UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DMAIC APPROACH TO IMPROVE EQUIPMENT EFFICIENCY

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

By

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ABSTRAK

Dalam dunia yang kompetitif hari ini, sektor pembuatan sedang menghadapi pelbagai cabaran untuk meningkatkan produktiviti dan mengurangkan kos. Dalam industri semikonduktor , kos mesin membentuk bahagian terbesar pelaburan modal pengilang dan dengan itu untuk memastikan penggunaan maksimum mesin ini adalah salah satu kebimbangan utama syarikat. Kecekapan mesin ini secara langsung ditentukan oleh mesin uptime, utilizations dan kelajuan proses, meningkatkan uptime secara langsung akan meningkatkan kecekapan mesin. Projek ini berpusat di sebuah syarikat pembuatan semikonduktor back-end berhadapan dengan downtime yang tinggi pada satu mesin penguji. Tujuan kajian ini adalah untuk meningkatkan kecekapan mesin penguji; yang dicapai dengan 3 objektif: (1) memahami aliran proses pembuatan untuk End of Line (EOL) di syarikat kes (2) menentukan mesin penguji (taping mesin) downtime dan (3) penyelesaian yang dicadangkan dengan menggunakan Six Sigma DMAIC (Define, Measure, Analyze, Improve and Control) metodologi untuk mengurangkan downtime mesin. Dalam Define fasa, masalah itu boleh ditentukan melalui pemahaman proses pengeluaran. Seterusnya , dalam fasa Measure, 2 bulan data sejarah downtime taping mesin akan diambil dari sistem TFM. Selepas pengumpulan data , Pareto Diagram dan Cause and Effect Diagram akan digunakan untuk menganalisis punca utama downtime mesin. Masalah Test Head , Masalah Flipper dan Lewat Response Time adalah tiga sebab utama untuk taping mesin downtime tidak berjadual. Dalam Improve fasa, beberapa penyelesaian yang dicadangkan kepada syarikat kes untuk mengatasi downtime mesin yang tinggi. Untuk Masalah Test Head, penyelesaian yang dicadangkan adalah menggunakan Pogo pin alat untuk menggantikan haus pin dan menggunakan plug dan play konsep. Plug dan play konsep juga boleh digunakan dalam Masalah Flipper. Untuk Lewat

Response Time, penyelesaian yang dicadangkan adalah dengan memasang sistem mencetuskan pembaz fasa pada taping machine. Kepentingan kajian ini mencadangkan penyelesaian kepada syarikat kes untuk mengurangkan downtime mesin merakam daripada 2.7 peratus kepada 2.5 peratus yang ditetapkan oleh syarikat kes.

ABSTRACT

In today's competitive world, the manufacturing sector is facing with various challenges to increase productivity and to reduce cost. In the semiconductor industry, machine costs makes up the largest portion of a manufacturer's capital investment and hence ensuring maximum utilization of this machine is one of a company's main concerns. As a machine's efficiency is directly determined by machine uptime, utilizations and process speed, improving the uptime will directly increase the machine efficiency. This project is based in a back-end semiconductor manufacturing company confronted with consistently high downtime for one of its tester machine. The aim of this study is to increase the efficiency of tester machine; which is achieved by 3 objectives: (1) understand the manufacturing process flow for End of Line (EOL) assembly in the case company (2) determine the tester machine (Taping machine) downtime and (3) proposed solutions by using Six Sigma DMAIC (Define, Measure, Analyze, Improve, Control) methodology to reduce the machine downtime. In Define phase, the problem can be determined through understanding of the production process. Next, in the Measure phase, 2 months historical data of the taping machine downtime will be collected from the TFM system. After the data collection, Pareto diagram and Cause and Effect Diagram will be employed to analyze the major causes of the machine's downtime. Test Head Problem, Flipper Problem and Late Response Time are three major causes to taping machine unscheduled downtime. In the Improved phase, few solutions are proposed to the case company to overcome high machine downtime. For Test Head Problem, the proposed solution are using pogo pin inserting tool to replace worn out pin and applying plug and play concept. The plug and play concept also can be applied in Flipper Problem. For Late Response Time, the proposed solution is to install buzzer triggering system on the taping machine.The Control phase follows to ensure continued and sustainable success with the desired output. The significance of this

study is proposing solutions to the case company to reduce the taping machine downtime from 2.7 percent to 2.5 percent which set by the case company.

