IMPLEMENTATION OF CRITICAL TO QUALITY IN MANUFACTURING COMPANY

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

by

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I hereby, declared this report entitled “Implementation of Critical to Quality in Manufacturing Company” is the results of my own research expect as cited in reference.

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APPROVAL

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

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(**Associate Professor Ts. Dr. Effendi Bin Mohamad)**

ABSTRAK

Isu kualiti adalah tumpuan utama dalam sektor perkilangan kerana ia merupakan salah satu komitmen untuk produk. Kritikal untuk Kualiti (CTQ) ialah parameter kualiti kritikal dalaman yang mengenal pasti keperluan dan kehendak pelanggan. CTQ adalah alat berkualiti yang dipilih dalam projek ini untuk meminimumkan sebab-sebab utama yang membawa kepada isu-isu berkualiti dalam syarikat pembuatan casting yang berada di Cheng, Melaka. Pada masa ini, masalah kritikal yang dihadapi oleh syarikat kes adalah tidak kritikal terhadap kualiti untuk dimensi, proses dan lukisan dan menyebabkan masa sisa bekerja semasa pemeriksaan. Justeru, matlamat projek ini adalah untuk menganalisis dan mengukur semua isu kualiti dengan melaksanakan CTQ. Kaedah Define-Measure-Analyze-Improve-Control (DMAIC) digunakan sebagai garis panduan melalui keseluruhan projek. Dalam setiap fasa DMAIC, alat-alat seperti rajah Supplier-Input-Process-Output-Customer (SIPOC), gambarajah Sebab-dan-Kesan dan Mod Kegagalan dan Analisis Kesan (FMEA) digunakan untuk melaksanakan CTQ. Penyebab utama masalah kritikal telah dikenal pasti dan penyelesaian untuk meminimumkan masalah disediakan. Berdasarkan hasilnya, pelaksanaan CTQ ke daftar periksa yang ada dikurangkan 27.8% pada setiap hari. Satu anggaran 41min 40sec boleh dikurangkan setiap hari selepas pelaksanaan. CTQ telah dilaksanakan untuk memproses dan lukisan produk baru dengan dikemaskini atau menambah titik kawalan, arahan kerja dan tanda CTQ. Untuk penambahbaikan berterusan, CTQ boleh dilaksanakan secara berterusan di jabatan dan dokumentasi lain.

ABSTRACT

Quality issue is the main focus in manufacturing sector since it is one of the commitments for products. Critical to Quality (CTQ) is the internal critical quality parameters that identify with the needs and want of the customers. CTQ is a quality tools which selected in this project to minimize the root causes that leading to quality issues in a casting manufacturing company which is located in Cheng, Melaka. Currently, the critical problem faced by case company is no critical to quality for dimension, process and drawing and cause some waste time work during inspection. Hence, the goal of this project is to analyze and measure all the quality issues by implementing CTQ. Define-Measure-Analyze-Improve-Control (DMAIC) methodology is being used as guideline through whole project. In each phase of DMAIC, tools like Supplier-Input-Process-Output-Customer (SIPOC) diagram, Cause-and-Effect diagram and Failure Mode and Effect Analysis (FMEA) were used to implement CTQ. The root causes of the critical problem were identified and solution to minimize the problem was provided. Based on the results, the implementation of CTQ to existing checklist was reduced 27.8% per day. An estimation of 41min 40sec can be saved daily after the implementation. CTQ was implemented to process and new product's drawing by updated or add in control point, work instruction and CTQ marking. For continuous improvement, the CTQ should be continuously implemented in other department and documentation.

DEDICATION

Only

my beloved father, Choong Hon Min

my appreciated mother, Ong Su Ling

my adored brother, Choong Kai Sin

for giving me moral support, money, cooperation, encouragement and also understandings

Thank You So Much & Love You All Forever

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LIST OF ABBREVIATIONS

CTQ	-	Critical to Quality
CTC	-	Critical to Cost
DMAIC	-	Define-Measure-Analyze-Improve-Control
DOE	-	Design of Experiments
DPMO	-	Defects Per Million Opportunities
FMEA	-	Failure Mode Effect Analysis
FYP 1	-	Final Year Project 1
FYP 2	-	Final Year Project 2
IPCP	-	In-Process Control Plan
MSA	-	Measurement System Analysis
NVA	-	Non-Value Added Activities
RPN	-	Risk Priority Number
SIPOC	-	Supplier-Input-Process-Output-Control
SOP	-	Standard Operational Procedure
VOC	-	Voice of Customer

CHAPTER 1
INTRODUCTION

1.0 Introduction

In chapter 1, the research and company background is briefly described. The concerns of Critical to Quality (CTQ) in the case company are indicated in the problem statement. Besides, the objectives and also the scopes of this project are explained in this chapter. At the end of this chapter, the significance of study as well as the thesis arrangement of this report is presented.

