THE INTEGRATED MODEL FOR QUALITY IMPROVEMENT FOR SEMICONDUCTOR COMPANIES

By

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LIST OF ABBREVIATIONS

CF	C-Frame
COPQ	Cost of Poor Quality
DS	Double Sided
DFSS	Design for Six Sigma
DMAIC	Define, Measure, Analyze, Improve, Control
DMAIES	Define, Measure, Analyze, Improve, Evaluate, Sustain
DOE	Design of Experiment
DPMM	Defect Part Per Million
FBD	Fishbone Diagram
FPCA	Flex Assembly
HT	Hard Tool
IPQC	In-line Process Quality Control
ISO	International Organization for Standardization
JIT	Just in Time
LC	Li Chin
M	Measure
ML	Multi-Layer
OL	Outline
PC	Piercing
PCB	Printed Circuit Board
PT	Panel Trim

PDCA	Plan-do-check-action
PPM	Parts Per Million
QC	Quality Control
QFD	Quality Function Deployment
QI	Quality Improvement
QP	Quality Planning
QT	Quality Tools
SA	Swing Arm
SMT	Surface Mount Technology
SS	Single Sided
SP	SubPanel
SPC	Statistical Process Control
ST	Soft Tool
TB	Tie Bar
TPM	Total Productive Maintenance
TQM	Total Quality Management
TRIZ	Theory of Inventive Problem Solving

MODEL BERSEPADU UNTUK PENAMBAHBAIKAN KUALITI DI DALAM SYARIKAT SEMIKONDUKTOR

ABSTRAK

Produk yang berkualiti tinggi akan membantu memenuhi kehendak pelanggan dan mengurangkan risiko dan kos untuk mengganti produk yang rosak. Salah satu faktor yang memberi kesan buruk kepada kualiti sesebuah syarikat adalah produk yang rosak, yang mana akan menyebabkan produktiviti menurun dan syarikat mengalami kerugian. Penambahbaikan kualiti yang digunakan dalam syarikat semikonduktor adalah penting untuk memastikan produk yang dihasilkan memenuhi kehendak pelanggan. Hasil kajian ini bertujuan untuk membina satu model untuk mendapatkan penambahbaikan dalam kualiti proses di mana DMAIC (*Define-Measure-Analyze-Improve-Control*) adalah pendekatan utama dengan penyerapan teknik TRIZ (*Theory of Inventive Problem Solving*). Kaedah DMAIC adalah sebahagian daripada inisiatif Six Sigma dan sering digunakan dalam peningkatan kualiti. Model DMAIC menyediakan struktur metodologi untuk proses menganalisa. Sementara itu, teknik TRIZ menggunakan strategi dan alat untuk mencari penyelesaian yang terbaik seterusnya dapat mengelakkan kesilapan semasa proses penyelesaian masalah. Di dalam kajian ini, kedua-dua pendekatan ini digabungkan untuk merekabentuk model penambahbaikan kualiti baru yang dinamakan model DMAIES (*Define-Measure-Analyze-Improve-Evaluate-Sustain*). Teknik TRIZ digunakan di dalam fasa *Improve*, manakala alat dan teknik kualiti lain yang dipilih digunakan di dalam fasa-fasa model DMAIES yang lain. Model ini telah disahkan melalui kajian kes di syarikat semikonduktor. Kajian kes ini mengambil kira dua persekitaran yang berbeza, iaitu proses pembuatan dan pemasangan. Hasil kajian ini akan mengurangkan kerosakan utama dan meningkatkan hasil pendapatan seterusnya menambahkan proses kualiti.

