UNIVERSITI PUTRA MALAYSIA

IMPROVED DEFINE-MEASURE-ANALYZE-IMPROVE-CONTROL METHODOLOGY FOR PROCESS IMPROVEMENT IN SEMICONDUCTOR INDUSTRY

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By

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IMPROVED DEFINE-MEASURE-ANALYZE-IMPROVE-CONTROL METHODOLOGY FOR PROCESS IMPROVEMENT IN SEMICONDUCTOR INDUSTRY

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Faculty: Engineering

In today's semiconductor industry, many researches have been done to investigate the procedure on problem solving, but still maintain high accuracy in order to keep the customer satisfied. In the past three years, Company A has been rated as "A" supplier from the top customers. Unfortunately, due to recent quality issues on Company A, few customers raised red alerts and quality excursions to Company A for immediate improvement to increase the quality level. Therefore, it is a must for Company A to utilize a best problem solving tool which is more effective and efficient to solve the problem as soon as possible. There are two major techniques chose in most of the Malaysia companies to improve internal defects and external customer complaint, which are Define-Measure-Analyze-Improve-Control (DMAIC) and Eight Discipline (8D). By comparing these two methodologies, there are still rooms for improvement for these two methodologies to reduce lead time as well as the quality of the solution. Current DMAIC structure is rather focusing of improvement projects than on problems that appear ad-hoc. Therefore, the effectiveness of DMAIC structure can be further improved in order to fit all the possible situations. The objectives of this project is first to investigate the effectiveness of DMAIC methodology used for problem solving in semiconductor industry and secondly is to develop a new improved DMAIC methodology to be used in semiconductor industry. Thirdly, the objective to validate the new improved DMAIC methodology in wire bond process. In this research, gaps of DMAIC methodology were studied and questionnaire survey instrument was used to collect the inputs on the process improvement methodology from seven semiconductor companies in Malaysia. There were total 98 respondents of executive levels (managers, senior engineers and junior engineers) participate in the survey. Based on the result from the survey, it is proven that majority of the respondents agreed that

containment action is not a comparable explicit step in the DMAIC process and majority of the respondents also agreed that there is weakness or limitation of the DMAIC methodology. In this circumstances, there are high numbers of the employees would like to apply if there is further enhancement of the DMAIC methodology. As a result, a new improvement DMAIC methodology has been developed which includes the Eight Disciplines (8D) inside the DMAIC- DMAIC ^{Plus} 8D with enhancement of containment action and best practice sharing. The author has also added the element of formally informed the team, project closure and cascade the improvements to all other relevant products within the enterprise. Lastly, a validation has been done with a case study tested in wire bond process to assess the new improved DMAIC methodology effectiveness. It is proven that with this new systematic approach, all the aspects of customer satisfaction and quality improvement can be achieved. The availability of containment action can avoid the defects escape to the customer and gain customer satisfaction. In a nutshell, this improved DMAIC methodology is a proven approach to achieve the next level of zero defects in all semiconductor industry.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

PENINGKATAN KE ATAS METODOLOGI DEFINE-MEASURE-ANALYZE-IMPROVE-CONTROL UNTUK PENAMBAHBAIKAN PROSES BAGI SEMIKONDUKTOR INDUSTRI

Oleh

ONG SIEW YING

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Pengerusi: Norzima bt. Zulkifli, PhD

