The application of the DMAIC Techniques For Business Performances: Case Study For Open Defect Of Single-Sided Flexible Circuit Board

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DECLARATION

Candidate's Declaration

I hereby declare that this report with the title of "The application of the DMAIC Techniques For Business Performances: case study for Open defect of single-sided Flexible Circuit Board" is the result of my own research except those cited in the reference. The report has not been accepted for any degree and is not concurrentlysummited in candidate of any other degree

Signature : .....

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Date :.....

Supervisor's Declaration

This thesis has been submitted as partial fulfilment of the final year project and I hereby declare that this thesis were supervised accordance with guidelines laid down by Universiti Sains Malaysia.

Signature : .....

Name :Datin Dr Norizah Mohamad

Date :.....

DEDICATION

To

Grandmother

Chia Siew Ngor

For being my first teacher, always teach me the theory of life to be a better person

Father & Mother

Chua Ching Kua & By Siew Huang

They always give me unconditional love and support. They are the spring and also a good example whose have taught me to work hard and insists to achive final solution

Brothers

They are a good listener and the person who able to trust unconditionally. They alway stand when things look bleak. I am truely grateful for having these family member in my life.

Final Year Project Supervisor

Datin Dr. Norizah Mohamad

Always give her generous support and guidance throughout this Project.

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ABSTRAK

Disebabkan peningkatan di dalam persaingan global, permintaan barangan yang berkualiti tinggi dujkari pelanggan dengan masa pembuatan yang singkat merupakan masalah yang serin g dihadapi oleh syarikat perkilangan pada masa ini. Untuk mengatasi permasalahan ini, pelbagai teknik dan konsep telah diperkenalkan. Teknik 'lean' merupakan salah satu kaedah yang digunakan untuk meningkatkan produktiviti dan prestasi kualiti. "DMAIC" merupakan antara teknik "lean" teknik digunakan. "DMAIC" merupakan satu kaedah yang boleh menyelesaikan masalah kerosakan barangan supaya dapat meningkatkan keberkesanan dalam prestasi perniagaan menerusi penambahbaikan yang berterusan. "DMAIC" merupakan kitaran penambahbaikan data yang dapat digunakan atas prestasi perniagaan untuk mengesankan kecacatan produk.

Sasaran projek ini adalah untuk mengurangkan "Open Defect" bagi litar di papan litar bercetak fleksibel dari 0.57% hingga 0.4% dengan mengunakan kaedah DMAIC. Daripada rekod laporan Hasil Pemeriksaan Visual, telah mendapati bahawa "Open Defect" adalah masalah utama kepada papan litar bercetak fleksible. Bahagian number (13236) telah dipilih sebagai penyelidikan utama dalam projek ini, sebab ia merupakan produk yang mempunyai kecacatan yang paling tinggi. Dalam kajian ini, tumpuan keutamaan penyelidik tertaruh kepada kawasan pengimejan kerana ia berkaitan dengan proses pembentukan litar. Dua penyebab utama pada kawasan pengimejan adalah masalah kotoran dan Pin Hole. Dalam kaedah Six Sigma DMAIC dimulakan dengan pengenalan masalah melalui rekod masa lalu. Kemudian, mengumpulkan data spesifikasi papan litar bercetak fleksibel yang sedia ada. Langkah-langkah yang seterusnya adalah menganalisis, kaedah yang digunakan adalah melalui carta trend dan rajah kesan-sebab. Documen penilaian adalah untuk membolehkan pemafahaman tentang punca keutamaan berlakunya "Open defect". Pada tahap penambahbaikan dan kawalan, pelbagai kaedah telah pun dikeluarkan seperti menghasilkan senarai semak dan penyeragaman kerja.

Dengan melaksanakan penyelesaian DMAIC, hasilanya diperhatikan dari Januari 2017 hinnga januari 2018, secara keseluruhanya "Open Defect" dari 0.6% (17781unit) berkurang kepada 0.37% (4766 units). Manakala bahagian 13236 yang mempunyai "Open Defect" tertinggi telah berkekurangan daripada 0.68% (2644) kepada 0.26%

(132unit). Selepas penambahbaikan , jumlah kos penjimatan terkumpul dari September 2017 hingga March 2018 adalah sebanyak RM1423.60, sekiranya dalam jangka masa yang panjang, ia boleh membantu syarikat untuk meningkatkan margin keuntungan

Abstract

Manufacturing company all around the world are facing the turbulent economic condition. This include global competition, customer demand for high quality product and reduced in lead time. In respond this need, various tools and tehniques have been developed. The lean principles tools are one of the strategies developed to enhance productivity and quality performance. One of the lean technique is the DMAIC. It is a methodology to solve the defect problem to increase the effectiveness and efficiency of the business performances is through “Continuous Process Improvement”. DMAIC is a data improvement cycle designed to applied on business process to find flaw or inefficiencies- particularly resulting in output defect.

