IDENTIFICATION OF CAUSES OF VARATION IN THE SEMICONDUCTOR
MANUFACTURING PROCESSES BY STATISTICAL ANALYSIS : A SIX SIGMA
APPROACH

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UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

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Signature   : ……………………………………

Name of Supervisor   : Miss. FARAH SHAHNAZ FEROZ

Date   : ……………………………………

Specially..
To my beloved parents
To my kind brothers and sisters
And not forgetting to all friends
For their
Love, Sacrifice, Encouragements, and Best Wishes

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I have just completed my Final Year Project (PSM) and thesis in sufficient time. First of all, I would like to take this opportunity to express my appreciation to some organizations and individuals who have kindly contributed for my final year project in UTeM. With the Cooperation and contribution from all parties, the objectives of the project; soft skills, knowledge and experience were gained accordingly even this is just part of the whole project. Furthermore, I would like thank to me supervisor. Miss. Farah Shahnaz Feroz for the proper guidance, cooperation and involvement throughout my Final Year Project. Her effort to ensure the successful and comfort ability of student under her responsibility was simply not doubtful. Moreover, I would like to extend my sincere acknowledgement to my parents and family members who have been very supportive for the past six months. Their understandings and support in term of moral financial were entirely significance towards the project completion. Last but not list, my appreciation goes to my fellow students in UTeM, especially for who are from KEKK. Their willingness to help, opinions and suggestions on some matters, advices and technical knowledge are simply precious while doing upon completion of my final year project.

ABSTRACT

Six Sigma is an improvement process, developed by Motorola in 1985 that continually strives for perfection by reducing variation in the production processes. In semiconductor industry, the output of production is important. Increasing the output without maintaining the quality would lead to increase in variation in the process. By reducing this variation, it will improve the quality of the product. The objective of this project is to detect and find possible ways to reduce the variation in semiconductor manufacturing production of IC (Integrated Circuit). Production data from the industry will be analyzed to detect data variation. From here, a possible solution will be proposed to the industry. Causes of variation can be classified as common and special causes. In this case, special causes of variation are taken as subject to do the analysis. Wrong ingredient, wrong process setting, or an untrained operator is example of special causes. To observe and analysis the variations of the data, the Process Capability (Cp) method is use. Process capability is a method by compress the output of an in-control process to the specification limits by using capability indices. The target to achieve in this analysis is to detect and find possible ways to reduce the special cause's variation in manufacturing of IC (Integrated Circuit). All products and services are a result of some process. Also, Six Sigma benefits others beside customers. Six Sigma not only treats manufacturing as parts of a large system, it removes the narrow, inward focus of the traditional approach. A thorough literature study on Six Sigma, Statistical Process Control tools and the implementation of Six Sigma in the semiconductor industry will be performed.

ABSTRAK

Laporan ini adalah laporan disediakan untuk Projek Sarjana Muda, kanduanan laporan ini termasuk rekacipta dan pembangunan untuk sistem penempahan gudang. Projek ini adalah seperti apa yang ingin disampaikan melalui tajuk di atas, iaitu projek ini menitikberatkan proses semasa penembahan produk dalam gudang dan juga penghantaran produk dari gudang. Jadi sistem ini juga akan implikasi sistem pengurusan gudang. Projek ini adalah direka dengan Visual Studio 2008 bergabung dengan pangkalan data yang direka dengan Microsoft Access 2007, manakala perkakasan projek ini, sistem ini boleh mengawal motor melalui mikropengawal, iaitu Microchip PIC 16f877A. Komunicasi perisian dengan perkakasan projek ini adalah melalui modul Universal Asynchronous Receiver Transmitter (UART). Komunicasi adalah dupleks penuh, ini merujukkan komunikasi ini adalah dua hala. Satu Universal-Serial-Bus-to-Serial-Port penukar yang menyepadukan dengan RS-232 digunakan untuk sambungan ini. Sistem ini juga membolehkan pengguna untuk menguruskan dalam process penembahan, pembayaran, gudang kawalan, penghantaran produk, laporan kerosakan, penukaran kerosakan, dan akhirnya pengawalan inventori. Pelbagai process yang disebuti adalah digabung menjadi sebuah sistem dan perkakasan ini diguna sebagai pengawal untuk mengawal tali pengakut untuk mengakut barang-barang dari gudang kepada stesen penghantaran. Perkakasn ini dikawal semasa penghantaran produk dan laporan kerosakan produk dalam sistem. Ia dikawal melalui sistem untuk diaktif dengan sistem bagi isyarat untuk membenarkan 2 motor berjalan dengan dua hala yang berlainan, satu untuk masuk dan pengeluaran produk. Untuk penembahan sistem ini, data-data akan disimpan dalam pangkalan data untuk menyenangkan pengurusan proses penembahan. Jaringan pangkalan data dengan sistem adalah disambung dengan modul

