

DMAIC APPLICATION FOR THE REDUCTION OF DEFECT IN MANUFACTURING INDUSTRY



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DMAIC APPLICATION FOR THE REDUCTION OF DEFECT IN MANUFACTURING INDUSTRY

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



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ABSTRAK

DMAIC adalah strategi kualiti yang didorong oleh data yang digunakan untuk meningkatkan keberkesanan dan kecekapan proses organisasi merentasi industri. Pada masa kini, DMAIC digunakan untuk meningkatkan kualiti pengeluaran dengan meminimumkan variasi, menghapuskan kecacatan, dan meningkatkan keupayaan proses. Tujuan projek ini adalah untuk melaksanakan metodologi DMAIC (Define-Measure-Analyse-Improve-Control) dalam industri pembuatan biskut untuk mengkaji pengurangan kecacatan. Projek ini mengikuti metodologi DMAIC untuk menyiasat secara sistematik punca kecacatan dan menyediakan penyelesaian untuk mengurangkan atau menghapuskannya. Alat Six Sigma yang sesuai digunakan seperti piagam projek, gambar rajah SIPOC, carta pareto, Why-why analisis, dan gambar rajah tulang ikan. Khususnya, teknik Design of Experiment (DOE) digabungkan untuk menentukan secara statistik sama ada pembolehubah proses utama iaitu suhu proofing, suhu ketuhar (pembakar), suhu ketuhar (pengeringan), dan berat doh, mempunyai kesan ke atas bilangan kecacatan kualiti yang dihasilkan. Dari analisis, didapati bahawa penyumbang utama kepada kecacatan bentuk dan saiz adalah suhu proofing, suhu ketuhar (pembakar) dan suhu ketuhar (pengeringan). Punca suhu mesin telah dikenalpasti, dan pelan tindakan telah dilaksanakan. Berikutan Perintah Kawalan Pergerakan (PKP), satu cadangan telah dibuat kepada Syarikat Biskut untuk melaksanakan Penyelenggaraan Pencegahan Menyeluruh (TPM) dan teknik pemotongan adunan baru. Projek ini menunjukkan bahawa kitaran DMAIC adalah pendekatan yang berkesan yang boleh menyelesaikan isu kecacatan menggunakan penyelesaian mudah. Ia mempunyai potensi untuk memberikan pulangan yang baik kepada syarikat jika dilaksanakan dengan betul dan cekap.

ABSTRACT

DMAIC is a data-driven quality strategy used to improve effectiveness and efficiency of organizational processes across industry. Nowadays, DMAIC is used to improve the quality of production output by minimize the variation, eliminate the defects, and improve the process capability. The aim of this project is to implement DMAIC (Define-Measure-Analyse-Improve-Control) methodology in a biscuit manufacturing industry to study the reduction of defects. The project follows the DMAIC methodology to systematically investigate the root cause of defects and provide a solution to reduce or eliminate them. Suitable Six Sigma tools is applied such as project charter, SIPOC diagram, pareto chart, Why-why analysis, and fishbone diagram. In particular, the Design of Experiments (DOE) techniques was combined to statistically determine whether the key process variables which is proofer temperature, oven temperature(baking), oven temperature(drying), and weight of dough, had an impact on the number of quality defects produced. From the analysis, it is found that the major contributor to the shape and size defect are the proofer temperature, oven temperature(baking) and oven temperature(drying). The causes of the machine's temperature were identified, and action plans were implemented. Due to a Movement Control Order (MCO), a proposal was made to the Biscuit Company to implement Total Preventive Maintenance (TPM) and a new dough cutting technique. The project demonstrated that DMAIC cycle is an effective approach that can solve a defect issue using simple solutions. It has the potential to provide good returns to the company if conducted properly and efficiently.

DEDICATION

Dedicate to my beloved parents, brothers, sisters, all my friends and relatives,
Thank you for your inspiration and encouragement,
You all are everything to me.
May Allah bless all of us. Insha-Allah



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LIST OF ABBREVIATIONS

DMAIC	-	Define, Measure, Analyse, Improve, Control
DMADV	-	Define, Measure, Analyse, Design, Verify
SIPOC	-	Supplier, Input, Process, Outcome, Customer
RCA	-	Root Cause Analysis
DOE	-	Design of Experiment
OPL	-	One Point Lesson
COPQ	-	Cost of Poor Quality
ANOVA	-	Analysis of Variance
DPMO	-	Defects per Million Opportunities
VSM	-	Value Stream Mapping
SPC	-	Statistical Process Control
SMED	-	Single-Minute Exchange of Die
SOP	-	Standard Operating Process
VOB	-	Voice of Business
VOC	-	Voice of Customer
MSA	-	Measurement System Analysis
QFD	-	Quality Function Deployment
R&R	-	Repeatability & Reproducibility
FMEA	-	Failure Mode and Effects Analysis
TPM	-	Total Productive Maintenance
HOQ	-	House of Quality
MCO	-	Movement Control Order

CHAPTER 1

INTRODUCTION

The introduction chapter shows an overview of the study. The overview starts with research background. Then, identify the project's problem statement. The chapter then provides the research objectives and scope of the project. Lastly, it concludes with an outline of the study and a chapter summary.