The target of this project is to reduce the open defect for the circuit on the Flexible Printed Circuit Board from 0.57% to 0.4% by implementation of DMAIC. From the record of Visual Inspection Yield Report, it is found that the Open defect is the main problem on the flexible printed circuit board. The part number (13236) has been choosen as the highest open defect problem for the research main focus. For this study, Imaging area will be the main focus because it is related to the process formation of the circuit. The main two causes on imaging area are Contamination problem and Pin Hole. Hence the Six Sigma DMAIC methodology are initiated by problem identification through the past record of the open defect. Then, the specification data of existing flexible printed circuit board are gathered. This is followed by the analysis and improvement steps, the tools such as trend chart, Cause-effect diagram. Then, evaluation form are distributed to understand the root cause of the process. At improvement and control phase, a series of solution (Checklist and standardisation) are presented.

With the implementation of the DMAIC solution, the result observed from January 2017 until January 2018, has shown that the overall open defect has decrease from 0.6%(17781 unit) decrease to 0.37%(4766 unit). While the part (13236) that have the highest defect also decrease from 0.68% (2644 unit) to 0.26% (132 unit). After the improvement were conducted, the total accumulated saving cost from September 2017 till March 2018 are RM 1423.60. This can help company to increase the profit margin in the long term.

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LIST OF ABBREVIATIONS

DMAIC	Define,Measure,Analyze,Improve,Control
DMAIV	Define,Measure,Analyze,Improve,Verify
FPCBs	Flexible Printed Circuit Boards
VSM	Value Stream Mapping
CTQ	Critical to Quality
FMEA	Failure Mode and Effect Analysis
LM	Lean Manufacturing
VA	Value Added
NVA	Non- Value Added
UCL	Upper Control Limit
LCL	Lower Control Limit
VOC	Voice Of Customer
SOP	Standard Operation Procedure
KPIV	Key Performances Input Value
KPOV	Key Performances Output Value
IPQC	In-Process- Quality-Check
RoHS	Restriction Of Hazardous Substances

Chapter 1

1.0 Introduction

Six Sigma originates from a 19th Century mathematical theory, but found its way into today's mainstream business world through the efforts of an engineer at Motorola in the 1980s. Now DMAIC as one of the leading methodological practices for improving customer satisfaction and improving business processes,

The main focus of DMAIC is always the goal, no matter how the changes of the setting : Six Sigma seeks to improve business processes by removing the causes of errors that lead to defects in a product or service. It accomplishes this by setting up a management system that systematically identifies errors and provides methods for eliminating them.[1]

Nowadays, Six Sigma is a method that provides tools for organizations to improve the capability of their business processes. This increase in performance and decrease in process variation lead to defect reduction and improvement in profits, employee moral, and quality of products. Six Sigma quality is a term generally used to indicate a process is well controlled (within process limits ±3s from the center line in a control chart, and requirements/tolerance limits ±6s from the center line).[2]

The statistical representation of Six Sigma describes quantitatively how a process is performing. To achieve Six Sigma, a process must not produce more than 3.4 defects per million opportunities. A Six Sigma defect is defined as anything outside of customer specifications. A Six Sigma opportunity is then the total quantity of chances for a defect. If the Six Sigma quality improvement methodology had to be summarized in one word, it would be the acronym DMAIC.The Six Sigma DMAIC process **(define, measure, analyze, improve, control)** is an improvement system for existing processes falling below specification and looking for incremental improvement. [3]

While the acronym gives an accurate summary of the process, it is only the beginning. The Six Sigma process improvement methodology cover much more than an acronym can describe. The main component of DMAIC is making continuous improvements to an existing process through objective problem solving. Process is the main focus of DMAIC. The methodology seeks to improve the quality of a product or service by concentrating not on the output but on the process that created the output.

The idea is that concentrating on processes leads to more effective and permanent solutions.[4]

Collectively, the process becomes a powerful tool to lead an organization to stronger performance standards and can be skillfully used to streamline resources and achieve the business goals.