ActiveX Database Objects. Pangkalan data direka dengan gabungan data yang dikumpul. Sistem ini boleh diaplikasikan di gudang industri, dan juga kedai kedai untuk menaikkan kadar kecekapan penembahan yang sedia ada kini dan mengurangkan kekurangan yang hadapi.

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DPMO - defects per million opportunities

IC - Integrated Circuit

Cp - Process Capability

PSM - Projek Sarjana Muda

SPC - Statistical Process Control

DFSS - Design for Six Sigma

DMAIC - define, measure, analyze, improve, and control

USL - Upper Specification Limit

LSL - Lower Specification Limit

UCL - Upper Control Limit

LCL - Lower Control Limit

Cpk - Critical Process index

Pp - Process Performance

Ppk - Process Performance Index

PPM - parts per million

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CHAPTER 1

INTRODUCTION

There is a letter in Greek, σ which is called as sigma used by statisticians to represent the standard deviation for a set of data [16]. The standard deviation is a value which indicated that the total number of individual data deviated from the mean value. This means that an estimation value of the variation in a set of data measurement is provides by the standard deviation. Currently, the sigma levels from one to six have been applied in different industries all over the world. However, the six sigma level is the best used in several manufacturing and non-manufacturing industry which is confirmed by Motorola. Six sigma is a quality-focused program that utilizes worker teams to accomplish projects aimed at improving an organization's operational performance. The Six Sigma has a vision in term of quality which equates with only 3.4 defects per million *opportunities* for each product or service transaction and it strives for perfection. Achieving the six-sigma quality can ensure both dependable quality and production efficiency. Its application not only to the production of goods and services, but it also concern about technical processes as well. In addition, it is capable to confront the highly competitive challenges and the variable changes of environment. Other than the application of Six Sigma in manufacturing and non-manufacturing industry, it has also implemented in several organization such as health care and financial service. Moreover,

its application is gradually following up in other services such as call centers, utilities and public services.

1.1-Project background

The Six Sigma concept was first established in the 1980s by Motorola [20]. Motorola has generated the idea which was related to the discussion of quality from measurement of quality level in parts-per-hundred change into a discussion of parts-per-million or even parts-per-billion. Based on the idea from Motorola, the old ideas about "acceptable quality levels" could no longer be tolerated as the modern technology become more complex. Hence, the perfect quality level was required in modern business.

A good quality services can cause the growth of economies which influence the increase of important services for the developed and developing nations. Therefore, interest in applying the Six Sigma concept is growing in manufacturing and services. Traditionally, the application of Six Sigma was not implemented in majority of manufacturing organization. With the implementation of Six Sigma, many service organizations have improving in terms of success rate and customer satisfaction. Most of the service organizations are Citibank, Bank of America, American Express, Caterpillar and Baxter Healthcare in US and Europe [6],[7],[8],[9],[15].

In any manufacturing semiconductor industry, the number of quality output of the production is important. With the increase of the output regardless on maintaining the quality would cause the increase in variation in the process. The way of reducing variations in the process is by maintaining the quality of products.
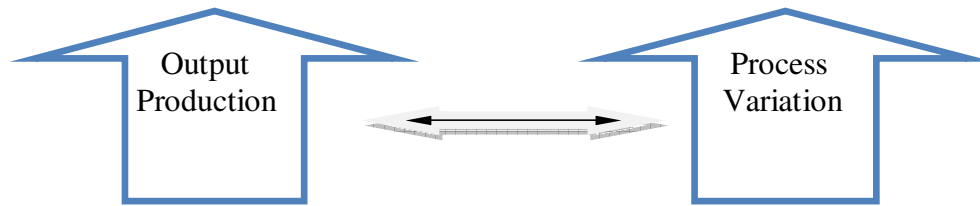
Figure 1.1:Industry production theories

The main objective of this project is to identify and find a possible solution to reduce the variation in semiconductor manufacturing production of IC (Integrated Circuit). Once the variation has identified, the problem can be solved effectively.