1.1 Research background

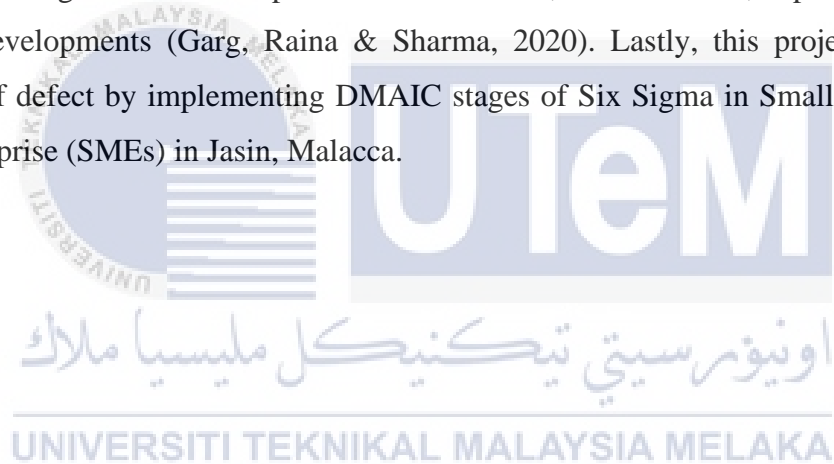
Manufacturing company may involve the volatile condition of economic. Nowadays, company and organization need to proactively stay in competition to survive within the competitors toward success. Therefore, the improvement needed to fulfill customers satisfaction such high quality product, eliminates waste, achieve low cost involved and maximizing the profit.

Many statistical and business tools have been developed and systemize by Six Sigma. The tools developed for reducing costs, decrease number of defects and improve cycle time of production. In all stages of the manufacturing and administrative process, the lean tools may be applied (Zu, Fredendall & Douglas, 2008). There are two main Six Sigma methodologies which are DMAIC (Define-Measure-Analyse-Improve-Control) and DMADV (Define-Measure- Analyse- Design- Validate). DMAIC is applied in the manufacturing of existing process or service. DMADV use to develop new products or process design.

The attention of Six Sigma is on the critical requirement to satisfy the customers. Therefore, The root cause is determined by Six Sigma and the faults or failures that may

affect processes or services are reduced (Jirasukprasert, Arturo Garza-Reyes, Kumar & K. Lim, 2014). DMAIC is an integral part of Six Sigma and refers to five interconnected phases that have been systematically designed to resolve issues and optimize their processes. The objective of achieving high quality or minimal defects can be defined as Six Sigma. Moreover, the objective of Six Sigma is achieved not more than 3.4 defects per million opportunities (DPMO) (Gaikwad, Teli, Majali & Bhushi, 2015).

With the original task of minimizing variance, the DMAIC stage model is a systematic problem-solving approach, the method is now common for more general tasks, such as quality improvement, performance improvement, cost reduction, and other activities in operations management, and beyond development in services, healthcare, and other forms of operations (Kumar & Sosnoski, 2009). Six Sigma is a process improvement tool which implement in organization to improve consumes time, determination, capital and groundbreaking developments (Garg, Raina & Sharma, 2020). Lastly, this project focuses on reduction of defect by implementing DMAIC stages of Six Sigma in Small and Medium-Sized Enterprise (SMEs) in Jasin, Malacca.



1.2 Problem statement

The company explores new ways of continuously maintaining consumer expectations by enhancing quality, production prices, leads to competitive improvement and growing market share (Srinivasan, Muthu, Prasad & Satheesh, 2014). Good performance companies will have low cost with high quality. Making quality and customer satisfaction a top priority for all employees in your company is one way to help ensure business success. In downturn days, every company focuses on reduction of defect ratio to improve economical production reduction which loss due to quality issues (Krishna Priya, Jayakumar & Suresh Kumar, 2020). DMAIC model is introduced to provide a better tool and method used in the driven line to minimize the rate of defects and improve the quality of product.

This project was carried out at the Small and Medium-sized Enterprises (SMEs) in Jasin, Malacca. The nature of the business of this enterprise is the bakery foodstuffs, and biscuit 'tongkat'. The company receives the customer complaint regarding the quality of biscuit 'tongkat'. The complaint was regarding the texture, appearance, packaging, and smell of biscuit. Table 1.1 shows the average number of customer complaints for one week. The biscuit's texture is the major problems where the complaint is about the shape and size of the biscuit. Also, the appearance of biscuit such the surface texture and overcook are a problem complained by customer. Figure 1.1 shows the example of biscuit 'tongkat' produce by company.

