A TRIZ APPROACH TO REDUCE UNSCHEDULED DOWNTIME IN SEMICONDUCTOR INDUSTRY

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A TRIZ APPROACH TO REDUCE UNSCHEDULED DOWNTIME IN SEMICONDUCTOR INDUSTRY

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

by

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DECLARATION

I hereby, declared this report entitled "A TRIZ Approach to Reduce Unscheduled Downtime in Semiconductor Industry" is the results of my own research except as cited in references.

Signature	:	
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Date	:	8th June 2016

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Management) (Hons.). The member of the supervisory committee is as follow:

.....

(Project Supervisor)

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ABSTRAK

Banyak organisasi sedang mengalami cabaran yang sama iaitu kemerosotan dalam keuntungan dan pemprosesan. Projek ini telah dijalankan di satu multinasional semikonduktor industri untuk meningkatkan keuntungan di industri ini. Berdasarkan pada data yang telah dikumpul, keseluruhan keberkesanan peralatan (OEE) yang disebabkan oleh ketersediaan mesin yang rendah telah menjejaskan pemprosesan dalam industri tersebut. Masalah ini adalah disebabkan oleh kerosakan mesin yang tidak berjadual. Jadi, projek ini mencadangkan penyelesaian untuk mengurangkan kerosakan mesin tersebut. Objektif projek ini adalah untuk mengenal pasti jenis kerosakan mesin yang berbeza, mengenal pasti punca-punca kerosakan tersebut dan akhirnya mengumpul and menganalisis data untuk mencadangkan penyelesaian untuk meningkatkan ketersediaan mesin. Kaedah TRIZ telah digunakan dalam projek ini. Data untuk "Taping Machine" di "Discrete Department" telah dikumpul dan dianalisis dengan carta Pareto untuk menentukan masalah yang paling kritikal. Seterusnya, "Cause and Effect Analysis" telah dilaksanakan untuk menentukan punca yang berpotensi. Selepas ini, "Trimming" telah dilakukan untuk memilih punca yang paling ketara. Akhirnya, "Contradiction Matrix" telah digunakan untuk mencadangkan penyelesaian untuk masalah yang paling kritikal dengan aplikasi "40 Inventive Principle". Dengan ini, sebanyak 4 penyelesaian yang telah dicadangkan, namun hanya 2 penyelesaian yang telah dilaksanakan dan diuji untuk 1 mesin. Keputusan uji kaji tersebut menunjukkan kerosakan mesin telah dikurangkan sebanyak 1.55% dan ketersediaan mesin telah ditingkatkan sebanyak 1.55%. Dengan ini, OEE telah ditingkatkan sebanyak 1.31% dengan mengunakan formula pengiraan OEE. Menurut status ekonomi industri ini, dengan meningkatkan OEE sebanyak 1.31% boleh meningkatkan profit industri sebanyak RM 500, 000 setahun. Ini juga boleh menurunkan cos penyelenggaran dan penggantian komponen. Oleh itu, projek ini boleh meningkatkan keuntungan dan mengurangkan pembaziran cos.

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ABSTRACT

Most organizations are facing similar challenges which involve decreasing profit and throughput. This project was conducted in a multinational semiconductor industry to improve its throughput and profit. Based on the data collected, low Overall Equipment Effectiveness (OEE) due to low machine availability affects the throughput of the company. Low machine availability happens because the machine unscheduled downtime is high. Therefore, the purpose of this study is to propose solutions to reduce machine unscheduled downtime of the case company. The objectives of this project are to identify different types of machine unscheduled downtime, to identify root causes of machine unscheduled downtime and to collect and analyse data to propose solutions to increase machine availability. TRIZ method was used for this project. First, real time data for taping machines in Discrete Department was collected via TFM system and analysed by using Pareto Chart to determine the most critical problems. Then, Cause and Effect Analysis was done to determine its potential root causes. After that, Trimming was done to eliminate all the not significant root causes and identify the most critical root cause. Lastly, Contradiction Matrix was applied on the most critical root cause that was determined to propose solutions by implementing the 40 Inventive Principle concepts. A total of 4 solutions were proposed but only 2 solutions were implemented and tested by pilot run on 1 machine. The pilot run results showed that the 2 implemented solutions had reduced 1.55% of taping machines unscheduled downtime and hence increases machine availability by 1.55%. By that, OEE was estimated to have an increment of 1.3% by using the OEE calculation formula. According to the case company's cost estimation, by increasing 1.3% in OEE enables the company to profit extra RM500, 000 in a year. Besides, it can also reduce maintenance and components replacement cost. Hence, the significance of this study is to enhance the profit of the case company and reduce waste of cost.

