ENHANCING THE EFFECTIVENESS OF QUALITY CONTROL SYSTEM USING LEAN SIX SIGMA APPROACH

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DECLARATION

I declare that this thesis entitled "Enhancing the Effectiveness of Quality Control System Using Lean Six Sigma Approach" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……

Name : NURUL NASREEN BINTI MOHD HASHIM

Date : 4 SEPTEMBER 2019

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Manufacturing Engineering (Industrial Engineering).

Signature	:	……
Supervisor Name	:	ASSOC. PROF. DR. ZUHRIAH BINTI EBRAHIM
Date	:	4 SEPTEMBER 2019

DEDICATION

To my beloved parents,

the reason of what I become today and always give me support endlessly.

To my big family,

thank you for the encouragement and also understandings.

To my supervisor,

You've have always been a great mentor to me.

To all my PG friends,

thank you for all of the memories over the past few months.

ABSTRACT

In the manufacturing industry, intense competition and more complex customer needs and demands have forced entire industries and organisations to continuously improve the quality of their products, as well as the Small and Medium Enterprise (SME) industry. A good Quality Control (QC) system is the one of the factors that a company should be taking care of in delivering the best products quality and services in order to overcome the other competitors and gain customer's loyalty. In this project, the company realises the need to enhance the effectiveness of their Quality Control (QC) system due to inconsistent judgment and repeated problems. Due to this problem, it could lower the production effectiveness and high reject and rework cases. The aim of this project is to enhance the effectiveness of the current Quality Control (QC) system by using Lean Six Sigma approach. In order to achieve the aim, there are two objectives that need to be achieved; (i) To identify the gaps between the current Quality Control (QC) system that used in the company and Quality Control (QC) system in theory and (ii) To enhance the effectiveness of current Quality Control (QC) system by eliminating and reducing the gaps. This project has been conducted using Lean Six Sigma approach which is the DMAIC methodology that consists of five stages Define-Measure-Analyse-Improve-Control. Analysis of the results shows that (i) Only certain process in the production line of flexible link that have QC inspection, (ii) High potential inspection error based on experience which is absent of standard references for the visual inspection, (iii) Company does not follow the acceptance sampling theory. In conclusion, the effective of current QC system at the company can be enhanced through the implementation of acceptance sampling based on theory. Furthermore, the development of standard references for QC inspection at the production process is essential for the enhancement of QC system.

ABSTRAK

Dalam industri perkilangan, persaingan sengit dan keperluan pelanggan yang lebih kompleks telah memaksa seluruh industri dan organisasi untuk terus meningkatkan kualiti produk mereka, termasuk Industri Kecil dan Sederhana (PKS). Sistem Kawalan Kualiti (QC) yang baik adalah salah satu faktor yang harus diambil oleh syarikat dalam memberikan kualiti dan perkhidmatan produk terbaik untuk mengatasi pesaing lain dan mendapatkan kesetiaan pelanggan. Dalam projek ini, syarikat sedar keperluan untuk meningkatkan keberkesanan sistem Kawalan Kualiti (QC) mereka akibat penghakiman yang tidak konsisten dan masalah berulang. Disebabkan masalah ini, ia dapat menurunkan keberkesanan pengeluaran dan kes penolakan dan penyingkiran yang tinggi. Tujuan projek ini adalah untuk meningkatkan keberkesanan sistem Kawalan Kualiti (QC) semasa dengan menggunakan pendekatan 'Lean Six Sigma'. Untuk mencapai matlamat tersebut, terdapat dua objektif yang perlu dicapai; (i) Untuk mengenal pasti jurang antara sistem Kawalan Kualiti (QC) semasa yang digunakan dalam sistem dan sistem Kawalan Kualiti (QC) dalam teori dan (ii) Untuk meningkatkan keberkesanan sistem Kawalan Kualiti (QC) semasa dengan menghapuskan dan mengurangkan jurang. Projek ini telah dijalankan menggunakan pendekatan 'Lean Six Sigma' yang merupakan metodologi DMAIC yang terdiri daripada lima peringkat iaitu 'Define-Measure-Analysis-Improve-Control'. Analisis keputusan menunjukkan bahawa (i) Hanya proses tertentu dalam barisan pengeluaran fleksibel yang mempunyai pemeriksaan QC, (ii) Kesilapan pemeriksaan berpotensi tinggi berdasarkan pengalaman yang tidak ada rujukan standard untuk pemeriksaan visual, (iii) Syarikat tidak mengikuti teori persampelan penerimaan. Kesimpulannya, keberkesanan system QC di syarikat berkenaan boleh dipertingkatkan menerusi pelaksanaan pensampelan penerimaan berasaskan teori. Tambahan pula, pembangunan rujukan standard untuk pemeriksaan QC pada proses pengeluaran adalah penting untuk peningkatan sistem QC.