THE INTEGRATED MODEL FOR QUALITY IMPROVEMENT FOR SEMICONDUCTOR COMPANIES

ABSTRACT

High quality product helps to maintain customer satisfaction and reduces the risk and cost of replacing faulty goods. One of the factors that affect quality performance is the defects of the products, which lead to lower productivity and profit. The application of quality improvement in semiconductor manufacturing company is important to ensure the quality of finished products as well as to fulfill customer's requirement. The purpose of this research is to develop a model in seeking an improvement in quality process where DMAIC (Define-Measure-Analyze-Improve-Control) being the main approach with infusion of TRIZ (Theory of Inventive Problem Solving) technique. The DMAIC method is an integral part of Six Sigma initiatives and often being applied in quality improvement. DMAIC model provided structured methodology upon analyze process. Meanwhile, TRIZ technique applied strategies and tools to find out the best solutions to avoid numerous trials and errors during problem solving process. In this research, these two approaches are integrated in designing a new quality improvement model named as DMAIES (Define-Measure-Analyze-Improve-Evaluate-Sustain). The TRIZ technique is applied in the Improve phase, while the others selected quality tools and technique is adopted in the other phases of the DMAIES model. This model was verified through a case study in semiconductor company. The case study considered two different environments, namely the manufacturing and assembly processes. The outcome of the case study is reduction of major defect and improvement in the percentage of yield, hence improve the quality process.

CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter is structured into five sections as to provide the general ideas of this research that has been conducted. First, the theoretical foundations of this research are presented in research background and further elaborated in second section discussing on quality improvement process and its components. Then, in the problem statement section, the current situation in quality improvement process is discussed. The next following section mainly discusses on the research objectives. Finally the overview of thesis structure is prepared in the last section.

1.2 Research Background

In today's highly dynamic and competitive industrial arena, organizations is facing with highly competitive market due to the drastic change of global market conditions. To win the competition, the company and service organizations must strive to sustain their business with a significantly higher investment cost to meet demand of extreme global competition. And, in trying to improve business performance, one of the ways to lead the market is by achieving outstanding quality, whether from manufacturing or service businesses (Abdullah et al., 2003). Dyk and Pretorius (2012) also mentioned that quality is the most important competitive weapons in global market. Therefore, many industries become aware of the need to prioritize quality as the competitive marketing strategy due to this phenomenon (Muturi et al., 2013).

According to Business Dictionary, quality is defined as a "measure of excellence or a state of being free from defects, deficiencies and significant variations". Hence, from a manufacturing standpoint of view, quality is simply

conformance to specifications. Quality is conducted to ensure that all products in the production are designed and processed according to customer requirement. Maintaining quality is usually related to avoiding defective products in production such as cracking, missing parts, overlapping, positioning and incomplete in order to avoid rework or repair that would lead to customer dissatisfaction.

High product quality image will result in higher customer satisfaction and will lead to an increase of a product's price. In the end, a company will experience increase in their productivity and profit (Abdullah et al., 2003). A company has to continually improve their quality processes through the implementation of suitable methodologies and tools to achieve world class company (Lopes et al., 2011). Quality control (QC) is one of the quality approach by which quality actions, such as inspection, testing and repair are carried out on the product after production and before it is released to the customer. However, this approach leads to high rejects and cost increment involving rework and replacement activities. Those activities are considered as waste because defects are produced.

Quality improvement (QI) is another quality approach, which serves as an alternative to the QC that is adopted by the industry. In general, QI is a continuous process that focuses on improvement and development of the product and quality service of the company to meet customer demand by using suitable tools, technique and methodology (Abdullah et al., 2003). Based on Islam et al. (2013), the application of QI will lead to better utilization of resources, decreased variations and maintains consistent quality of the process output. Therefore, the purpose of having a QI in manufacturing industries is basically to improve the productivity and increase the profitability by minimizing rework activities. Table 1.1 illustrates the three types of quality approaches normally adopted and practice in industries. The basic objectives

of these three different modes of quality approaches are to produce a good product or service and better productivity.

Table 1.1: The three universal approach for managing quality (Bisgaard, 2007)

Features	**Quality Planning (QP)**	**Quality Control (QC)**	**Quality Improvement (QI)**
Functions	Method and tools to develop new programs and services to revamp existing one	The process for meeting quality goals during operations	Set of method and tools to optimize an existing process performance
Actions	➢ Determine who the customer are ➢ Determine the needs of the customers ➢ Develop product featured that respond to customer needs ➢ Develop the processes able to produce the product features ➢ Transfer the plans to operating forces	➢ Evaluate actual product performance ➢ Compare actual performance to product goals ➢ Act on difference from the outcomes	➢ Establish the infrastructure ➢ Identify improvement projects ➢ Establish project teams ➢ Provide teams with resources, training and motivation to: • Diagnose root cause • Stimulate remedies • Establish controls to hold the gains • Disband the team
Results	A process capable of meeting quality goals under operating conditions	Conduct of operations in accordance with quality plan	Conduct of operations at levels of quality distinctly superior to planned performance

1.3 Quality Improvement (QI) Process

Improvement is the process of moving from one state to another state considered to be better. From a quality point of view, improvement is very important to increase a good product which implies the productivity. According to ISO

(International Organization for Standardization), the definition of QI process is the actions taken throughout the organization to increase the effectiveness of activities and processes to provide added benefits to both the corporation and its customers (Görener and Toker, 2013). In other words, QI is a continuing process to improve the product and service quality of the company to meet customer satisfaction by using suitable tools, techniques and methodology.