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DEDICATION

This thesis is specifically dedicated to my beloved family members, friends and university. Thank you for all the unlimited support and encouragement.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

A	-	Availability
AM	-	Autonomous Maintenance
ARAMS	-	Automated Reliability, Availability, and Maintainability
ARIZ	-	Algorithm for Inventive Problem Solving
BM	-	Breakdown Maintenance
CBM	-	Condition-Based Maintenance
DMAIC	-	Define, Measure, Analyse, Improve, Control
DS	-	Discrete
EPT	-	Equipment Performance Tracking
Fab	-	Fabrication
FYP	-	Final Year Project
ID	-	Identity Document
IFR	-	Ideal Final Result
JIPM	-	Japan Institute of Plant Maintenance
LO	-	Logic
NiAu	-	Nickel Gold
OEE	-	Overall Equipment Effectiveness
P	-	Performance
PdM	-	Predictive Maintenance
PM	-	Preventive Maintenance
POM	-	Power Melaka
Q	-	Quality
RAM	-	Reliability, Availability, and Maintainability
RCM	-	Reliability Centered Maintenance
RM	-	Ringgit Malaysia
ROI	-	Return of Investment
RTF	-	Run-to-Failure
RTM1	-	Real-time Monitoring

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SD	-	Scheduled Downtime
SENS	-	Sensor
Su-Field	-	Substance Field
TFM	-	Total Fabrication Monitoring
TPM	-	Total Productive Maintenance
TRIZ	-	Theory of Inventive Problem Solving
TSLP	-	Thin Small Leadless Package
TSSLP	-	Thin Super Small Leadless Package
UD	-	Unscheduled Downtime
UV	-	Ultraviolet
WIP	-	Work in Process
$	-	United States Dollar
%	-	Percent
>	-	More than

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CHAPTER 1
INTRODUCTION

This chapter discusses and shows the background of study, problem statement, objectives, scope and limitation, significance of study and organization of this project. All the topics are described and explained in detailed.

1.1 Background Of Study

In 1960, semiconductor industry was formed when the semiconductors become an applicable option (Tanner, 2015). From over $1 billion in 1964, this industry has grown rapidly to $335.8 billion in 2014. There are 6 broad categories to classify semiconductors such as data processing, communications, consumer electronics, industrial, automotive and military and civil aerospace. This project is carried out in a semiconductor company that produces product for communication and automotive.

Since the product of this industry is in such high demand now, productivity rate for semiconductors is very crucial. Productivity is the measure of efficiency of a machine, human, process, system or factory to convert inputs into useful outputs. Therefore, productivity equals to value divided by time (Pavlina, 2005). The value is the quality that has to be defined by the individual or company itself. There are plenty of ways to measure productivity. Overall capabilities should be focused on for productivity measurement, not on one set of costs (Chew, 1988). Productivity measurement is basically the total units of output divided by the total units of input. To increase productivity, Total Productive Maintenance (TPM) is commonly implemented in industries.

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TPM is a combination of Japanese concepts of total employee involvement and total quality management with American preventive maintenance (Nakajima, 1988). TPM is a proven manufacturing strategy that has been implemented globally in organizations to support its lean manufacturing system for achieving organizational objectives (Ahuja and Khamba 2008). The main goal for TPM is to increase production, while at the same time increases employee ethics and job satisfaction. One of the most important productivity metric in TPM is Overall Equipment Effectiveness (OEE). OEE is a metric that measures the percentage of planned production time that is genuinely productive. When is OEE score is 100%, this indicates that the production is perfect where there is no downtime, manufacture only good parts and fast production. The OEE represents the effective operating rate for equipment by involving the "6 big losses" of TPM into one number (New, 2014). OEE involves 3 main components which are machine availability, performance and quality. Each of these components represents a different angle on how close the manufacturing process is to perfect production. Availability involves machine downtime loss, performance involves speed loss and lastly quality involves quality loss.

This project involves and focuses on machine downtime which is an element in machine availability. Availability is the percentage measure of the actual time that the machine or system is capable of production compared to the planned production time (Mobley, 2009). When the downtime of a machine or system is high, it results in low availability which will reduce the OEE value. Downtime can be classified into 2 types which are Scheduled Downtime (SD) and Unscheduled Downtime (UD) according to the Semi E10 standard. Scheduled downtime is a planned suspension of machine from operating for maintenance or testing while unscheduled downtime is when a machine is not being able to perform its intended function due to unplanned events. When the unscheduled downtime of a machine is high, it shows that the machine availability and OEE is low.

In this modern age, manufacturing machines are getting more expensive. Organizations want to invest on machines that provides them highest efficiency and availability to increase production in order to ensure them a high return of investment

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(ROI). ROI is the financial ratio to measure the benefit obtained from an investment (Stice et al., 2005). If the machine downtime is high, it shows that the machine produces low throughput and results in low ROI. Every organization wants to have machines that can provide them the highest efficiency in order for them to achieve perfect production rate.