DEDICATION

Dedicated specially for my beloved family and friends

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LIST ABBREVIATIONS

NPC	=	National Productivity Corporation
EOL	=	End of Line
FOL	=	Front of Line
DMAIC	=	Define, Measure, Analyze, Improve, Control
GE	=	General Electric
DPMO	=	Defects per Million Operations
DFSS	=	Design for Six Sigma
DMADV	=	Design, Measure, Analyze, Design and Validate
IDOV	=	Identify, Design, Optimize, Validate
CTQ	=	Critical to Quality
COPQ	=	Cost of Poor Quality
KPIV	=	Key Process Input Variables
MSA	=	Measurement System Analysis
FMEA	=	Failure Mode and Effect Analysis
SOP	=	Standard Operating Procedure
OEE	=	Overall Equipment Efficiency
PR	=	Process Run
SB	=	Standby
UD	=	Unscheduled Downtime
SD	=	Scheduled Downtime
FYP 1	=	Final Year Project 1
FYP 2	=	Final Year Project 2

CHAPTER 1
INTRODUCTION

1.1 Background of Study

In today's advanced manufacturing industry, many organizations face different type of challenges to increase productivity in order to compete with other organizations. According to Karim et al. (2007) it is unavoidable that the manufacturing sector has an important role to play in many economises. As a result, the organization needs to explore new ways to run operations, ensure low-cost material resources, create new products with shorter lead time in order to deliver the products at a competitive price.

According to Mansur (2005) the main challenge for the Malaysian manufacturing sector is how to sustain market competitiveness like maintaining low cost of product, good product quality and shorter lead time in worldwide markets. The National Productivity Corporation (NPC) of Malaysia has put an efforts to improve productivity and quality across industries, either in manufacturing or in service industries (Ariff, 2005). Ooi (2007) reported that the Malaysian semiconductor manufacturing industry is considered to be one of the major contributors to the Malaysian economy. This sector accounts for about 30% of total current manufacturing output and about 25% of the country's exports.

This study is conducted in a semiconductor manufacturer company located in Melaka. This company is the world's second largest chip supplier to the automotive industry. It serves as the automotive applications such as the car's power train, and safety management. With a global presence, this company operates through its subsidiaries in the USA, Singapore and Japan. The products produced by this company are Discrete Semiconductors, Power Semiconductors, Logic and Sensor Products. In order to sustain in the markets, this company should continue look for a new way to improve machine downtime. High machine unscheduled downtime is the main causes to the low machine throughput. This will lead to low machine efficiency and subsequently will increase the overall operation cost. The machine throughput can be calculated as the output divided by the machines hour or capacity utilized.

The focus of this study is to investigate the impact of machine downtime to the productivity of the company. Through the implementation of the right methodology, it will increase the efficiency of the machine, which subsequently increases the productivity of the company.

1.2 Problem Statement

The case company is currently facing low productivity of the product. One of the main reasons is due to the high machine downtime in the backend inspection process which included Vision Inspection, Test Operation, and Taping process. Figure 1.1 shows the trend of taping machine downtime in percent. From the chart, the current percentage of unscheduled downtime is much higher than the target value 5% which is set by the case company.

High machine unscheduled downtime is one of the issues which affect the machine efficiency and subsequently will decrease the throughput of the machine. One of the main problems is "how to reduce the machine unscheduled downtime on taping machine in order to increase the efficiency of the machine?"

