PROCESS IMPROVEMENT USING SIX SIGMA METHODOLOGY

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Specially dedicated to..

My love for his endless encouragement, support and care,

and Mum, Dad, and Sis

for their love and support.

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ABSTRACT

The purpose of this thesis is to solve the screw stuck issue of Sensor Module in Agilent Technologies, using Six Sigma methodology D-M-A-I-C. The current yield loss due to this defect had contributed to the increased production cost due to higher material scrap and rework time. Project objectives were set in *Define* phase to increase the yield of both functionality and reworkability of Sensor Module from current baseline yield to 99.4% (targeted four sigma). The baseline data was collected in the *Measure* phase and shows that baseline yield for functionality and reworkability was 74% and 62% respectively. *Analyze* phase results revealed the relationship of vital few causes to the screw stuck issue, which led to the defect's root cause as thread galling. Thread galling phenomena was associated with the fasteners material and torque speed (rpm), therefore the relationship between these factors and the functionality and reworkability yield was developed. In *Improve* phase, the solution was chosen to replace the fastener's material and reduce the torque speed considering factors such as effectiveness, cost and lead time. Optimization test or DOE was carried out to determine the best options on the fastener's material selection and the torque speed. Experiment reveals improved yield with SP series nut new type, wax coated stainless steel screw, and manual torque driver. Pilot run was conducted successfully with 100% yield on functionality. In final *Control* phase, all the changes and implementation were institutionalized with proper training, documentation, process monitoring, response plan and sustainability plan. The result from the project has provided an insight on actual successful deployment of Six Sigma methodology DMAIC with application of its various statistical tools and techniques, and as the systematic problem solving framework on solving actual industrial issues.

ABSTRAK

Tujuan thesis ini adalah untuk menyelesaikan masalah skru tersekat pada unit Sensor Module di Agilent Technologies dengan menggunakan metodologi "Six Sigma" DMAIC. Kemerosotan hasil daripada masalah ini telah menyumbang kepada kenaikan kos pengeluaran akibat kenaikan bahan sekerap and masa pembaikian. Objektif projek telah disetkan di fasa *Define* untuk meningkatkan hasil kefungsian dan pembaikpulihan daripada hasil dasar kini ke 99.4% (matlamat empat sigma). Data dasar kefungsian dan pembaikpulihan yang dikumpul di fasa *Measure* telah menunjukkan hasil sebanyak 74% dan 62%. Keputusan fasa *Analyze* telah menunjukkan hubungan antara beberapa kemungkinan punca penting untuk masalah skru tersekat, dan seterusnya telah mendedahkan punca sebenar iaitu "ulir skru melecet". Masalah "Ulir skru melecet" yang berkait rapat dengan bahan skru dan nut, dan kelajuan tork (rpm) seterusnya mewujudkan perhubungan faktor-faktor tersebut dengan kefungsian dan pembaikpulihan. Pada fasa *Improve*, penyelesaian telah diambil untuk menukar bahan skru dan nut, dan mengurangkan kelajuan tork. Ujian optimasi atau DOE telah dijalankan untuk menentukan penyelesaian terbaik untuk bahan skru dan kelajuan tork. Eksperimen yang telah dilaksanakan telah menunjukkan hasil kenaikan dalam pengunaan nut baru jenis SP, skru keluli tahan karat bersalut lilin dan alat pemutar skru tork tangan dengan percubaan pengendalian 100% untuk hasil kefungsian. Pada fasa akhir *Control*, kesemua perubahan and implementasi adalah diinstitutasikan dengan latihan yang sesuai, dokumentasi, proses pengawasan, pelan respons and pelan pengekalan. Hasil kajian projek ini telah memberikan satu pengertian yang mendalam untuk aplikasi metodologi *Six Sigma* DMAIC sebagai satu kaedah penyelesaian masalah yang sistematik untuk penyelesaian masalah industri.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Six Sigma was introduced into the manufacturing arena in the early 1980s, by Bill Smith, an engineer at Motorola. Harry Mikel then formulated the details of Six Sigma methodology that generated widespread enthusiasm toward the concept and its application (Eckes, 2005). The initial approach Motorola took toward implementing Six Sigma was virtually at the tactical level. Motorola eventually developed its Six Sigma tools curriculum and created Six Sigma practitioner qualifications. These early efforts led the company to winning the Malcolm Baldrige Award in 1988 (Hendericks and Kelbaugh, 1998).