1.1 Brief Overview

In this project will use 6 Sigma DMAIC is used to investigate the problem, and generates sustained success of the related problem. Besides, set up performances goal for each function, business unit, quality control, and individual has different targets and standard. Then, through the scientific and structural measure, by reduce the defect rate for the open defect of the flexible printed circuit board fot improve the performancest.of the business. This project will discuss the implemention of DMAIC project in a case study company

1.2 Project background

Every business stands to attain its predefined goals and objectives while particularly stressing on its ability of maintaining its survival and profitability constantly. In doing so, the effectiveness and efficiency counts greatly. On the one hand on the basis of these two terms a business goes to heighten its level immensely, on the other hand it bears losses in the absence of the results being associated with effectiveness and efficiency. It is thus essential for a business to maintain effectiveness and efficiency continuously.

Improve the performance of business processes has become a central issue in both academia and business, since organizations are challenged to achieve effective and efficient results. Applying some tool to improve the performance measurement of effectiveness and efficiency also one business strategy, which implies that the choice of performance indicators is organization-dependent.

In this project i utilised DMAIC (Define- Measure- Analysis- Identify- Control) tool is used. DMAIC has several advantages, it is a very structured approach. It has a very detail analysis process before the ideas trying to implementing any improvement. Second, DMAIC provides a business road map for solutions. This helps the business

to solve the problem from starting of the manufacturing process to finish while producing bottom line results. Besides, DMAIC do support an analytical approach, allowing the business to use the collected data. This help the business ensure the accurate baseline

The DMAIC tool have 5 phase. D represent Define phase. It is the first phase of Lean Six Sigma improvement process. In this phase, need to create a project charter, a high-level map of the process and start to understand the needs of customer

Phase 2 is Measure (Quantify the problem). How does the process currently perform? In this phase, need to collecting data of process as well as measuring what customer care about. The main 2 focus are reducing lead time or improving quality

Phase 3 is Analyze. It is to identify the cause of the problem. The ideality of this phase is to brainstorm potential root cause (not solution), develop hypothesis as to why problem exist and then work to prove or disprove their hypothesis. Verication includes both process analysis and data analysis has to be complete before implementing the solution

Phase 4 is improve phase. It is implement and verify the the solution. After the verification of the root cause, will brainstorms solutions, pilots process changes, implement solution and lastly collect data to confirm there is measurable improvement. A structured improvement effort can lead to innovative and elegant solutions that improve the baseline measure and ultimately, the customer's experience.

The last phase is control phase pursue the solution. This phase is all about how to maintain the improvement. In this phase, the process problem is already solve and the solution of improvement are in that place, thus in this control phase, it more focused on how to create a monitoring plan to continue measuring the success of the updated process and developing a response plan in case there is a dip in performance. In others words is to prevent the process for reverting back to the "old way"

1.3 Problem Statement

The effectiveness and efficiency of business performances have relationship with the rapidly changing in the technology and business environment. The improvement on business should be linked to a process, whether manufacturing or non-manufacturing and the capability of these process obviously influences an organization's achievement. Therefore in this project, we will use continuous improvement tool (DMAIC) phases on improving quality, reduce defect, faster and cheaper for improving the effectiveness and efficiency of a business for that company through the scientific and statistical quality assessment for all process through the measurement of all process.

1.4 Research Objective

This research is focus on go through the manufacturing process of single flexible Printed Circuit Board and find out the solution to reduce the open defect of the circuit.

A) To investigate the the non-value added activity and waste of the single sided flexible Printed Circuit Board process using DMAIC.

B) To reduce open defect from 0.5% to 0.4% by end of december 2017 by using DMAIC techniques

C) To propose standardise documentation for control the Open defect of single-sided flexible circuit board.

1.5 Scope of Work

The work is undertaken at manufacturing line of the single-sided flexible printed circuit board, then understand the basic problem and defect on the formation of circuit. In general, it is divided into 5 phases. First, is define phase, define the problem. Second phasse is measure phase, measure the current performances of the process. Third phase is analyse phase, it is to examine the process and verify the cause of the problem. Forth phase is improve phase, it is to develop a solution to solve the problem. Last phase is control phase, it is to control the performances after implement the solution.

1.6 Significant of the Study

The study is based on the real previous manufacturing data. The defect rate can be identified based the measurement of the previous manufacturing data. Some of the non-value added process also will be decrease. According to the objective of study, the open defect problem for the product will decrease and a series of solution will come out to reducce the defect rate. In the manufacturing process of formation of circuit, DMAIC team will figure out the main root cause of open defect, and brainstorm the solution.