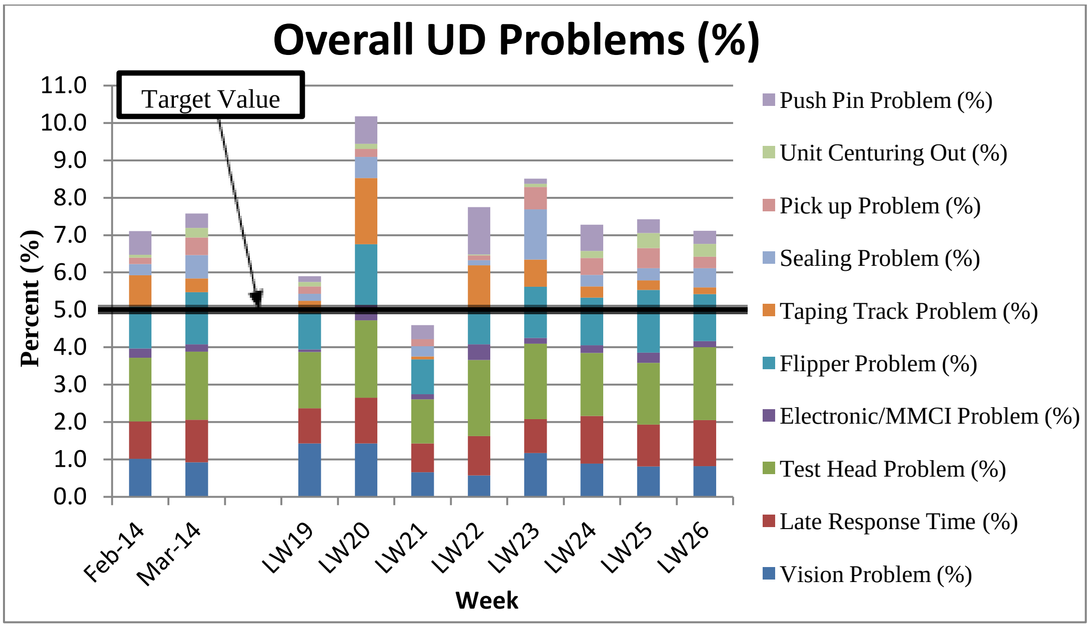

Figure 1.1: Unscheduled Downtime of Taping Machine in percent

1.3 Objective

The main aim of this project is to improve machine efficiency. The objectives are:

i. To understand the manufacturing process flow for End of Line (EOL) in the case company;

ii. To determine the taping machine downtime;

iii. To propose solutions by using Six Sigma DMAIC (Define, Measure, Analyse, Improve, Control) methodology to reduce the machine unscheduled downtime.

1.4 Scope of Study

The scope of this project is limited to the application of Six Sigma DMAIC approach as a methodology for EOL assembly line in case company. It focuses on taping machine and Thin Super Small Leadless Package (TSSLP) production line.

1.5 Organization of Dissertation

This report is structured as follows:

Chapter Two – Literature Review. This chapter presents the literature review of Six Sigma DMAIC implementation in industry according to journal, books and other resources. It also discusses about the different types of methodology found in Six Sigma, the background of Six Sigma and the benefit of applying Six Sigma.

Chapter Three – Methodology. This chapter described the appropriate methodologies chosen to carry out this study.

Chapter Four – Package Assembly and Taping Process. This chapter discussed the background and product package of the case company and the assembly process for the TSSLP package. It also explained about various types of machine downtime occur in taping machine.

Chapter Five – DMAIC Methodology and Discussion. This chapter presents about the DMAIC methodology used to reduce the high taping machine unscheduled downtime.

Chapter Six – Conclusion and Recommendation. This chapter will conclude the project and recommendation for the future research also presented.

CHAPTER 2
LITERATURE REVIEW

This chapter provides literature review about this project. It covers the work done by previous researches and writers from significant references. It also reviews about the Six Sigma DMAIC implementation in manufacturing and service industries, background of Six Sigma, and benefit of applying Six Sigma.

2.1 Introduction of Six Sigma

Six Sigma is a methodology for wide quality improvement in manufacturing and service industries. It aims to eliminate non-value added and inefficiency throughout the process of each product. Six Sigma is a strategy of continuous improvement of the administration to find and eliminate the causes of the errors, defects and delays in processes. Six Sigma is initiated by Motorola in the early 1980s. Many administrations such as Sony, American Express, Honeywell, Raytheon, Caterpillar, Ford, Toyota Kodak and General Electric (GE) already successful implemented six sigma in their own company.

According to Antony and Banuelas (2001) and Linderman et al. (2003) described Six Sigma is a method applied to improve existing process and create new processes to reduce the product lead time. By reducing the product lead time, it consequently will increase the productivity and competitiveness for companies.