QI process has drawn tremendous attention from many researchers, in various approaches from different perspectives in the quality environment. Further discussion on the various QI models will be given in the Chapter 2. An analysis and comparison QI model should be carried out before selecting the optimal model of the QI model to be designed and implemented on the shop floor environment. On the other hand, the improper framework in the QI process may lead to the high rejection in the production process (Kumar et al., 2006). Thereby, it will reduce the productivity and profitability which are affected by the improper QI model (Islam et al., 2013).

Bunney and Dale (2006) have found that the use of quality tools (QT) and techniques is a vital component of any successful QI process. This statement is agreed by Putri and Yusof (2009). According to (Liang, 2010), the QT and techniques should be integrated with a structural QI process and each QT have different functions in the QI process. Thus, from the information, it can be concluded that the QI process can be executed properly based on the proper QI model and the suitable application of QT and techniques.

1.4 Problem Statement

The quality issue in production continuously happened even though the inspection activities are being carried out, one that is widely known as quality

inspection. This is due to the fact that the lack of an effective methodology in the QI process (Chiarini, 2011). This scenario will lead to the production produce a product not relying a customer requirement. Hence, the production increase the contribution of reject parts which lead unnecessary rework and related cost. Therefore an evaluation and the determination of an optimal methodology for QI process is essential.

One of the issues that normally arise is how to develop a systematic model of QI process is to ensure that the solution solves the current problem satisfactorily (Jani, 2013). This is due to some of the practitioners remaining using the traditional method to solve the problem in improvement process such as trial and error method. Su and Lin (2008) claimed that trial and error method is the unsystematic method in the search for a solution and thus time consumptions and cost augments. Therefore, evaluating solution given and selecting the best solutions with a systematic model is imperative for the success of the QI project.

Commonly, QT cannot fix every quality problem, but they certainly are a means for solving problems (Sokovi et al., 2009). Putri and Yusof (2009) have found that there are some difficulties faced by manufacturing industries in adopting QT. However, Kwok and Tummala (1998) claimed that the root causes of failure in applying these QT are not due to the fact that they are ineffective, but due to lack of clear understanding by people regarding when, where and how to apply the tools. Therefore, knowledge about the function of each QT is important before selecting the suitable QT to use in a case study.

The other issues are most of the implementer are lack of in-depth knowledge and skills in analyzing and managing the QI process. In most cases, they tend to carry out an improvement project based on their previous working experience (Lee and Chuah, 2001). Therefore, due to the difficulty to perform based on their experience,

this will indirectly cause the organization is too depend only on some employees, which may affect the organization performance if these people move out of the company. Consequently, as an initial effort toward preserving this occurrence from happening and overcoming the stated problems, a model is developed in this research as a QI guidance tool to increase the success rate of QI.

1.5 Research Objective

The objective of this research is to develop a systematic QI model which can facilitate and guide implementers carrying out QI activities by using correct tools and technique. In the meantime, it is hoped can give the highest benefit of implementation as well as decrease the failure of QI activities. The objectives of this research are to:

1. To formulate and develop an integration model of QI based on the existing QI models and approaches.
2. To test and verify the developed QI model from two different environments by using real case studies in a selected semiconductor company.

1.6 Thesis Outline

The thesis contains seven chapters. Chapter 1 provides an overview of quality, quality improvement and the objectives of the research. Chapter 2 provides the reviews on the available literatures which encompass the critical thinking, ideas, and approach of QI model. This chapter also provides information on quality tools and techniques used in the industry. Chapter 3 discusses the methodology for this research case study. Chapter 4 discusses the model development based on a literature review in Chapter 2. Chapter 5 describes the details on case study carried out in the selected semiconductor