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First and foremost, all praise to The Almighty, that I managed to complete this Master Project successfully although sometimes I hit the rock bottom.

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Finally, I would like to thank everybody who was important to this Master Project, as well as expressing my apology that I could not mention personally each one of you.

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LIST OF ABBREVIATIONS

QC	-	Quality Control
LSS	-	Lean Six Sigma
AQL	-	Acceptance Quality Limit
ATR	-	Acceptance Test Report
QI	-	Quality Inspection

CHAPTER 1

INTRODUCTION

This report portrays a study on enhancing the effectiveness of quality control system in Small and Medium Enterprise (SME). This chapter gives a clarification of the background of the project, problem statement, objectives and scope of the project, significant of the project, and lastly thesis outline.

1.1 Background of the Project

The rapid growth of global industries has introduced a fierce competition among companies in supplying high quality products to fulfil the requirement of the customer. Due to the increasing of customer demand for certain products have led the company strives to meet customer needs and expectations, thus required the company to ensure that their processes are continuously monitor and quality of its products are improved. Company will get profit in terms of marketing and satisfaction from customer if they provide good quality products.

Although the company has been endeavouring hard to make a high quality product, there is still a few product that have defect and need to rework. Lack of systematic Quality Inspection System is the main factor that contribute to low productivity due to rework and defect. Moreover, if many defect products are produced, it will increase the cost for rework and time consuming. Besides that, defect products also can increase customer complain and lead to bad reputation of the company itself. In order to cope with the product defects, each

company must have a quality control system that to ensure each product has its own quality standard.

The important of this project is to enhance the effectiveness of the current quality control system in Company X, through implementation of Lean Six Sigma methodology to reduce rework of the product, which subsequently increase the productivity of the company. Company X which situated at Ayer Keroh, Melaka has become one of the main supplier to produce electrical component which is flexible link that showed in Figure 1.1. Flexible link are extremely flexible components and are manufactured out of braided copper wire, layered to meet its designated capacity which promotes large surface areas.

Figure 1.1: Example of Flexible Link

High product quality is very important to this company to achieve the best value to the customers. The biggest challenge of this company is to increase the quality inspection and acceptance rate at same time minimizing the resources and reduce rework. Apart from that, it is necessary to acquire knowledge to deploy projects effectively by having common concepts for accurate understanding such as Lean Six Sigma and Quality Control System. A thorough study on relevant literature reviews was carried out in order to strengthen more knowledge on the current Quality Control (QC) system used by Company X and how to enhance the effectiveness using Lean Six Sigma implementation.