1.7 Thesis Outline

The thesis is divided into five chapters. Chapter One (Introduction) discuss about the project background, background of the case study, problem statement, research objective, scope of work, significant of the study and research methodology. Chapter 2 (Literature Review) will discuss more detail about the lean six sigma Methodology and lean concept manufacturing, Chapter 3(Methodology) will focus on the Lean six sigma steps conduct in company. While chapter 4 (Result and Discussion) will disccuss about the changes and achievement after implementation of DMAIC technique. Lastly, chapter 5(Conclusion) will sum up this project.

Chapter Two

Literature Review

2.0 Overview

This chapter will discuss more about the lean six sigma DMAIC methodology, DMAIC cysle, Lean Concept Manufacturing , Waste in LM, Lean tool, and DMAIC phase tool

2.1 Lean Concept Manufacturing

The concept of lean become famous through Womack [5] in his book 'The Machine that changed the world'. Lean manufacturing has been define in many different ways. The lean concept always evolve along with the development of the industry, that the reason 'Lean Concept' lack a coherent definition. Nonetheless, the main goal of lean system is to produce products or services of high quality with the lowest cost and least time used by eliminating wastes [6].

Lean Manufacturing (LM) has been widely applied in the management of manufacturing processes [7]. LM aimed for the elimination of activities and procedures that do not add value to the final product [8]. Reductions of waiting time, cycle time and inventory were among the improvements to manufacturing processes.

Lean production has expanded and lean thinking is applied to all aspects of the supply chain. There are many well documented examples of the application of 'lean thinking' to business processes such as project management [9]; construction, design, and so on. Lean can be applied to all aspects of the supply chain and should be if the maximum benefits within the organization are to be sustainably realized. The two biggest problems with the application of lean to business processes are the perceived lack of tangible benefits and the view that many business processes are already efficient. Both assumptions can be challenged [10]:

Lean Manufacturing are more customer-value focus. Every customer want value, they only will consumed if the value of the product or service can meet theirs need. They will not pay for the defect or extra cost of having large inventories.

Lean principles defines the value of the product/service as realised by the customer and then making the flow in-line with the customer pull and striving for perfection through continuous improvement to eliminate waste by sorting out Value

Added activity(VA) and Non- Value Added activity(NVA). The sources for the NVA activity wastes are Transportation, Inventory, Motion Waiting, Overproduction, Over processing and Defects. Elimination of these wastes is achieved through the successful implementation of lean elements

2.1.1 Waste in Lean Manufacturing

Japanese word 'Muda' is meaning waste. It referred to the human activities that need exploit the resources but does not create any profit or value. Taiichi Ohno, a toyota executive, present the concept of 'Muda' in industry of manufacturing, to denote all the activities that require resources but do not add value to the process or to the product [11]. In particular, he defined seven classes of waste that typically affect a manufacturing process: Table 2.1 shown the seven waste of lean Manufacturing

Table 2.1 Seven Waste of Lean Manufacturing

	Overprocessing	Adding more value to a product than the customer actually require such as painting area that will never be seen or be exposed to corrosion
	Waiting	It is the act of doing nothing or working slowly whilst waiting for a previous step in the process. How many times you seen operators stood waiting for a previous operation, a delivery products to arrive or just slowly working for lengthen the time since run out of material.
	Transportation	It is the movement of products from one location to another. Eg: This could be from the machining shop to the welding shop, or from the production facility in china to the assembly line in America. This transportation add no value to the product.
	Inventory	Is the raw materials, work in progress (WIP) and finished goods stock is held, we often hold far more than is required to produce goods and services when the customer wants them using Just In Time (JIT)
	Motion	Waste being a process step that is not value adding, moving is not necessarily working. The main causes of the waste of motion are with regards to cell layout, placing product at floor level on pallets, poorly arranged space, tools that are disorganized, lack of space and organization for component parts and so on.

	Defect	Defect are when products or service deviate from what customer requires or the specification. Defect can be cause by many kind of problems, some should be avoidable with a little thought when designing the product, non-standard operation, different in the way that processes are undertaken by different operator on different shift.
	Overproduction	Overproduction is making products in too great a quantity or before it is actually needed leading to excessive inventory.