In statistical terms, “Sigma” or σ is a letter in Greek alphabet that represents the standard deviation to describe variability. The sigma scale is measured as defects per million opportunities, parts per million defectives and probability of defects. As the sigma scale increases from 1σ to 6σ, the total number of part defects will decrease from 691,462 to 3.4 units. Table 2.1 shows the Sigma process capability, percentage of good part and percentage of bad part, and the DPMO (Defects per Million Opportunities).

Table 2.1: Sigma Process Capability, Percentage of Good Part, DPMO, and Competitive Level (Schroeder, 2008)

σ	Percentage of Good Part (%)	DPMO	Competitive Level
1	30.9	691,462	Non-competitive
2	69.1	308,538	Non-competitive
3	93.3	66,807	Industry Average
4	93.38	6,210	Industry Average
5	99.977	233	World Class
6	99.9997	3.4	World Class

2.2 Definitions of Six Sigma

Six Sigma is often defined as a methodology used to improve quality by reducing the number of defects to as low as 3.4 parts per million opportunities (DPMO) or 0.0003%.

Various other definitions of Six Sigma:

- Six Sigma is a comprehensive, statistics-based methodology that aims to achieve nothing less than perfection in every single company process and product (Paul, 1999).

- Six Sigma is a disciplined method of rigorous data gathering and robust statistical analysis to speck sources of error and ways of eliminating them (Harry and Schroeder, 1999).

- Six Sigma is a methodology for measuring, analyzing, improving, and then controlling or "locking-in" processes. This statistical approach reduces the occurrence of defects from a three sigma level or 66,800 defects per million opportunities (DPMO) to a six sigma level of less than 4.0 DPMO (Bolze, 1998).

- Six Sigma is an improvement plan that combined and organized process for reviewing the amount of improvement in delivering appropriate products and services (Shahin and Ahmandi, 2008).

- Six Sigma described as a quality control tool which reduces defects or variation in a process that optimizes output included improves quality, speeds up the deliveries and reduces costs (Kumi and Morrow, 2006)

Six Sigma definitions can be applied in every organization either in manufacturing or service industries. Implementing Six Sigma give benefits to everyone, including suppliers, customers, and employees. According to Chua (2001) described that Six Sigma is a customer-focused methodology that eliminate waste, improves level of quality and improves the financial performance of organizations to breakthrough levels.

2.3 Six Sigma Methodologies

Six Sigma has two key methodologies which are DMAIC (Define, Measure, Analyze, Improve and Control) and DFSS (Design for Six Sigma). DFSS consists of DMADV (Define, Measure, Analyze, Design and Validate), and IDOV (Identify, Design, Optimize, Validate). DMAIC is used to improve the model both to projects and to process design or redesign projects whereas DFSS is used to design new products, processes and services from the ground up. According to Montgomery (2009) who described that "the alphabet I in DMAIC may become DFSS"- in other words, the improvement can only be done by creating new one and redesigning the process. According to Dedhia (2005) both objectives of DMAIC and DFSS are the similar which continually find ways to improve, minimize defects and increase savings.

2.3.1 DMAIC Methodology

DMAIC is a methodology which aims to process improvement by eliminating defects. It plays an important role in making Six Sigma success in business. The following are the steps of DMAIC methodology.

i. Define the process improvement goals to fulfill the customer demands.
ii. Measure current process and collect the relevant data for comparison.
iii. Analyze the process to determine the causality factors.
iv. Improve or optimize the process by attacking root causes.
v. Control the improved process performance in order to meet the target.

2.3.2 DMADV Methodology

DMADV is often known as DFSS. It can be used outside of a Six Sigma functionality to achieve the results by creating new products, processes and services. The following are the steps of DMADV methodology.

i. Define the goals of design that meet customer demands.
ii. Measure and identify Critical to Quality (**C**TQ), production process capability, and risk assessments.
iii. Analyze to design and develop alternatives, and evaluate design capability to select the best design.
iv. Design a detailed process to meet customer needs.
v. Verify the design of performance to meet customer needs.

2.3.3 IDOV Methodology

IDOV is a methodology which commonly used for DFSS. It assists those processes by offering right methodology to decrease the development time. The following are the steps of IDOV methodology.

i. Identify the customer and specifications (CTQs).
ii. Design and translate the customer CTQs into functional requirements and solution alternatives.
iii. Optimize the uses of advanced statistical tools and modeling to predict the performance.
iv. Validate the developed design to meet the customer CTQs.