QUALITY IMPROVEMENT IN MANUFACTURING INDUSTRY USING SIX SIGMA METHODOLOGIES

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

by

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

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

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Date : 26 Jun 2018

APPROVAL

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

……

(**En. Nor Akramin bin Mohamad**) – Principal Supervisor

……

(**En. Ng Yew Seong**) – Co Supervisor

ABSTRAK

Tujuan projek ini adalah untuk menggunakan kaedah Six Sigma DMAIC methodology dalam sebuah syarikat untuk melaksanakan peningkatan kualiti. Sebuah syarikat pembuatan bahagian kereta telah terpilih, dan salah satu masalah yang dihadapi oleh syarikat adalah aduan pelanggan. Oleh itu, terdapat tiga matlamat dalam projek ini, iaitu, mengenalpasti bahagian-bahagian kereta dengan masalah yang mempunyai bilangan aduan yang tertinggi, menganalisis punca utama bahagian-bahagian kereta dengan masalah yang mempunyai jumlah aduan yang tertinggi dan akhirnya, meningkat dan mengekalkan kualiti produk. Untuk mencapai matlamat ini, kaedah Define-Measure-Analyze-Improve-Control (DMAIC) yang terdiri daripada lima fasa telah digunakan diikuti dengan alat dan teknik seperti carta pareto, carta kawalan, reka bentuk eksperimen, pelan kawalan statistik dan lain-lain telah digunakan dalam setiap fasa. Rujuk kepada objektif pertama, aduan pelanggan utama adalah masalah pelarasan daripada cermin pandang belakang kerana sukar untuk menyesuaikan cermin. Oleh itu, daya pergerakan untuk menyesuaikan cermin pandang belakang mesti dikurangkan untuk mencapai kepuasan pelanggan. Analisis telah dibuat terhadap beberapa faktor daripada segi Bahan, Kaedah, Mesin dan Reka bentuk. Hasilnya menunjukkan bahawa hanya Bahan dan Reka bentuk memberi kesan yang ketara. Selain itu, melalui analisis DOE, antara semua pilihan, Bahan-2 dan Reka bentuk-2 memberi kesan yang terbaik dengan mengurangkan daya yang diperlukan untuk menyesuaikan cermin. Daya pergerakan telah dikurangkan daripada 17N ke 13N dengan menggabungkan Material-2 dan Reka bentuk-2. Pengesahan penambahbaik telah dibuat untuk menunjukkan penambahbaikkan yang ketara dan kaedah seperti SPC, Pelan Kawalan Mutu dan Program Jaminan Kualiti digunakan untuk mengekalkan keadaan.

ABSTRACT

The aim of this project is to apply six sigma DMAIC methodology in a company to perform quality improvement. The selected company is a car parts manufacturing company. One of the problem faced by the company was Customer Complaints. Therefore, there were three objectives in this project which were to identify the car parts with problem that has the highest number of customer complaints, analyse the root cause of the problem with highest number of customer complaints and to improve and maintain the product quality. To achieve these objectives, Define-Measure-Analyse-Improve-Control (DMAIC) methodology that consists of five phases was used and tools and techniques like pareto chart, control chart, design of experiment, statistical control plan and others were applied in each phase. Refer to the first objective, the main customer complaint was about the adjustment problem from rear-view mirror, customer complaint that it was difficult to adjust the mirror. So, the force to adjust the rear-view mirror must be reduced to achieve customer satisfaction. Analysis has been made on several factors like Material, Method, Machine and Design. The result showed that only Material and Design gives significant effect. Besides, through DOE analysis, among all the options, Material-2 and Design-2 give the best effect that reduce force required to adjust the mirror. The movement force has been reduced from 17N to 13N by incorporating Material-2 and Design-2. Verification of improvement is made to show the significant improvement and tools like SPC, Quality Control Plan and Quality Assurance Program are used to maintain the situation.

