UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DMAIC APPROACH TO REDUCE TOTAL DURATION OF PROTOTYPING PROCESS

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

by

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **DMAIC Approach to Reduce Total Duration of Prototyping Process**

SESI PENGAJIAN: 2015/16 Semester 2

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This report is submitted to the Faculty of Manufacturing Engineering of UTEM as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Management) (Hons.). The member of the supervisory committee is as follow:

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ABSTRAK

Dalam dunia yang kompetitif hari ini, kilang pembuatan telah menumpukan kepada produk inovatif. Prototaip memainkan peranan penting bagi produk inovatif kerana ia dapat membantu pihak kilang pembuatan melaksanakan ujian fungsi dan kestabilan produk. Kepopulariti sesuatu produk di pasaran dapat ditingkatkan menerusi prototaip dengan mengambilkira kehendak pelanggan. Setelah produk mendapat respon yang baik daripada pesaran, pengeluaran produk boleh dijalankan secara pukal. Projek ini dijalankan di sebuah kilang pembuatan penyedut habuk. Tujuan projek ini adalah mengurangkan masa proses prototaip dengan mengguna kaedah DMAIC. Terdapat banyak masalah berkaitan dengan proses prototaip dijelaskan di fasa *Define*. Objektif dan skop projek juga ditentukan. Proses prototaip diterjemah menggunakan peta proses. Selepas itu, jenis ukuran untuk prototaip proses ditentukan di fasa *Measure*. Data untuk proses prototaip dikumpulkan dan digambarkan dengan graf. Masa proses prototaip dikirakan dan masa ini adalah penanda aras masa untuk proses prototaip untuk projek ini. Punca masalah dikajikan dengan menggunakan rajah sebab dan akibat, analisis mod kegagallan dan kesan, dan carta Pareto di fasa *Analyze*. Penyelesaian masalah dicadangkan selepas mengetahui punca masalah. Satu model telah digunakan untuk menghasilkan pelan penyelesaian. Proses untuk prototaip diubahkan dan diikatkan dengan jawatan kuasa berkaitan. Data untuk proses prototaip dikumpulkan semula lagi selepas melaksanakan pelan penyelesaian. Data menunjukkan keputusan yang baik. Kepentingan projek ini adalah mengurangkan masa proses prototaip dan masa proses prototaip dikurangkan dari 12.4 minggu kepada 10.4 minggu. Ini menunjukkan 16 percent pengurangan untuk masa proses prototaip.

ABSTRACT

In today's competitive world, many manufacturing companies focus on the innovative product. Prototype played an important role for innovative product because prototype helps the company to test the functionality and stability of a product. The popularity of the product on the market also can be done by using prototype to determine the customer interest on the product. Once the product received good feedback from the market, the product will enter the mass production phase. This project is conducted at research and development department of a vacuum cleaner company. The purpose of this project is to reduce the total duration of prototyping process by using DMAIC approach. In Define phase, the problems faced by the company were highlighted. The objectives and the scope were determined. A process mapping showed the processes involved in the prototyping process. Next, the data were collected in the Measure phase after the type of data measurement was determined. The data were used to set the benchmark for the current total duration of prototyping process. During Analyze phase, the cause and effect diagram, failure mode and effect analysis, and Pareto chart were used to determine the major causes of the problem. Once the major causes were identified, a solution plan was proposed in Improve phase. A brainstorming workshop process optimization model was used to develop the solution plan. All the processes involved in prototyping process were overhauled and calibrate so that the processes are cleansed and the roles and responsibilities are justified. The solutions were then conducted a pilot run. The data of pilot run were collected. The results showed overall improvement in the prototyping process in Control phase. The significance of this project is that the total duration of prototyping process reduced from 12.4 weeks to 10.4 weeks, which is a 16 percent reduction of the total duration.

DEDICATION

Dedicated specially for my beloved family, my project supervisor and friends

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LIST OF ABBREVIATIONS AND SYMBOLS