2.1.2 The Use of Lean tools

In the era of globalization and modenisation, automotive industries are require new tools and techniques to produce products that able to compete and sustain in the market. Manufacturers today more focus on how to deliver the products or services quickly with good quality and low cost. Application of lean manufacturing principles and technique can change improve the manufacturing operation and promise the quality of the product. Lean manufacturing is the set of 'tools' that assists in the identification and elimination of waste.Lean manufacturing. These tools focus on certain orientation and manufacturing process to eliminate waste and improve quality while production time and cost are reduced.

1. Standard work

Standard work is a lean tool that developed by Onho. According to Jang & Lee [12], it is defined as the classification of rules and operational procedures which are formalised. The method aim to eliminate the variation and inconsistency of results by instructing workers to execute manufacturing activities following clearly defined procedures. The goal can be achieved by both defining an optimal procedure and ensuring its performance. There is no room for improvision. Therefore, the operation are often referred as an inflexible work standard. They are used as a training assistant tool as well [13]. Besides, promote the development of sustainable methods over time that will lead to reduced variation in the process and products, which reduces the amount of product, electricity consumption and raw materials waste.[14]

Benefits of standard work

i. Cost reduction

By means of waste reduction derived from inefficient work procedures, the system becomes more cost-effective.

ii. Quality improvement

If the same operation were to be executed differently depending on the person, the probability of defects would increase

iii. Worker involvement

Standard work shifts the blame for errors from the worker to the system

iv. Variability reduction

The work effort becomes stable and measurable

v. Continuous improvement

This tool is essential for continuous improvement, since it facilitates change to improved standards, making it easier, faster and more efficient overall

2. 5S

The 5S lean tool was developed in Japan by Sakichi Toyoda, Kishiro Toyoda and Taiichi Ohno in 1960 [15]. This tool aims to achieve a clean and organized workspace in order to maintain an outstanding excellent environment [16].This method consists of 5 steps.First, Seiri (Sort) – Consists on the removal of everything deemed unnecessary. The workplace should only have what is needed to perform the activities

Second, Seiton (Set in order)- Quick and visual identification of tools and areas saves time and facilitates processes. Thirdly, Seizo (Shine) – Cleaning the workspace is essential. It reduces the risk of accidents and aids on the inspection of products. Fourth, Seiketsu (Standardize) – In order to optimize the first three S's, standards must be created and followed. Shitsuke (Sustain)- Last step, consists on developing a method to ensure the 5S technique is followed. . 5S bring benefits to a company, decrease of waste of time and space. According to Hirano [17], the rewards of applying 5S are extended to quality, security and hygiene.

3. Visual Management

According to Galsworth [18], visual management is a "self-explaining, self-ordering self-regulating, and self improving work environment where what is supposed to happen on time, because of visual devices".It is the basis of several other lean tools,

such as 5S and standard work.[19]. There are several visual management systems such as informative boards, space delimitations, andons and work instructions. The goal is to enable workers to manage their own work environment, reducing errors and further forms of waste.

4. Kanbans

Developed by Ohno on Toyota production lines, kanbans [20] emerged as a solution to the tendency of factories to overproduce.Kanban can be translated from the Japanese as card or signal, and is a visual input used in pull systems [21] Arbulu, Ballard & Harper define kanban as a lean approach developed in the automotive industry to "pull" materials from the production line in a "just in time" concept [22]. The concept of this method consists on promoting the replenished of materials only when required, by receiving and sending signals, usually in the form of cards. This process can be either internal or external to the company [23]

2.2 LEAN SIX SIGMA DMAIC METHODOLOGY

Six sigma was developed by Motorola in early to middle 1980's based on quality management fundamental, after that it become a popular management approach at General Electric(GE) in the early 1990's. Six Sigma is a systematic methodology aimed at operational excellence through continuous process improvements. Six Sigma has been successfully implemented worldwide for over 20 years, producing significant improvements to the profitability of many large and small organisations. [24]. Lean Six Sigma is a data-driven philosophy of improvement for various defect problems. It drives customer satisfaction and the bottom-line results in reducing variation, waste, and cycle time, while promoting the use of work standardization and flow, thereby creating a competitive advantage. It applies anywhere variation and waste exist, and every employee should be involved.[25]

The Integrated Approach [26] has the main overall requirement of the completeness, consistency and intended purpose. Based on this approach Six Sigma and Lean reinforced each other. DMAIC is one of the tools of quality management which may be considered as methods of quality improvement. DMAIC is an acronym from the words Define-Measure-Analyze-Improve-Control. This method is based on process improvement according to Deming cycle. Whilst, DMAIC strategy can be used as a