DEDICATION

Only

my beloved family

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 & SPECIALIZED NOMENCLATURE

ROI	-	Return of Investment
DMAIC	-	Define, Measure, Analyse, Improve, Control
DMADV	-	Define, Measure, Analyse, Design, Verify
DPMO	-	Defects per Million Opportunities
SIPOC	-	Supplier, Input, Process, Outcome, Customer
VSM	-	Value Stream Mapping
QFD	-	Quality Function Deployment
QC	-	Quality Control
ANOVA	-	Analysis of Variance
DOE	-	Design of Experiment
SN	-	Signal-to-Noise
SPC	-	Statistical Process Control
TQM	-	Total Quality Management
R&R	-	Repeatability and Reproducibility
USL	-	Upper Specification Limit
LSL	-	Lower Specification Limit
UCL	-	Upper Control Limit
LCL	-	Lower Control Limit
ABS	-	Acrylonitrile Butadiene Styrene
QCP	-	Quality Control Plan
UTeM	-	Universiti Teknikal Malaysia Melaka

LIST OF SYMBOLS

$\overline{X}$	-	Sample Mean
σ	-	Sigma or Standard Deviation
μ	-	Mean
$\overline{\overline{X}}$	-	Grand Mean
$\overline{R}$	-	Average Range
σ_x	-	Population Standard Deviation
n	-	Subgroup sizes
d_2	-	Factors for Central Line
A_2	-	Factors for Control Limits
D_3	-	Factors for Control Limits
D_4	-	Factors for Control Limits
N	-	Newton
cm^3	-	Volume
Cp	-	Process Capability
Cpk	-	Process Capability Index

CHAPTER 1
INTRODUCTION

1.1 Six Sigma Methodology

The main objective of a company is to have a higher Return of Investment (ROI). Over emphasizing on product quality will involve cost and time and this will reduce the productivity of a company. So, to achieve a higher ROI. Cost and time is the first thing that comes in head, motivate worker's attitude towards working, and reduce waste and rejection. The ongoing trend is not just to make profits but need to benefit the organisation and customer satisfaction. The internal benefit of an organization is the monetary where the external benefit is customer satisfaction. In order to achieve the balance score, the organization must reduce the waste and improve product quality, thus, fulfil the customer requirements. The internal management like waste, defects and other internal problem must reduce to satisfy the customer. Therefore, Six Sigma, Define-Measure-Analyse-Improve-Control (DMAIC) methodology was used to achieve all these objectives.

Six Sigma methodology is a quality improvement tools for continuous improvement in the process of an organization (Johnston et al., 2009; Su & Chou, 2008). There are 2 sub methodologies and have a total of 5 phases for each cycle which are DMAIC and DMADV. Define-Measure-Analyse-Design-Verify （DMADV） methodology is usually used to create a new product and process design, and DMAIC Define-Measure-Analyse-Improve-Control is the most common Six Sigma methodology used for process improvement. Applying a problem through DMAIC phases together with team will eventually find the root cause of the problem and find possible solution. Six Sigma DMAIC is like a continuous loop, if the result obtained is not good enough, continuous improvement is recommended where the problem will undergo the 5 phases again.

Six Sigma uses statistics information to describe quantitatively how a process is performing. A process must not produce more than 3.4 defects per million opportunities (DPMO) to achieve six sigma which means 99.7% percentage yield is required and only 0.00034% of defects.

1.2 Problem Statement

A good product that can penetrate the market is to fulfil three criteria which are Good Quality, Competitive Price and Good Service. One of the problem faced by the company is customer complaints. Table 1.1 and Figure 1.1 shows the number of customer complaints received which consists of 5 different car parts and three categories of problem. The number represents the number of customer complaints received in batches. Adjustment is the main problem here, all coming from Rear-view mirror with total customer complaints of 20 batches in a year. The car parts that received the highest number of complaint is also rear-view mirror with a total complaint of 22 batches, another 2 batches coming from function problem. A quality team was formed to investigate this problem. The adjustment problem came from the plastic moulded part from the rear-view mirror which is shown in Figure 1.2, the stay ball and retainer are joined to adjust the mirror position, stay ball part is attach to the car body and retainer part attach to the mirror. the customer complain that it is difficult to adjust the rear-view mirror especially on the side.