3D	-	Three Dimensional
8D	-	Eight Disciplines Problem Solving
BOM	-	Bill of Materials
BWPO	-	Brainstorming Workshop Process Optimization
CAD	-	Computer aided design
CTQ	-	Critical-To-Quality
DMAIC	-	Define, Measure, Analysis, Improvement, Control
FMEA	-	Failure Modes and Effects Analysis
FYP	-	Final Year Project
NPD	-	New Product Development
NPD	-	New Product Introduction
OEE	-	Overall Equipment Efficiency
PDP	-	Product Development Process
PO	-	Purchase order
QFD	-	Quality Function Deployment
R&D	-	Research and Development
RACI	-	Responsible, Accountable, Consulted, Informed
ROI	-	Rate on Investment
SIPOC	-	Supplier, Input, Process, Output, Customer
SOP	-	Standard Operating Procedure
TRIZ	-	Theory of Inventive Problem Solving
UK	-	United Kingdom
VOC	-	Voice of the Customer
VSM	-	Value Stream Mapping
σ	-	Sigma
®	-	Trademark

CHAPTER 1
INTRODUCTION

1.1 Background Study

Competitive advantage is one of the important factors for a company to gain a larger market share. A company with competitive advantage able to keep their product demand at a high level for a period of time before other companies release their product. In this era, the world is changing rapidly and the latest innovative technology products come one after another. Many companies tried a lot of strategies to become the market leader and intended to gain competitive advantage by release the latest innovative technology product before their competitor. Some companies implemented Six Sigma practice into their research and development (R&D) department and the companies managed to gain the competitive advantage for their innovative products because of the Six Sigma practice.

Six Sigma is a business enhancement methodology that aims to capitalize on shareholder value by improving quality, speed, customer satisfaction and costs. Six Sigma project is conducted by using the DMAIC methodology. The DMAIC methodology consists of five phases: Define phase, Measure phase, Analyze phase, Improve phase, and Control phase. These stages are planned to get the team through a step-by-step process improvement and it starts from inception to completion (Wheeler, 2010). What are the reasons that Six Sigma practices should implement into new product development (NPD)?

Many companies have attempted to introduce Six Sigma practices into NPD stage because Six Sigma practices are a customer-focused methodology that improves the product's quality and optimizes organization's financial performance (Chua, 2001). NPD is the most important touchstones for a manufacturing company to maintain and achieve competitive advantage. The potential value of NPD is boundless and the design only limited because of an individual's creativity. Linderman (2003) described Six Sigma is a method applied to improve existing process and create new process. The customer demands for new product increased in term of innovation, speed, quality, product performance, and function. The NPD process should be improvised as the customer requirement change. It is important for a company to satisfy the customer demand in order to remain competitive in the market. Therefore, this study focused on the implementation of Six Sigma practice into NPD.

1.2 Company Background

The case company is a multinational company and also a multi-million dollar company which known for its creativity. The case company design and manufactures vacuum cleaners, hand dryers, bladeless fans, and heaters. Their products are available in over 70 countries. The company was first founded on 8th July 1991 in England. The company has grown from one man and one idea to a technology company with over 1000 engineers worldwide. In year 2002, the company transferred the vacuum cleaner production to Malaysia. According to the company, the production costs in Malaysia are lower by 30 percent compared with the production in United Kingdom (UK). The cost savings from transferring production to Malaysia enable the company to make more investment in their R&D project. The engineers and scientists from the company always work on refining the ideas for R&D project. The company engineers do more prototyping as they pursue perfection on the products. The duration of prototyping process is one of the important elements that company wants to optimize in order to shorten the breakeven point for their investment.

1.3 Problem Statement

A successful Six Sigma implementation helps companies uphold growth and amplifies business profitability. However, many Six Sigma implementation efforts begin with much fanfare and fizzle out without realizing the anticipated results. There are many obstacles that will be faced by the company when the company implements Six Sigma practices into NPD. The implementation of Six Sigma practices for NPD is important to keep a company remain competitive among their competitors. Many companies have already started introducing Six Sigma practices into the product development stage. Most of the companies have their own approaches for Six Sigma implementation, but not many companies are able to implement Six Sigma practice successfully. The Six Sigma implementation failure rate is relatively high. Thus, there must be a consideration when implementing Six Sigma practices into NPD. The relevancy between Six Sigma practices and NPD stage should be distinguished to ensure Six Sigma implementation is an essential need for NPD.

In year 2015, a vacuum cleaner manufacturing company found out that their new product development projects had some problems achieving the target time and predetermined specification due to some issues related to the processes. One of the processes that have been identified by the company which need to make an improvement is prototyping process. Several problems that were raised by many departments involved in the new product development project are delayed completion of prototyping machine, the confusion about the part readiness status, disorganization of the management of prototype activities and many other problems. The main challenge which gives a very high impact to the new product development project is the total duration of the prototyping process. The delay of a new product launched caused the loss of the competitive advantage for the product in the market. The aim of this project is to reduce the total duration of the prototyping process so that the company able to gain the competitive advantage by releasing their innovative product ahead their competitors.