1.2-Objective

The objective in this project is:

1. To study and explain the benefits of the implementation of Six Sigma in the semiconductor industry to gain competitive advantage.
2. To identify production problems related to shifts and variations through control charts and Process Capability Index (Cp) analyses.
3. To identify possible solutions in reducing the defective IC in a semiconductor industry.
4. To propose a method using the Six Sigma approach to reduce variation in the production process.
5. To suggest possible ways in improving business performance and process management in semiconductor industry.

1.3-Problem statement

Today, most of the highly innovative semiconductor industry companies such as Motorola, Toshiba and Agilent Tech have to proceed with high volume production before their process achieve to maturity. The high volume of production is for the company to maintain their reputation and compete with other semiconductor industry. Beside that, the customer product also must have good quality. Therefore, most of the well known companies faced with the problem of high variation in a process when the yielding of output product is increased. Due to this problem, quality of product will also decrease. When product quality is not within the customer specification, other process will affect simultaneously. An increase in variation will cause the increment of expansion in production cost. In addition, time spent for rework for defect products lead a lot of problem and chaos in the production line. This entire problem is required to be overcome to maintain the reputations of the company.

1.4-Scope

In this project, there are three assumptions are made from the data collected:

- Independence of the data.
- Normal-Gaussian distribution also called the Gaussian distribution is an important family of continuous probability distributions, applicable in many fields. Each member of the family may be defined by two parameters, location and scale: the mean ("average", μ) and variance (standard deviation squared) σ^2, respectively.
- The data is randomly distributed.

In this project, it has two limitation levels that cannot to avoid. Firstly, to get the zero-defects of the variation of producing an IC. This is because every process has its variation. From here, possible ways to reduce process variation will be studied.

Secondly, data collection is confidential and it is handled by the company staff. I have no contact when the data is collected and how data collection is handled. Human error that occurs when taking the data also affects the analysis.

To analyze the data, Six Sigma method used with the help of Statistical Software such as MINTAB 14.

1.5 -Methodology project

I will also perform a thorough literature study and review on Six Sigma, Statistical Process Control tools, and the implementation of Six Sigma, Statistical Process Control tools, and the implementation of Six Sigma in the semiconductor industry. The technique of statistical process control, control charts and Process Capability Index (Cp) can be used to identify productions problems related to shifts and variation. The flow chart have shown in below is related to my procedure to implement this project
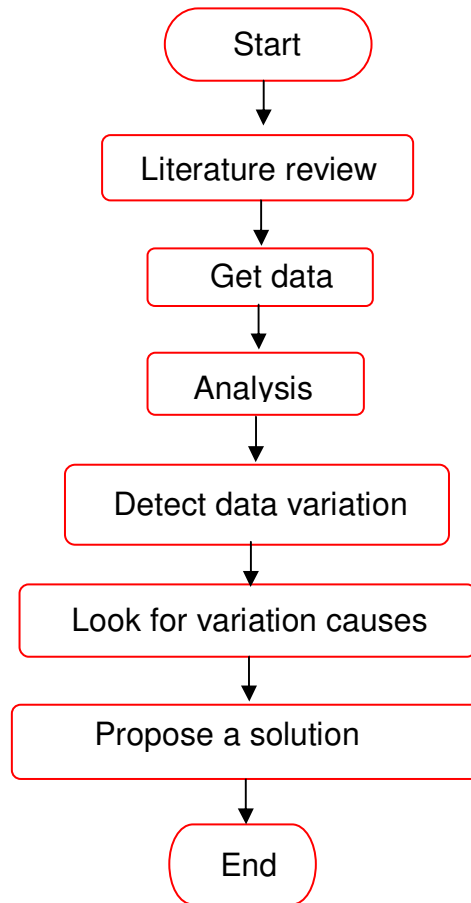
Figure 1.2: Project flowchart

In this project, I propose a method using Six Sigma approach to reduce variation in the production process. This would thus eliminate rework and customer callbacks caused by defects, leading to lower production costs and improve customer's satisfaction.

1.6-Outline of PSM report

This PSM report consists of five chapters. The first chapter discusses the background, objectives, problem statement, scope and methodology of this project. Chapter two discusses the theory of Six Sigma and includes the literature reviews that have been done. In addition, it also discusses the process flow of producing an IC and