Table 1.1: Customer Complaint on Car Parts Problems

Car parts/Problems	**Others**	**License Plate Lamp**	**Rear-View Mirror**	**Side-View Mirror**	**Signal Lamp**	**Grand Total**
Appearance	1			8		9
Function	1	1	2	4	1	9
Adjustment			20			20
Grand Total	**2**	**1**	**22**	**12**	**1**	**27**

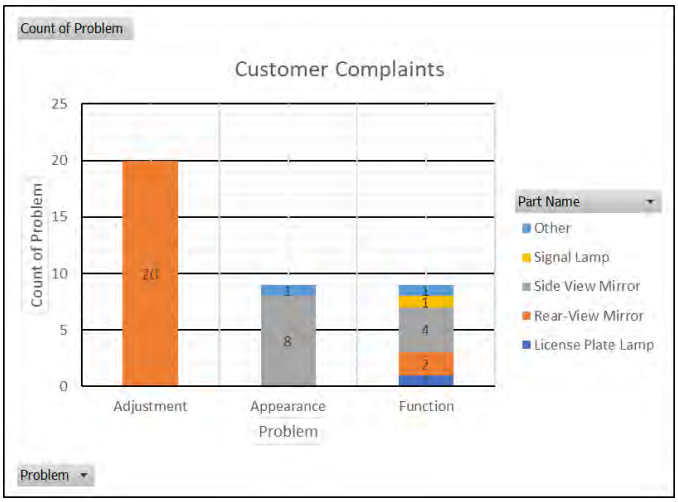

Figure 1.1: Customer Complaints

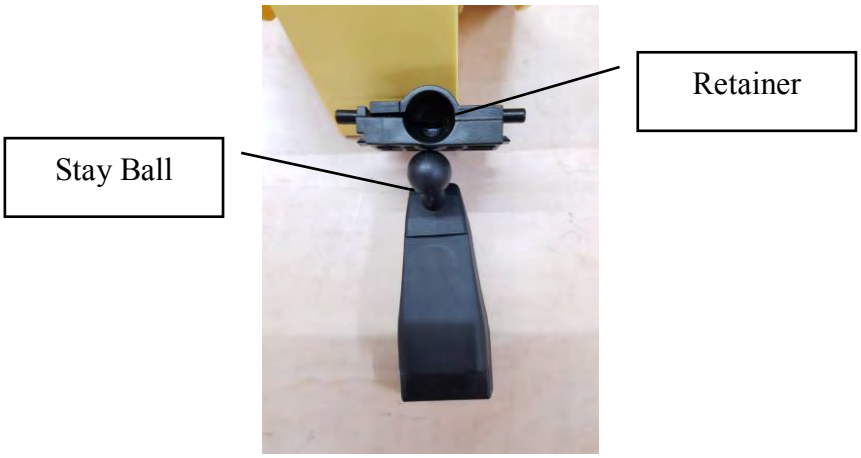

Figure 1.2: Stay Ball and Retainer

1.3 Objectives

The main objective of this project is the application of Six Sigma DMAIC methodology to solve the problem by defining the problem, collect information and conduct analysis to achieve customer satisfaction and then maintain the quality.

Here are several sub-objectives to be achieved and make this project successful:

a) To identify the car part with problem that has the highest number of customer complaints.
b) To analyse the root cause of the problem with highest number of customer complaints.
c) To improve and maintain the product quality.

1.4 Scopes

This project involves a car parts manufacturing industry by using Six Sigma DMAIC methodology in a car parts manufacturing industry. The data collected were from October 2016 to September 2017 within a year. The focus will be given to the rear-view mirror (retainer and stay ball) refer to Figure 1.2, because these components are the parts that will control the movement of the mirror. Besides, Implementation of Six Sigma is time and cost constrained.

1.5 Importance of Study

Six Sigma and reliability, reliability is the key for customer. Customer will always want a reliable product that has no defect. So, to reduce defect rates, increase reliability and customer satisfaction, variation in the key processes that are involved in making products needs to be reduced, this in turn requires understanding the processes, determining how it can be improved, and implementing the changes.

1.6 Report Outlines

The entire research covers 5 main parts which are:

Chapter 1: Introduction

This chapter discusses about the background of study, which mentioned about the reasons why six sigma methodology, descriptions and importance of six sigma methodology. Problems are identified through customer complaints. Followed by Objectives to be attained and scopes which will help to narrow down the area of study. The importance of study also mentioned here to explain why the research is carried out.