Table 1.1: Customer complaints on quality of biscuit 'tongkat'

Complaint defect	Count
Seal	3
Plastic torn	2
Surface texture	5
Overcook	4
Shape	14
Size	11
Smell	2



Figure 1.1: Example of biscuit 'tongkat'

1.3 Objective

The objectives of this project are as follow:

1. To define the problem occurred and current situation of production based on customer complaints.
2. To analyse the root cause of problems which affect the quality of product.
3. To propose method to reduce the defect and improve the quality of product.

1.4 Scope

This project involves applying the Six Sigma DMAIC strategy in the manufacturing sector. The Implementation of DMAIC model in selected manufacturing industry for reduction of defects. The research focuses on reducing the defect issue and improve the quality of the product. Also, DMAIC approach as a methodology for cost reduction and quality improvement within the research period. Due to the pandemic Covid-19, the idea of improvement will not be implemented in industry. A proposal for the proposed idea will be submitted to the company for feedback.

1.5 Significant of Study

The study will enhance the effectiveness of the Six Sigma approach to reduce the percentage of defects, especially in the manufacturing sector, by focusing on reducing costs and improving the quality of product. The outcome of this project is confirmation that the Six Sigma approach is a systematic methodology and is relevant for the enhancement of quality and productivity in the manufacturing industry.



1.6 Outline of Study

This project is divided into five chapters:

Chapter 1: Introduction

The study begins with a research background, problem statements, research objectives, scopes, significance of the study, outline of study and conclusion.

Chapter 2: Literature Review

Literature review of the critical points of current understanding in the application of DMAIC phases in the manufacturing industry. Literature review is to past case study on type of lean tools and how the experiment is carrying out to find a solution in manufacturing industry. After that, the literature review briefly addresses the application and implementation in different industries of the Six Sigma DMAIC strategy.

Chapter 3: Methodology

Description of the steps used in the development of this study. The designated tool and problem-solving technique used during the project period. This chapter explain the data collection method, conceptual framework, process flowcharts, and diagrams used to explain the problem and method to solve the issue.

Chapter 4: Result and Discussion

Presentation of the data collection, data analysis, and identified problem during the project period. Then, this chapter shows and discusses in detail about the data and result from implementation of DMAIC stages using lean Six Sigma tools.

Chapter 5: Conclusion and Recommendation

Conclusions and recommendations for further lines of research on the subject.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews the related DMAIC application literature and case study to minimize the gap in the manufacturing industry. The chapter discusses the definition of manufacturing, followed by introduction on Six Sigma. The second part is discussed on six sigma methodology, DMAIC model and five phase of DMAIC. The last part is focus on lean tool used in industry and implementation of DMAIC stages of Six Sigma methodology.

2.1 Definition of manufacturing

Manufacturing is a business and organization where manufacture process of raw materials or component part into a finished product. According to Encyclopedia Britannica, Manufacturing is characterized as an industry that, through the use of manual labor or machinery, produces products from raw materials and is commonly divided by labor. Desai and Shrivastava (2008) stated that the important issue to increase the sales for the company's profit is quality and cost of the products. The manufacturing or service, firms continuously to plan to improve the quality of the products. Barot et al., (2020) stated that in any manufacturing industry, most important factor in manufacturing is reduction of defects and fulfill customer's requirement by achieve good quality of product.

2.2 Introduction of Six Sigma

Six Sigma tools is designed and implement in many manufacturing sectors, which aiming to make continuous improvement. Six Sigma is a validated technique for enhancing process variation, lowering costs, and obtain high quality of end products which lead to profitability of the organization.

Omachonu and Ross (2004) indicate that the variation of process or output is measure by based on value of sigma (σ). Six Sigma may be a systematic approach focused on data and statistical analysis to analyze and enhance the company's operating efficiency and to recognize and eliminate "defects" in processes relevant to production or service. Six Sigma's aim is to reach a sigma value of less than 3.4 defects per million opportunities. Moosa, & Sajid (2010); Lei (2015) stated that a defect is defined as any error or irregularity issue regarding the manufacturing product which does not fulfill requirements and specification of customer.

The introduction of Six Sigma was studied to lead the production and advancement of several statistical and business techniques (Zu, Fredendall & Douglas, 2008). The result of the application is to reduce the cost of manufacturing, reduce the number of failures and production cycle time and, at the same time, improve market share, retain consumers and product growth. Six Sigma is implemented at all stage of the processes in production and apply in administrative process.

At the beginning, Six Sigma was suggested and apply in manufacturing processes. Gijo, Scaria & Antony (2011a) stated that in marketing, marketing, accounting, invoicing, taxation, human resources, and consumer call answering tasks, the Six Sigma approach has now been applied. The goal is to reduce the overall number of errors in the operations of the company. Moreover, Six Sigma may be a strategy of defining and reducing the amount of flaws that contribute to customer satisfaction in the tire industry (Gupta et al. 2012).

As studied by Kaushik & Kumar (2017) Six Sigma's key concept is to increase the efficiency of the process and make the procedure more efficient for the development of the process of waste reduction within industries. Six Sigma is a strategy for quality management by implements a systematic approach and analytic methods to identify and analyze the