Traditionally, Six Sigma is a statistical concept that measures a process in terms of defects and is used to represent the range of values of a population with a normal distribution as mathematically 99.73 percent of all values can be expected to fall within a range that extends from three sigma below and three sigma above the population mean (Goh et. al., 2004). Six Sigma enthusiasts seek exponentially higher quality results having as an ultimate goal of virtually all products, attributes, or services being with specification ($\mu \pm 6\sigma$) thus producing fewer than 3.4 defects per million even when shift of 1.5σ occurs.

One of the first organizations to inquire about Six Sigma from Motorola was Unisys. It was at Unisys that the term Black Belt was coined, as both Mikel Harry and Cliff Ames, a Unisys plant manager were both martial art enthusiasts (Eckes, 2005). Other large companies that has also embarked on the Six Sigma bandwagon include Texas Instrument (TI), Asia Brown Boveri (ABB), AlliedSignal and General Electric (GE).

Six Sigma is also a management philosophy aimed at improving the effectiveness and efficiency of an organization. (Eckes, 2005). Financial benefits are substantial when an operating system performs at 6-sigma quality level instead of 3-sigma quality level where control limits equal the specification limits. At the operational level, the goal of implementing “Six Sigma” is to move product or service attributes within the zone of customer satisfaction and reduce process variation (Blakeslee 1999, Hahn *et al*. 1999, Harry and Schroeder 2000).

Agilent Technologies is no stranger to Six Sigma, for it has engrained the quality improvement plan into its culture to ensure the quality of business decisions and strength in execution. Agilent is the world’s premier measurement company. Agilent operates two primary businesses, electronic and bio-analytical measurement, where the latter is supported by Agilent Laboratories, its central research group. Agilent is committed to providing innovative measurement solutions that enable the customers and partners deliver the products and services that make a measurable difference in the lives of people everywhere. Agilent is also a leading supplier to the telecommunications industry.

Agilent spun off from Hewlett-Packard Company in 1999 as part of a corporate realignment that created two separate companies. Its roots date to 1939, when Bill Hewlett and Dave Packard started a company that helped shape Silicon Valley and the technology industry. The two founders are renowned for their visionary approach to management (known as the "HP Way") and for their commitment to making products that contribute to advances in science and technology. Agilent continues to support the values that made Dave Packard and Bill Hewlett's company a success: dedication to innovation; trust, respect and teamwork; and uncompromising integrity. Added to these are speed, focus and accountability to meet customer needs and create a culture of performance that draws on the full range of people's skills and aspirations.

Agilent has established Six Sigma vision and financial benefits guidelines, and developed its 1st wave of Black Belt and Champions since its launch in 2006. Six Sigma has now been recognized as a key methodology for achieving results by the shareholders, customers and employees. Supplemental skills development has also been extended for new and existing Belts and Champions, while quarterly management reviews at business & corporate levels are becoming standard.

1.2 Statement of the Problem

Gelato Sensor Module, one of Microwave Test Accessories Agilent produces has been experiencing screw stuck issue resulting in high material scrap in the production floor for the last two years, since 2006. The Sensor module is build by manual assembly, consisting of electrical and mechanical components, connectors, cables, covers and fasteners. The materials scrapped are the bottom cover and main deck used in the module when the screw assembly is stuck and unable to be removed. In this particular problem of the Sensor module, it provides an opportunity to further investigate how the Six Sigma methodology (DMAIC) and tools can be used successfully to reduce the material variability and defects that leads to scrap of the Sensor module's bottom cover and main deck.

1.3 Objectives

The research's ultimate objective is to increase the yield of the Sensor Module by solving its screw stuck issue by focusing on the reduction of its process and material variability. Research will be carried out using Six Sigma methodology and tools to study the relationship that exists between key variables that influences the parts and the assemblies. Recommended solution will be implemented to monitor its effectiveness.

1.4 Scope and Key Assumptions

The focus of the research is to improve the quality and reduce the material defect of Sensor module's parts through Six Sigma methodology (D-M-A-I-C) within the research period of approximately 8 months. The research is only limited to one product, Sensor Module and is focused on the screw stuck on the cover only. The study will also not include Design for Six Sigma (DFSS), since a natural starting point of a Six Sigma venture is the use of Six Sigma in the production.

1.5 Organization of the Report

The first chapter of the thesis presents all introduction to Six Sigma and the problem statement. This is followed by the second chapter which summarizes the literature reviews. The third chapter contains the methodology of the research, consisting of DMAIC's Define and Measure phase, while the fourth chapter presents the research's analysis and results consisting of the final three phases of Analyze, Improve and Control. Finally the last chapter summarizes the conclusion and recommendation for future work.

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