Equipment Materials International

SIM	-	Subscriber Identification Module
SOP	-	Standard Operating Procedure
SPC	-	Statistical Process Control
TFM	-	Total Fabrication Maintenance
TPM	-	Total Productive Maintenance
TPS	-	Toyota Production System
TRIZ	-	Theory of Inventive Problem Solving
UK	-	United Kingdom
USA	-	United States of America
UTeM	-	Universiti Teknikal Malaysia Melaka

CHAPTER 1
INTRODUCTION

The background of study and information about the case company are introduced in this chapter. The problem statement and the purpose of increasing quality in the industry is shown. The objectives are well-defined followed by the scope which set the boundaries of this study. Lastly, the significance of the study and organization of the report is delivered in this chapter.

1.1 Background of Study

Nowadays, every manufacturer has to increase the performance when the economy nowadays are becoming more competitive. Many companies are required to apply a lot of programs regarding the increasing of the productivity so can survive in the real world (Ng *et al.* ,2014). A company which can fulfil the customer need with the better quality may exceed its competitors (Kurniati *et al.* ,2015).

The fundamental for being in the world is to fulfil the customer requirement and satisfaction. Customer need a product with a high quality, but low cost, and the product can get on time (Madanhire and Mbohwa, 2016). Semiconductor manufacturer have the big hope on the quality and the competitor is so powerful, so they have to overcome the challenge (Chandurkar *et al.*, 2015). The semiconductor manufacturer keep finding the way for the yield improvement so that can chase the technology recently. It is a major problem that company want to decrease the rework and the defects when the assembly process. There are a lot of reason that can cause the yield losses and therefore can increase the costs. So it is important to inspect the manufacturing process of the products. Based on the research done, identified the root cause is a very hard problem of engineering. There are many factors that

can contribute the yield losses (Rokach and Hutter, 2012). Hence, quality tool need to integrate to improve the yield.

A completed product can have a few behaviour of quality. A product is identified fail or fulfil requirement by comparing with the standard products. Continuous monitor the products can make sure the products meet the specification. The machine play an important role as the reason for the product to be fail maybe come from the previous process. The performance of the machine will give an effect on the quality of the product. (Chen *et al*., 1997)

There are several techniques have been established to backing the enhancement of production processes, exclusively in Japan during its industrial development quest. A familiar method which is total productive maintenance (TPM) that technologically advanced by S. Nakajima in 1971 (Becker *et al.,* 2015). Company need to increase their production system to adjust and decrease the overall production cost in line for to the above industrial challenges. This is generally driven by customers' requirement for product price reduction. The quality, delivery, cost and flexibility have to satisfy the customer requirements. (Eng and Choi, 2016)

In this day and age, customer wants the thing that buy to have the amazing quality, trustworthy transport and reasonable valuing. This requests that the producer's machines and progressions are highly reliable (Bon and Ping, 2011). TPM has the aim of aggregate the production equipment effectiveness. There are six types of losses that can be recognised and reduced. The losses are failure of equipment, set-up and adjustment times, idling and minor stoppages, reduced speed of equipment, defects in process, and reduced yield. Overall equipment effectiveness (OEE) is introduced by TPM to measure equipment effectiveness as backbone for eliminating these losses. By constantly evaluating the effectiveness of tools, production managers and workers can react quickly to eventual production troubles and that aids them to circumstance standard and lasting continuous improvement programmes (Becker *et al*., 2015).

Recently, in the semiconductor company OEE has generally accepted. Executives gain such grouped metric rather than many detailed metrics because OEE is an easy and flawless overall metric. In semiconductor manufacture company, there is quantitative tool

that is crucial to the yield measurement which is OEE. OEE has been broadly used as its risky capacity controlled facility investment. The traditional ways for determining yield, throughput, and application are lacking in problems findings and core enhancements required to growth production (Ron and Rooda, 2005).

OEE has three general parameters which is availability, performance efficiency, and rate of quality. Availability is to measure the effectiveness of remain the tools in a capable condition. SEMI E10-96 creates metrics for computing tools reliability, availability, and maintainability. Performance Efficiency can look on the effectiveness on the way equipment been used in production. Next, Rate of Quality is to evaluate the effectiveness of the industrial process to reduce scrap, rework and yield loss(Pomorski, n.d.).

Effectiveness is presented below in Equation 1.1 where A=Availability, PE=Performance Efficiency and RQ=Rate of Quality

$$OEE = A \times PE \times RQ \quad \text{Equation 1.1}$$

On the other hand, the equation of these parameters is established on the common definition and approaches. There are several techniques to calculate the parameter of OEE. Some company will modified the equation. This will not provide an accurate value for the OEE metric. The set point of standard value maybe incorrect when the performance measures of the tool is not appropriate. Thus, the control or enlargement will not achieve satisfactorily.

1.2 Background of Case Company

This project is conducted in a global semiconductor maker company located in Melaka. The company is a German based company. The company has been continuously developing its operation by expanding the manufacturing facilities, test equipment and adding new product.

The company is a world forerunner in the semiconductor arrangements that intended to make the life easier, more secure and greener. The company involves in assembling in

addition testing of discrete semiconductors, power semiconductors, logic ICs and sensor products. As of 30 September 2017, the company had about 37,500 workers universal. In the economic year of 2017, the business reached sales of €7.1 billion. Frankfurt Stock Exchange and the USA on the over-the-counter market International Premier had recorded this company.

The corporation consist of four business segments. One of it is automotive (ATV). The company provides semiconductor products for use in powertrains, comfort electronics such as steering and also safety systems such as airbags and ABS. The manufactured goods collection includes microcontrollers, power semiconductors and sensors.

Industrial Power Control (IPC) also one of the business segments. The industrial separation of the organization contains regulator semiconductors and modules that utilized for age, transmission and utilization of electrical energy. Its tender ranges cover mechanism of electric energies for modern tools and family unit machines, modules for sustainable power source creation, conversion and transmission.

Another business segment is Chip Card & Security (CCS). CCS are useful for the cell phone SIM cards, safety chip. Furthermore, chip-based are used for travel papers, personality cards and also the authority records. The company passes on countless for the new German character card. CCS gives ways for applications with high security necessities.

On the other hands, Power Management & Multimarket (PMM) also another segments. The separation Power Management & Control aggregates up the business with semiconductor parts for effective power administration or high-recurrence applications. The discover application in lighting administration frameworks and LED lighting, control supplies for servers, PCs, laptop and purchaser devices, consumer gadgets for fringe devices, game consoles, applications in therapeutic innovation, high-recurrence segments having a defensive capacity for correspondence and tuner frameworks and silicon MEMS receivers.

The world's growth populace, the big city and the increasing demand for vitality is encouraging the company to reconsideration numerous parts of present days of life. Semiconductor and framework arrangements from the organization add to a superior future which is making the world easier, more secure and environmental friendly. These minor,