1.1 Background of Study

In this era, manufacturing industry had a rapid development and become extremely great competitive in the worldwide marketplace. As the climate change and depletion of the mineral resources, the amounts of cost for all the resources increase day by day (Kishita *et al*, 2016*)*. The growth in business should satisfy consumers based on products, delivery and adding quality (Desai, 2006). Thus, the industrial company has realized that the cost, quality and reliability of product influence overall performance of manufacturing industry (Karim, 2009).

Quality of a particular product justified based on customer satisfaction and no customers' complaints (Diaz, 2014). It is essential to satisfy respective customer in every stage of manufacturing in order to achieve best overall quality of final product (Mitra, 1993). The most frequency tools used to solve or improve quality issues in industry are Total Quality Management (TQM), Lean, Six Sigma, Kaizen, 5S, Just In Time (JIT), Statistical

Process Control (SPC) to non-traditional ones as Failure Mode Effect Analysis (FMEA), Test of Hypotheses and else (Pyzdek, 2003).

Many researchers are found to consolidate the principles of quality improvement approach like Six Sigma with statistical tools to analyze manufacturing quality and problems effectively (Chowdhury *et al*, 2014). Six Sigma methodology or name as Define-Measure-Analyze-Improve-Control (DMAIC) methodology widely used in all sector to settle and improve quality issues. To identify customer requirements, commonly critical to quality (CTQ) being useful and effective. Critical to quality tree is a simple tool that moves from common needs of the customers to the more detailed requirements (Desai, 2006).

This project is carried out in XYZ Company located at Cheng, Melaka which is a casting manufacturing industry producing door closers to its group of companies. XYZ Group are one of the main three organizations of access control and security arrangements on the worldwide market. XYZ Group are currently there for customers through each development period of their building venture, empowering the best answers for their requirements and plans to develop products, solutions and services that make life for their clients and end-users progressively basic and secure.

1.2 Problem Statement

Quality issue is the main focus in manufacturing sector since it is one of the commitments for products. Quality of products will affect the profit of company and number of customers. There are some of the current problems found in the company. One of the critical problem is no critical to quality for dimension, process and drawing. Dimension are not indicated in the drawings and outgoing checklists. Most of the accessories, components and finished products inspection in floor are based on quality experiences. There can be said that the quality of products not stable. Those problems will cause the risk of customer complaints or feedbacks increase. Besides, there are a lot of dimensions for each product have to check one by one by using the current product inspection checklist. Time taken to inspect product dimension increase and decrease the productivity of workers. Thus, the case company planned to improve on drawings, processes and products to prevent all the possible root causes that running at a loss to the company.

1.3 Objective

The objectives of this project are:

a. To analyze quality problems that occurred in the company.
b. To measure the quality problems.
c. To implement Critical to Quality.

1.4 Scope of Study

This project mainly concentrates on the implement CTQ at improve stage to minimize the root causes that leading to quality issues. This project is conducted in casting company. This project using the DMAIC methodology as guideline through whole project. Last phase of DMAIC won't be focus in this project due to timing issue.

1.5 Significance of study

The goal of this project is to prevent the quality issues that may be causes the dissatisfy of customers, the loss of profit, the rework activities. The root causes that contribute to the quality can be determined by discussion with experienced workers. Thus, a suitable preventive action will be taken to minimize the problem. Once the problem of the company is being prevented, the company able to attain a betterment of quality of product and process as well as giving impact on profitability to the company in terms of saving cost and customers' satisfaction.

1.6 Thesis Arrangement

The title of this report is an implementation of Critical to Quality in manufacturing company. There are totally five chapters often presented in this report.

Chapter 1: Introduction

This chapter involved the short overview of the background of project followed the problem faced by the company. Next, the objectives of this project are stated in this chapter as well as the scopes and significance of this project are described in this chapter. Finally, the thesis arrangement also includes in this chapter.

Chapter 2: Literature Review

This chapter consists of prior study or research that related to this project. All the valuable information regarding the basic theories of quality, Critical to Quality, seven QC tool, Six Sigma Methodology are collected from journals, books, articles and other resources. After that, all the information is summarized and acts as guidance throughout this project.

Chapter 3: Methodology

In this chapter, the general summary of methodology in this project are marked out. It portrays the suitable procedural information on the data gathering and understanding methodology with the end goal to achieve the objectives of the project.