Chapter 2: Literature Review

This section explains about simple summary and basic theories from the previous studies from journals and books. The five phases DMAIC are explained and described here. Besides, common tools that used in Six Sigma methodology are recommended and further explanation is made.

Chapter 3: Methodology

This part focuses on the method to carry out the research, tools used during progression of project in the 5 phases, Define, Measure, Analyse, Improve, Control. Besides, the reason to use the tools suggested also discussed in this chapter.

Chapter 4: Analysis and Discussion

This part mentioned about data collection, analysis, and improvement that has been made according to the result obtained through the 5 phases of DMAIC.

Chapter 5: Conclusion & Recommendation

The conclusion is made based on the result obtained and reflection of objectives. Recommendation is suggested to further improve.

CHAPTER 2
LITERATURE REVIEW

This chapter mainly describes about the theory and researches which have been explained, described and done by previous researcher years ago. Related information is being extracted as references and discussion based on their research about theory, background, five phases of DMAIC, methodology, tools and techniques used, advantages and application of Six sigma.

2.1 Introduction of Six Sigma

To improve the performance of an organization, one of the methodology use is Six Sigma methodology by using various statistical tools and techniques (Ratnaningtyas & Surendro, 2013) and acquire sustainable solution(s) to minimize or eliminate the problem, to keep the organization in a competitive position (Boon Sin et al., 2015) Six Sigma has a positive impact on quality improvement referred to (Indrawati & Ridwansyah, 2015; Moradinaftchali et al., 2016) stated that improvement in quality may lead to a better level of productivity, because Six Sigma strive to achieve a high quality and low variability by identifying and removing defects causes (Nunes, 2015). There are many definitions for Six Sigma. Based on (Su & Chou, 2008), Six Sigma is defined as "a flexible system for improved performance and leadership". Whereas for (Harry & Schroeder, 2000), Six Sigma is a strategy that depends on its capability to fulfil its goals. Whereas, (Adina & Roxana, 2014) defined Six Sigma as an organized and systematic approach used to enhance processes and develop new products and services to reduce defects defined by customer based on statistics and scientific techniques.

According to (Erbiyik & Saru, 2015; Su & Chou, 2008), the basics of six sigma is related to statistics and the level of quality increases when sigma level increases, sigma (σ) is the symbol for standard deviation which is a measurement unit for statistical dispersion and spreading.

Six Sigma is a strategy to focused on customer satisfaction and also a methodology used to reduce the defects level to 3.4 defects per million in production, product design, management processes and delivery that strive to obtain the same result every time and utilizes the well-defined problem-solving approach via statistical tools. Figure 2.1 shows the percentage distribution of Six Sigma, to achieve Six Sigma, 99.7% percentage yield is required and only 0.00034% of defects.

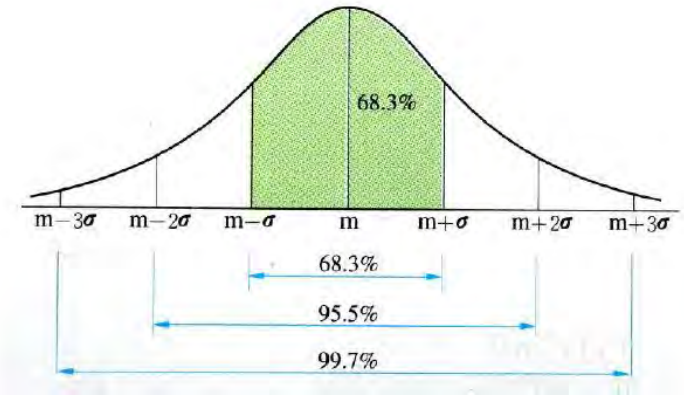

Figure 2.1 Percentage distribution of 6 Sigma (Erbiyik & Saru, 2015)

Six Sigma approach concentrates on 3 topics, which is to increase satisfaction level of customer, reduce cycle times and reduce failures or defects.

2.2 Six Sigma Methodology

There are 2 approaches in Six Sigma which are DMAIC and DMADV. (Adina & Roxana, 2014) shows that DMAIC (define-measure-analyse-improve-control) approach is used for products and services, whereas, for products and processes another approach called DMADV (design-measure-analyse-design-verify) is being used. However, (Yang, 2005) suggested that DMADV methodology is appropriate to use when designing service processes.