1.2 Problem Statement

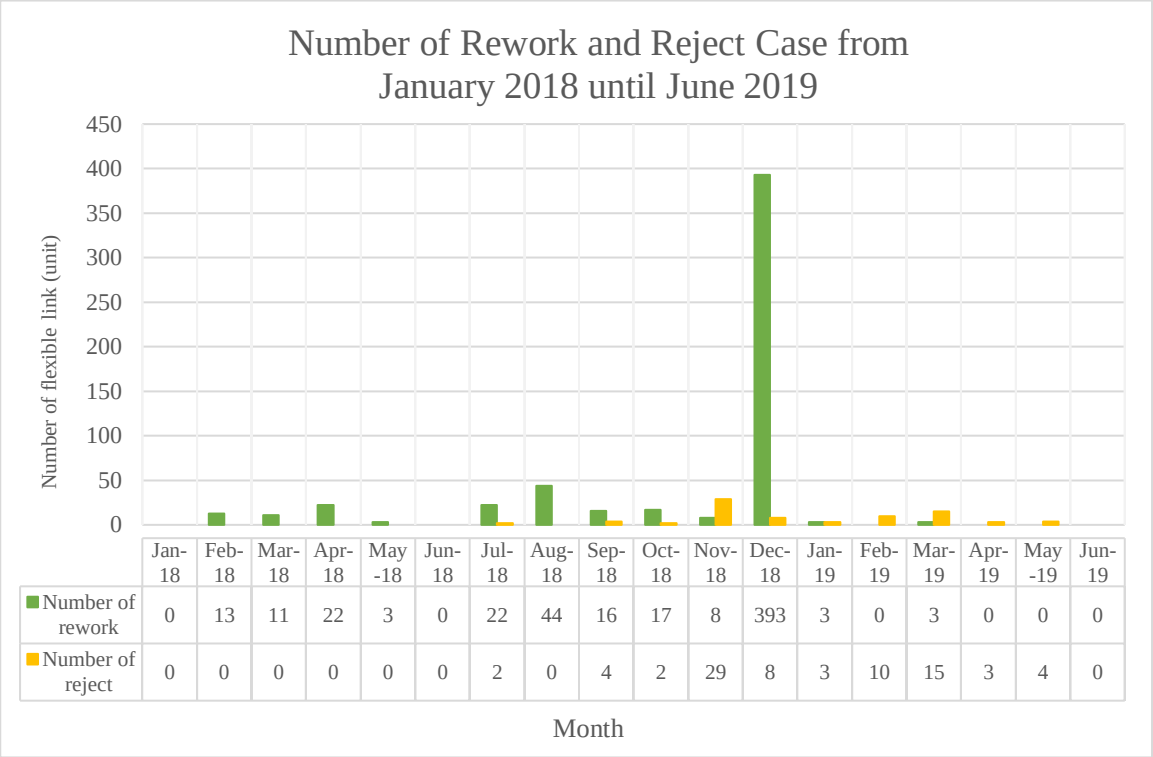
Most company will encounter the problem of producing defective product and the root causes are still in finding. Due to this problem, it could lower the profit of the company and the production efficiency. Company X is the only local producer and distributer of flexible link in Malaysia. The company realises the need to enhance the effectiveness of their Quality Control (QC) system due to inconsistent judgment and repeated problems.

Here, the inconsistent judgement refers judgement that have been made based on experience without referring to any standard references. While, repeated problems refer to rework that need to be done after QC inspection. Table 1.1 shows ineffective Quality Control (QC) system at Company X due to inconsistent judgement and repeated problems based on the observation.

Table 1.1: Problems occur in Flexible Link process

Process	Inconsistent Judgement	Repeated Problem
Incoming raw material	-	-
Pipe pre-forming	-	-
Assembly	-	-
Pressing	Yes	Yes
Glue	-	-
Marking	Yes	Yes
Drilling	Yes	Yes
Glue/Reamer	-	-
Cutting	Yes	Yes
Re-press	Yes	Yes
Grinding	Yes	Yes
Cleaning	Yes	Yes
Acceptance Test Report (ATR)	-	-
Packing	-	-

As a result, the company is facing higher rework case along the production of flexible link. Figure 1.2 shows the month of rework and reject cases for flexible link from January 2018 until June 2019.



	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19
Number of rework	0	13	11	22	3	0	22	44	16	17	8	393	3	0	3	0	0	0
Number of reject	0	0	0	0	0	0	2	0	4	2	29	8	3	10	15	3	4	0

Figure 1.2: The number of rework and reject case for flexible link from January 2018 until February 2019

In total, there were 555 units of flexible link that need to be rework which is contributed 3.76% of the total output, meanwhile 80 units of reject cases. Hence, this project aims to improve the effectiveness of Quality Control (QC) system at the Company X through elimination of inconsistent judgement and repeated problems.