Chapter 4: Result and discussion

This chapter analyzes the data collected and the result is obtained in the project in the form of text, figures, or tables to highlight the key information. The data is gathered from the research company will be discussed in details. The quality tools such as Ishikawa diagram and FMEA are used to identify the causes that contributed to quality issues. There is some recommended solution implemented for CTQ at the end of this chapter as well.

Chapter 5: Conclusion and recommendation

The finding in this project and relative information based on the previous chapter is concluded in Chapter 5. Finally, recommended actions for the future improvement and sustainability of the project are briefly discussed.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

In this chapter, summary of all information related to research is organised and discipline of study is needed for this project. The research included definitions, historical data, previous case studies example and papers by experts. This chapter will be the reference for the whole project from the methodology until the end of FYP 2.

2.1 Quality

Quality can define from numerous points of view and the definition has changed over time. Quality could be characterized as a fundamental apparatus for a characteristic property of any great or administration that enables it to be contrasted and some other great or administration of its kind (Diaz, 2014). Gejdoš (2015) stated that the quality is the satisfaction of customers' requirements and the degree of customers' expectations. He defines that quality is a product which can be produced in steadily process from the beginning to the end, which generated a product with acceptance variability. Stevenson (2014) indicated that quality refers to the volume of an item or service to meet or overdo customer requirements or desires. In other case, quality defined as customer-dependent because of different customers will have different necessities.

Figure 2.1 is clearly illustrating the fundamental parameters of quality can be assembled into three regions that are quality of conformance, quality of performance and quality of design. Quality of conformance manages how well firms and their providers comply with the design requirements, including the cost necessity (consistency and

trustworthiness). For instance, statistical quality control techniques are vigorously utilized here. Next, quality of design manages deciding the attributes of an item (i.e. products and/or services) or a process in a given market section at a given expense. Marketing, finance, accounting, statistics and so on would be engaged with deciding these quality characteristics. Last fundamental parameter of quality is quality of performance. Quality of performance manages how well the item performs in the market-place, i.e. how is seen and acknowledged by the clients. Consumer satisfaction, sales analysis, cost correlation (e.g. cost of quality) and so on would be a portion of the methodologies utilized here (Mergen *et al.*, 2000).

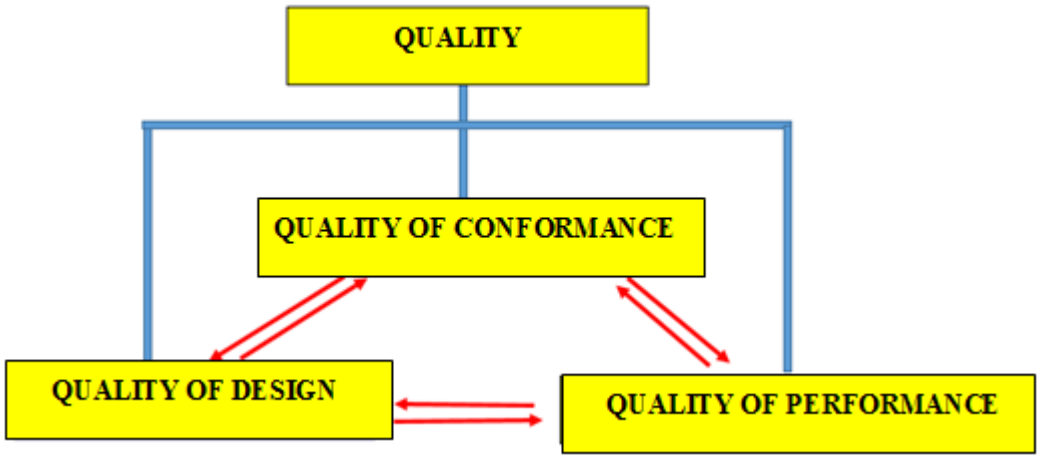

Figure 2.1 Relationship between Three Quality Aspects (Mitra, 1993)

2.2 Quality Management

Quality management is a logic which concerns on the hierarchical change that makes the manufacturing organizations to get benefits when the quality concert and effectiveness have improved (Khanna *et al*, 2010). Bisgaard (2008) stated that quality management are the basis within statistical quality control, quality improvement, the design of experiments and reliability operate for the industrial application. Stevenson (2015) also focuses on the satisfaction of customer and all of the top management and employees to increase and improve the quality. It also offers the structure, strategies, and organizational environment which works together with the quality professionals and statisticians (Bisgaard, 2008).

Juran (1986) portrayed concept of the quality trilogy in quality management which include quality planning, quality control and quality improvement as shown in Figure 2.2. Quality planning is the beginning stage that is making a process that will have the capacity

to meet established objectives and quality standards. Quality control is fundamental with the goal to know when corrective action is required; and quality improvement will discover better methods for getting things done. The fruitful implementation of the quality management can enhance the authoritative quality performance in the globalization economy today.