1.4 Objectives

The objectives of this project are listed as below:

1. To identify the relevancy of Six Sigma practices for new product development.
2. To determine the total duration of prototyping process.
3. To propose solutions by using Six Sigma DMAIC methodology to reduce the total duration of prototyping process.

1.5 Scope

The scope of this study is focused on the application of DMAIC approach on prototyping process of NPD. All five stages of DMAIC are studied and examined. The relevancy of Six Sigma practices for NPD is the focus scope for literature review. This study is conducted in a manufacturing company and the focus is on the R&D vacuum cleaner product.

1.6 Significant of the Project

There are some vital reasons to conduct this study. It helps determine the relationship between Six Sigma and NPD. The DMAIC approach as a methodology for NPD in the manufacturing company also revealed through this study. This study created a benchmark measurement of prototyping process for case company and increased the efficiency of prototyping process through the actual study at case company.

1.7 Report Outline

Chapter 1- Introduction. This chapter discusses the background of the study and the problem statement that identified through the real situation occurred at the company. This is followed by objectives to be achieved throughout the study and scope which narrows down the area of the study. The impact of the study to the company is also exposed.

Chapter 2-Literature Review. This chapter introduces the literature review of Six Sigma and NPD according to journal, books and other resources. It also discusses about the significance of Six Sigma implementation.

Chapter 3-Methodology. This chapter described the step required to carry out this study. There are total seven stages conducted for this study and each stage got their own task to be completed.

Chapter 4-Results and Discussion. This chapter analysed all five phases of the DMAIC. Every phase should be completed their tasks and provided the information required to the next phase. Define phase defined the problem and customer needs. Measure phase measured the problem and collected the data for measurement. Analyze phase reviewed the problems and found out the main causes of the problem. Improve phase developed the solutions plan and implemented it. Control phase showed the results of the implementation and a long run monitoring control plan is prepared.

Chapter 5-Conclusion and Recommendation. This chapter summarized all the work done in this study. The objectives for this study are achieved and a few recommendations for future work on this study are written.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Literature review is the collection of information of the study area. This chapter helps the reader to further understand the study area of the project. It consists of three main part which are new product development, Six Sigma and significant of Six Sigma for new product development. The definition of new product development need to be studied and the processes involved in new product development stage need to be understand because it ensure the analysis for the new product development problems faced by the company that will be done at Chapter 4 are correct. The theory of Six Sigma is studied in order to perform a better application for DMAIC methodology. There are total five phase of DMAIC methodology: Define phase, Measure phase, Analyze phase, Improve phase, and Control phase. Each phase got their main objectives to achieve. Several tools are used to achieve the objectives and all the tools are explained in this chapter. To achieve the first objective of this project, the significant of Six Sigma practices for new product development need to be studied and analysed. The work done by previous researchers where the study involved Six Sigma practices and new product development help to determine the important of Six Sigma practices for new product development.

2.2 New Product Development

Kotler and Armstrong (2010) defined that "New product development (NPD) is the development of original products, product improvements, product modifications, and new brands through the company own research and development (R&D) efforts". NPD is a high risk activity but also is a most vital strategy for manufacturing industries (Clark et al., 2006). The participation of customers plays an important role for NPD. However, even among some company with millions of customers, only few company that will have the willingness to fully engaged with participation of customers in the product development (O'Hern and Rindfleisc, 2009). The perceptive of customer needed for the purpose of prioritize customer value is most crucial for a company.

A market oriented NPD is defined by Kohli and Jaworski (1990) is "The development of new product, which is based on the generation of market information, the dissemination of the information across department and responsiveness of various department to it". A new product is introduced to the market and the ability to get attentions from the market always is the main focus of the company marketing strategy (Mccole and Ramsey, 2005). The speed for the process of NPD is critical because nowadays product life cycles are shrinking and end of life for product is shorter compare with the past. Reducing development time is a key factor to achieve competitive advantage (Cooper, 2001). Companies that develop products quickly gain many advantages over competitors: premium prices, valuable market information, leadership reputation with consumers, lower development costs, and accelerated learning (Cooper, 2001).

The relationship between R&D and Marketing in product development has been the interest for researcher all the time. In a NPD, large technologically intensive companies deserve special attention because unlike smaller businesses, big companies in better position to carry out technologically innovative systematic activities in product development process (PDP). In many cases, large companies have sufficient resources