1.3 Objectives of the Project

The main objective of this study is to enhance the effectiveness of the current quality control system in the case study company by implementing Lean Six Sigma. In order to achieve this main objective, some sub-objective can be developed:

i. To identify the gaps between current Quality Control (QC) system and Quality Control (QC) system in theory.

ii. To enhance the effectiveness of the Quality Control (QC) system at the company by eliminating and reducing the gaps.

1.4 Scope of the Project

This project will focus on how to increase the efficiency of current quality control by solving the problems; (i) inconsistent judgment, (ii) repeated problem. This study is carried out by using Lean Six Sigma approach which is DMAIC (Define, Measure, Analyse, Improve, Control) methodology. In addition, the scope of this Lean Six Sigma implementation study is limited to flexible link production process. Data are collected through interviews, document reviews, and observation focussing on the process of the product.

1.5 Significant of the Project

This project will be a significant aim in improving the current quality control system used in company production line in terms of minimizing the non-value added activities in Quality Control (QC) system. The outcome of this project also allowed the company to enhance the effectiveness of Quality Control System in the production line from incoming raw material until the last process which is shipping by eliminating the non-value added activities.

1.6 Thesis Outline

This thesis consists of five chapters that will explain details about this study. The first chapter of this report is about the introduction of this study and tool that will be use in this study. Problem statements are identified and objectives to achieved are determined. The scope of the project will narrow down the area of the study.

It is then followed by Chapter 2 which described the literature review on what has been highlighted from the previous researchers about Quality Control, Lean Manufacturing, Lean Six Sigma and DMAIC to support the methodology of study. The literature review will be done online by searching journal, case study, article and from other reliable source.

Chapter 3 explains on the research design, research procedures and tools used in this project. In this chapter also will explain about how data is collected and analysed the data.

Chapter 4 discusses about the results and finding from the project. The result obtained from the implementation will be analyse in order to identify the problem.

The last chapter which is Chapter 5 concludes the findings related to the objectives, whether the objectives were achieved or not achieved. Moreover, suggestion for future improvement also included in this chapter.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews the previous literatures and references which give support for this project. It explained regarding the Quality Control (QC) system and applying Lean Six Sigma approach into this project in order to enhance the effectiveness of the current QC system in the company.

2.1 Quality Control

Quality control can be defined as the process of inspecting product or output to ensure that the output meets the required quality standards. It is important element that company have to utilize to ensure high quality in their product or service in order to meet customer demands. Tedious inspection has to be carried out after the manufacturing process to avoid defected products are shipped to customers. In order to maintain customer satisfaction, the inspection in the production process is necessary (Sandra et al., 2001).

Quality control is a very traditional method, but still a quite popular method of trying to manage the level of product quality and it involves the concept of inspecting the product as it goes through the production process. The main objective of quality control is to detect defective product rather than allowing the product to go out and reach the customer. And it is not always possible to check all the products, so normally the company requires to apply sampling plan.

Sampling plan refer to take a representative sample of product and check whether the product met the quality standards or not. Besides, if it too much sampling and inspection, it can cause the quality control process became quite costly.

Generally, the quality inspection was carried out by human. Nowadays, many of workers have lost their role in manufacturing as various automated inspection systems have been invented to replace them. This is due to human will experience fatigue when they do their work for too long and as a result, human performance is quite not reliable.

In any case, several companies still do not prefer using automated system rather than human to perform the quality control inspection due to high investment cost to maintain the machine or system. Despite the fact that inspection by human tends to be not 100% accurate, it keeps on being one of the regular methods applied to check the product defect (Tetteh et al., 2006). The work idea of quality control includes sorting, inspecting, testing, weighting and sampling. Among these, visual inspection task is one of the basic techniques (Khasawneh et al., 2003).

Thus, a lot of tremendous efforts were done to carry out by researchers in order to increase the effectiveness of the visual inspection tasks. As a result, there are a lot of researchers had been carried out to improve the productivity of quality control tasks.