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Dalam industri semikonduktor hari ini, terdapat banyak penyelidikan telah dijalankan untuk menyiasat prosedur pada penyelesaian masalah. Dalam tempoh tiga tahun yang lalu, Syarikat A telah dinilai sebagai "A" pembekal daripada pelanggan. Sejak kebelakangan ini, berdasarkan kepada isu-isu kualiti yang berlaku di Syarikat A, beberapa pelanggan telah mengeluh ketidakpuas hati ke atas Syarikat A. Oleh itu, ia adalah satu kemestian bagi Syarikat A untuk mengaplikasikan cara-cara penyelesaian yang lebih berkesan dan kecekapan untuk menyelesaikan masalah. Terdapat dua teknik utama yang dipilih dalam kebanyakan syarikat Malaysia, Define-Measure-Analyze-Improve-Control (DMAIC) dan Eight Disciplines (8D). Dengan membandingkan kedua-dua kaedah, masih banyak lagi ruang untuk penambahbaikan bagi kedua-dua kaedah untuk meningkatkan kualiti penyelesaian. Struktur DMAIC bukannya memberi tumpuan projek-projek peningkatan daripada masalah yang muncul ad-hoc. Objektif pertama projek ini adalah untuk menyiasat keberkesanan metodologi DMAIC digunakan untuk penyelesaian masalah di semikonduktor industri dan keduanya adalah untuk mempertingkatkan metodologi DMAIC yang baru untuk digunakan dalam industri semikonduktor. Ketiga adalah untuk mengesahkan metodologi DMAIC baru ini di “wire bond” process. Dalam kajian ini, jurang metodologi DMAIC dikaji dan instrumen kajian soal selidik telah digunakan untuk mengumpul input mengenai kaedah penambahbaikan proses daripada tujuh syarikat semikonduktor di Malaysia. Terdapat sejumlah 98 responden tahap eksekutif (pengurus, jurutera senior dan jurutera junior) mengambil bahagian. Berdasarkan keputusan daripada kaji selidik itu, ia terbukti bahawa majoriti responden bersetuju bahawa tindakan pembendungan (Containment action) tidak adalah langkah yang jelas dalam proses DMAIC itu. Kebanyakan pekerja ingin memohon jika ada peningkatan metodologi DMAIC itu. Jurang terbesar dalam metodologi DMAIC

seolah-olahnya tindakan pembendungan interim (Interim Containmen). Tindakan pembendungan interim adalah tindakan membendung segera dengan penyelesaian sementara dalam proses. Dengan itu, satu peningkatan metodologi DMAIC yang baru telah diwujudkan di mana ia merangkumi “Eight Disciplines” (8D) dalam DMAIC -DMAIC Plus 8D dengan adanya peningkatan tindakan pembendungan dan perkongsian pengajaran (best practice sharing) dengan segmen lain. Penulis juga telah menambah elemen makluman secara rasmi kepada pasukan, penutupan projek dan penambahbaikan kepada semua produk lain di dalam perusahaan. Akhirnya, pengesahan telah dijalankan di proses wire bond untuk menilai keberkesanan dalam metodologi DMAIC baru ini. Ia membuktikan bahawa dengan metodologi yang sistematik baru ini, semua aspek-aspek kepuasan pelanggan dan peningkatan kualiti dapat dicapai. Dengan adanya tindakan pembendungan yang boleh mengelakkan defek produk mengirim kepada pelanggan dan mendapat kepuasan daripada pelanggan. Secara kesimpulannya, metodologi DMAIC persepadian ini adalah satu pendekatan yang terbukti dapat mencapai “zero defects” dalam industri semikonduktor.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master Science. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

D	:	Define
M	:	Measure
A	:	Analyze
I	:	Improve
C	:	Control
8D	:	Eight Disciplines
VoC	:	Voice of Customer
CtQ	:	Critical to Quality
FMEA	:	Failure Modes and Effect Analysis
SIPOC	:	Suppliers, inputs, process, outputs and customer
DoE	:	Design of Experiment
FAB	:	Free Air Ball
CVR	:	Content Validity Ratio

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Six Sigma is new, emerging, approach to quality assurance and quality management with emphasis on continuous quality improvements. The main goal of this approach is reaching level of quality and reliability that will satisfy and even exceed demands and expectations of today's demanding customer (Pyzdek, 2003).

The main objective of Six Sigma initiative is to aggressively attack costs of a quality. Overall costs of quality are usually divided in tangible and intangible part. The tangible or visible part of costs of quality, e.g. inspection and warranty costs, scrap, rework and reject, can be approximated with only 10–15 % of overall costs of quality. Remaining 85-90 % of quality costs is usually intangible and, therefore, overlooked and neglected in companies' quality costs analyses. Tools and methodology within Six Sigma deal with overall costs of quality, both tangible and intangible parts, trying to minimize it, while, in the same time, increasing overall quality level contribute to company business success and profitability (Breyfogle, 2003).

Six Sigma is a framework that was created by Motorola. It is a systematic approach in order to reduce defects in an organization's processes, products and services, through the use of analytical and statistical methods. Six Sigma is also growing to become a business strategy that focuses on improving business productivity, financial performance and the understanding of customer requirements (Anbari et al., 2006).
According to Banuelas et al. (2006) the Six Sigma projects are opened based on the voice of their customers. From the survey made by Banuelas et al. (2006) companies were asked which tools or methods they use to identify potential Six Sigma projects. The most common method were Brainstorming, other popular tools used were, CTQ (Critical-to-quality) tree, focus groups, interviews, customer visits, QFD, Kano model and surveys (Banuelas et al., 2006).