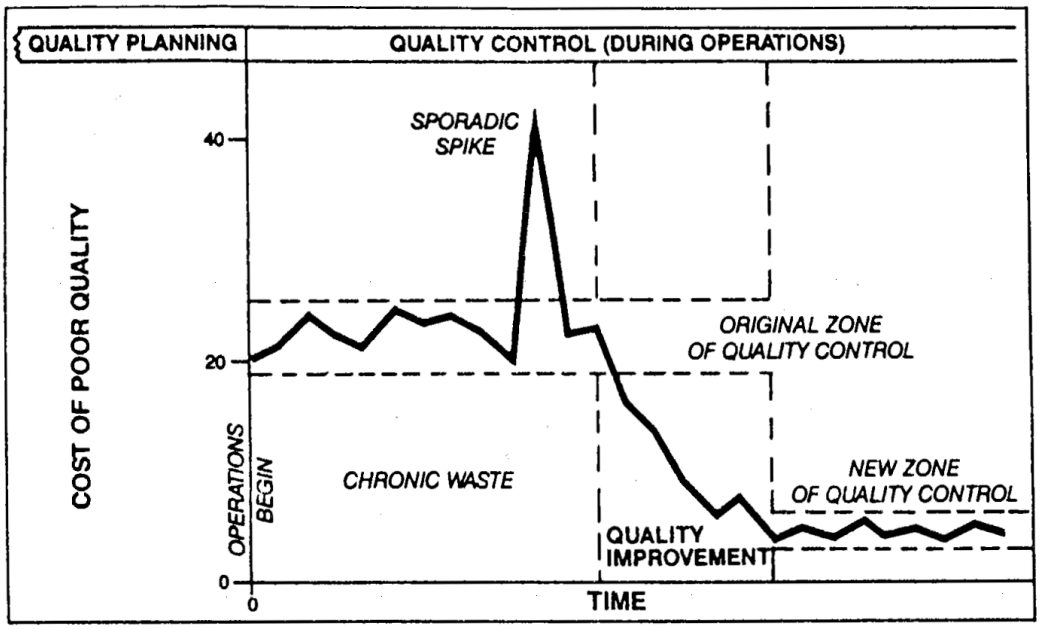

Figure 2.2 The Quality Trilogy (Juran, 1986)

2.3 Six Sigma

Six Sigma is an implementation of an estimation structure to gather information, analyze results and also integrate the data into processes (Aggogeri & Gentili, 2008). Six Sigma is a wide methodology used to indicate precisely the way of organization supervisors set up and accomplish objectives. It shows the improvements fix to substantial bottom-line outcomes can be accomplished (Soković *et al*, 2009). Antony (2004) stated that Six Sigma uses the theory of statistical thinking and empowers the utilization of verified statistical tools and techniques for the reduction of defect through process fluctuation decrease techniques (e.g. design of experiments and statistical process control). According to Stevenson (2014), six sigma can use for a business process for enhancing quality, reducing costs, and expanding consumer satisfaction. He concluded that six-sigma programs have turned into a key method to enhance quality, save time, cut expenses, and enhance consumer satisfaction.

The basic aim of the six sigma methodology is use to implement of a measurement that concentrates on process enhancement and variation reduction. Six Sigma as an incredible technique has been much recognized as fundamental for accomplishing and sustaining operational and service. While the first focus of six sigma was on manufacturing, today it has been generally acknowledged in both service and transactional processes (Antony, 2004).

Six sigma depends on these directing principles:

1. Reduction of variation is an imperative objective.

2. The methodology is data driven; it requires valid measurements.

3. Outputs are dictated by inputs; focus on modifying as well as controlling inputs to improve outputs.

4. Only a critical couple of inputs have a significant affect outputs (the Pareto effect); concentrate on those.

The end reason, in receiving the Six Sigma methodology, is to make an output, precisely as wanted by the clients, by inside removing all the possible source of defects and diminishing non-value activities from the esteem stream.

2.3.1 DMAIC methodology

According to Aggogeri (2008), the Six Sigma methodology or DMAIC methodology gives a problem-solving strategy to structure product and process, utilizing tools, training and measurements. The design purpose is to meet client expectations at Six Sigma quality levels. Define-Measure-Analyze-Improve-Control, or DMAIC, is a simple performance improvement model or tool used for analyzing and correcting existing products or processes (Chowdhury *et al*., 2014). Gejdoš (2015) stated that refers to an information driven enhancement cycle utilized for improving, advancing and balancing out commercial procedures and plans. Figure 2.3 shows the DMAIC improvement cycle is the center instrument used to drive Six Sigma projects.