2.2 The Seven QC Tools

The Seven Quality Control Tools popularly called the 7 QC Tools, contain graphical techniques and help to change the information into effectively understandable graphs or diagrams. The Seven QC tools are flowchart, check sheet, cause and effect diagram, pareto chart, control chart, histograms and scatter diagram. These tools are very easy to understand the circumstance or to analyse the issue effectively and leads to creating idea which aim towards quality control improvement.

2.2.1 Flowchart

A flowchart is a graphical technique for reviewing a system activity or process. Flowchart comprises of a few standard symbols connect in a logical way to portray the flow of process or information in the ideal sequence and it is very helpful in identifying errors that found in the production process (Forbes and Ahmed, 2010). Vijayarangam (2017) stated that flowcharts are used in analysing, documenting or managing a process in various fields. A common flowchart illustrated in the Figure 2.1 below.

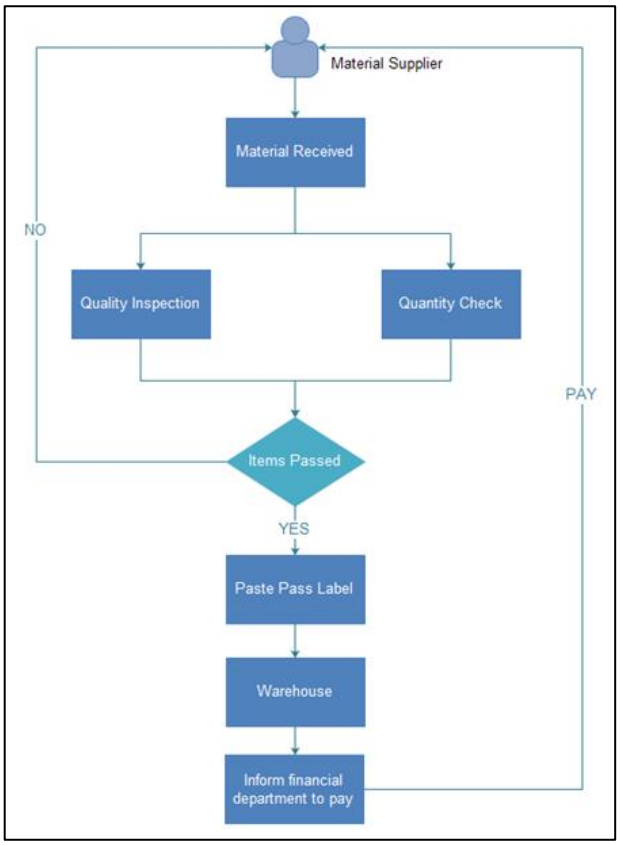


Figure 2.1: Flowchart of Incoming Material (Anonymous, 2019)

2.2.2 Check Sheet

Check sheets is a list in the form of a diagram or table format in order to record data and it is useful for later analysis. It is also called as a tally sheet. Check sheets are tools for collecting data. A few examples of check sheets are maintenance record, attendance record, production logbooks, defects record and also failure records (Magar and Shinde, 2014). The main advantages of check sheets are to be very easy to apply and comprehend, and it can make a clear picture of the circumstance and condition of the company. They are productive and useful assets to identify possible issues, however they do not have the ability to analyse the quality issue in the workplace. Figure 2.2 is shown an example of tally check sheet that can be used for collecting data during the production process.

Motor Assembly Check Sheet

Name of Data Recorder: Lester B. Rapp

Location: Rochester, New York

Data Collection Dates: 1/17 - 1/23

Defect Types/ Event Occurrence	Dates							TOTAL
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
Supplied parts rusted		|||||||	|||||	||||	||			20
Misaligned weld			|||			||		5
Improper test procedure								0
Wrong part issued								3
Film on parts								0
Voids in casting								6
Incorrect dimensions								2
Adhesive failure								0
Masking insufficient								1
Spray failure								5
TOTAL		10	13	10	5	4		

Figure 2.2: Check Sheet of Motor Assembly (Penfield, 2010)