This research is carried out in one of the multi-national semiconductor company in Malacca, Malaysia. The main headquarter is located in Germany while it has many branches in different countries. The case company focuses on three major divisions such as automotive, industrial electronics section and chip card manufacturing and security applications. There are four main departments in this company such as Power Melaka (POM), Discrete (DS), Sensor (SENS) and Logic (LO). This study will be focusing on only Discrete Department.

1.2 Problem Statement

The case company is currently facing low throughput in the Discrete Department resulting in low productivity. One of the main reasons for low throughput is due to low OEE of the machine in this department. When the company has low OEE, it shows that the overall equipment, process or system of the company is not effective. The reason this company is having low OEE and process capability is due to the increment of machine downtime. The need to reduce downtime is the key to maximize equipment effectiveness.

High downtime results in low machine availability. Based on the collected data, high machine unscheduled downtime is one of the concerns that affects machine efficiency which will latterly decrease the throughput of machine. Therefore, one of the main problems that will be discussed in this study is “how to reduce the machine unscheduled downtime in order to increase machine efficiency?”

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1.3 Objectives

The aim of this project is to improve machine availability by reducing machine unscheduled downtime. The objectives of this project are as follow :

a) To identify the different types of machine unscheduled downtime.
b) To identify the root causes of machine unscheduled downtime.
c) To collect data and analyse data to propose solutions to improve machine availability.

1.4 Scopes And Limitation Of Study

The scope of this project is limited to taping machines in the case company. There are a total of 24 taping machines that will be studied and unscheduled downtime data will be collected from these 24 taping machines. These machines are chosen due to the low OEE value and it is the bottleneck of the assembly line. This study focuses on the production line for product for telecommunication, automotive and consumer. It consists of Thin Small Leadless Package (TSLP) and Thin Super Small Leadless Package (TSSLP). The cost, quality, performance and scheduled downtime will not be taken into account in this report. The unscheduled downtime for other machines that are available in this company will not be discussed as well.

1.5 Significance of Study

Key benefit of this study is to identify solutions to reduce machine unscheduled downtime in the semiconductor company. By minimizing the downtime, the machine availability will be increased. This improves the OEE of the company and increases productivity. This study helps to identify the causes of machine breakdown and classify them into different types of breakdown. By understanding the root causes of problem, solutions can be proposed and implemented to solve the problem. This research paper can also be utilized in any semiconductor industries.

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1.6 Organization of Dissertation

This report is structured as below :

Chapter 1 – Introduction. This chapter specifies the problem statement and defines the main objectives of this study. It defines the scope on which aspect to be covered and what will not be covered throughout the entire project period.

Chapter 2 – Literature Review. This chapter presents the literature review of the main topics related to unscheduled downtime such as TPM, OEE, machine availability and approaches by other researchers to reduce machine downtime and to solve problems in different industries. The information was extracted from journals, books, archival collection and other resources. It also discusses about the semiconductor standard that are strictly followed by every semiconductor company.

Chapter 3 – Methodology. This chapter describes the appropriate methodologies applied to execute this project.

Chapter 4 – Product Assembly, Taping Process, Data Collection and Data Analysis. This chapter discusses the production flow of the selected department from case company and the processes of the selected machine in this department. Data collection method will be discussed and the data collected will be analysed in this chapter.

Chapter 5 – TRIZ Problem Solving Methodology and Discussion. The different types of machine breakdown and its root causes will be discussed in this chapter. Solutions to reduce downtime are proposed and discussed in this chapter.

Chapter 6 – Conclusion and Recommendations. This chapter concludes the project. Recommendations will be given for further research or studies.

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CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter present the literature review regarding this project. It covers the researches done by previous writers and researches from significant references that are relevant to this project topic. It reviews about the definition of productivity and maintenance, SEMI Standard, Total Productive Maintenance (TPM), Overall Equipment Effectiveness (OEE) and different approaches and implementation that was carried out to reduce machine unscheduled downtime.

2.2 Productivity

Many organizations have to undergo multiple challenges and hardship of increasing productivity in this highly competitive environment to compete among companies in favour of becoming more advantaged in the quality, cost, flexibility and speed aspects (Mefford, 2009). “Productivity is defined as the relationship between the input and output” (Shamsuddin et al., 2005). “The outputs represents produced physical products, whereas the inputs are fixed or working capital in the case of the capital productivity and labour employed (hour/cost-direct or indirect) in the case of manufacturing production productivity” (Shamsuddin et al., 2005).

The term “Productivity” is used to represent the strength of industrial management in utilizing facilities in a production line. In other words, it can be classified as a measure of output of goods or services that is produced from a given amount of input

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