Define - this progression is to unmistakably verbalize the organization problem or issue, objective, potential assets, risk extension and abnormal state risk course of events. This data is regularly caught within project charter document.

Measure - this step is to impartially build up recent starting point as the reason for development. This is an information gathering step, the purpose for which is to build up process accomplishment baselines. It is normal for groups to put a great deal of application into evaluating the appropriateness of the proposed estimation frameworks.

Analyze - this progression is to distinguish, approve and select primary driver for end. A substantial number of potential root causes of the project problem are recognized via root cause analysis (for example a cause-and-effect diagram). A data collection plan is made and information are gathered to set up the overall commitment of each root causes. This procedure is repeated until usable root causes can be recognized.

Improve - this step is to identify, investigate and execute an answer for the problem; to a restricted extent or in entirety. Distinguish innovative solutions for dispose of the main root causes with the end goal to settle and avoid process issues. Brainstorming or complex analysis tools like Design of Experiments can be used but attempt to focus on obvious solutions.

Control - this progression is to manage the gains. Monitor the enhancements to guarantee proceeded and economical achievement. Create a control chart and control plan. A Control chart can be useful during this to evaluate the stability of the enhancements after some period by serving as guideline to continue observing the process.

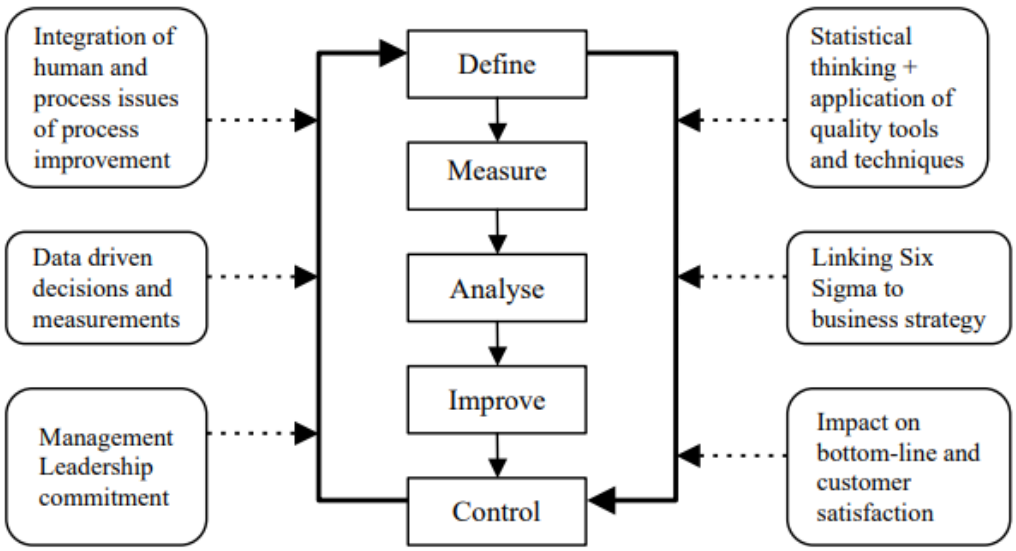

Figure 2.3 Six Sigma Methodology (Antony, 2006)

2.4 Statistical Tools and Techniques

2.4.1 Seven QC Tools

Quality tools are essential parts to assess and dissect the reasons for quality issues. Ishikawa (in the 1960s) is a Quality Management Gurus that shows the seven quality tools which can use to determine 95% of the quality related issues (Soković *et al*., 2009). Lazzaroni (2009) guaranteed that the quality tools that cooperate with quality control can enhance the quality of products and decrease the process costs caused by the defect and reject units. As indicated by Kiran (2016), quality tools are essential which able to evaluate and analyze the issues related to quality. It is a set of useful graphical practices to solve the quality related troubleshot issues. The seven quality tools are easy to handle and valuable when join with one another to tackle the issues. Soković *et al*. (2009) utilized the seven quality tools for product improvement until the administration of a production process to accomplish the quality dimension. This implies the quality tools utilized for an application must meet the real reason so just can resolve the issues. The seven quality tools are clarified as pursue:

1. Check sheet
2. Pareto chart
3. Histogram
4. Cause and effect diagram
5. Flowchart
6. Scatter diagram
7. Control chart

Figure 2.4 clearly shows the tools used for identification were around then considered as tools to analyze or for the two processes that are identification and analysis. Pareto and cause-and-effect diagrams are normal and fundamental in both method.