In recent years there has been a significant increase in the use and development of the Six Sigma methodology in manufacturing industry and others. It is high time to have a review on the Six Sigma approach. Many researchers' summary issues within the sub-category of the initial Six Sigma concepts: basic concept, DMAIC, DFSS and deployment. It is more important to learn how to enhance the Six Sigma methodology and improve implementation issues for the growing number of firms that are choosing to adopt it as a means of process improvement (Wang, 2008).

Hammer and Goding (2001) argued that six sigma has been the target of criticism and controversy in the quality community characterizing it as 'Total Quality Management on Steroid'. One of the main criticisms is that Six Sigma is nothing new and simply repackages traditional principles and techniques related to quality. Organizations must realize that six sigma is not the universal answer to all business issues, and it may not be the most important management strategy that an organizations feels a sense of urgency to understand and implement six sigma. To ensure the long-term sustainability of the six sigma method, organizations need to analyze and accept its strengths and weaknesses and properly utilize six sigma principles, concepts, and tools (Catherwood, 2002).

1.2 Problem Statement

A study has been conducted on the effectiveness of problem solving methodology in semiconductor companies. The author is a part of Quality team in a semiconductor company and has been involved in quality improvement development within the organization. In the past three years, Company A has been rated as “A” supplier from the top customers. Unfortunately, based on recently quality issues which happened in Company A, few customers raised red alerts and quality excursions to Company A for immediate improvement to increase the quality level. Throughout the whole year of 2010, the number of wire bond process failures have increased and caused huge yield or scrap loss (6% of the losses) in Company A (Yearly Quality Review in Company A, 2010). Therefore, it is a must for Company A to utilize a best problem solving tool which more effective and efficiency to solve the problem as soon as possible. There are two major techniques chosen in most of the Malaysia companies to improve internal defects and external customer complaint, which are Define-Measure-Analyze-Improve-Control (DMAIC) and Eight Discipline (8D). Other researchers also pointed out that both methodologies can generate huge improvements for an organization. Indeed, there are similarities and differences between these two methodologies. By comparing these two methodologies, there are still rooms for improvement for these two methodologies to reduce lead time as well as the quality of the solution. Current DMAIC structure is rather focusing of improvement projects than on problems that appear ad-hoc (Marcus, 2011). Many of researchers and practitioners are trying to integrate six sigma with other existing innovative management practices that have been around to make six sigma method even more attractive to different organizations that might not have started or fully implemented the six sigma method (Revere and Black, 2003). Therefore, the effectiveness of DMAIC structure can be further improved in order to fit all the possible situations.

1.3 Research Objectives:

The main objectives of this research are:

1. To investigate the effectiveness of Define-Measure-Analyze-Improve-Control (DMAIC) methodology used for problem solving in semiconductor industry.
2. To develop a new improved Define-Measure-Analyze-Improve-Control (DMAIC) methodology to be used in semiconductor industry.
3. To validate the new improved Define-Measure-Analyze-Improve-Control (DMAIC) methodology in wire bond process.

1.4 Scope of Study

The scope of this study is to compare the similarities and differences between DMAIC and 8D problem solving methodologies by using both qualitative approaches. The target is to investigate the effectiveness of DMAIC methodology used for problem solving in semiconductor industry. Analysis of this study was done in seven different semiconductor companies with focus on employees' knowledge and opinion in DMAIC methodologies. The author also studied the possibility of enhancement in DMAIC methodology. Hence, the finding from this study is limited to the semiconductor companies. Manufacturing process of semiconductor devices involves wafer fabrication, die bonding, wire bonding, molding, plating, testing, taping and packaging. For the validation, an experiment is concentrated on problem solving in wire bonding process which causes highest scrap cost in Company A.

1.5 Benefit and Significance of the Study

In order to survive in a competitive market, companies need to re-engineering business process and measuring performance systems. It is very significant to accurately apply the TQM's tools and techniques to fulfill customer needs. This study has examined the possibility of designing an integrated implementation methodology by using DMAIC and other tools that can be used as a benchmarking model for the company and as well as other semiconductor industry. With this new improved DMAIC methodology, the author hopes that it is valuable method for achieving the goal of next level of zero defect and gain customer satisfaction.

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