UNIVERSITI TEKNIKAL MALAYSIA MELAKA

IMPLEMENTING SPC TOOLS IN A HIGH PRECISION MANUFACTURING COMPANY

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

by

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Management). The members of the supervisory committee are as follow:

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ABSTRAK

Penggunaan konsep SPC dalam kilang pembuatan boleh membantu dalam pemerhatian dan pengawalan kualiti terhadap sesuatu product yang dihasilkan. Maka mengaplikasikan SPC dapat mengurangkan penhasilan kecacatan atau kerosakkan product dan secara tidak langsung dapat mengurangkan perbelanjaan syarikat. Oleh itu, tujuan kajian project ini dijalankan adalah untuk mengaplikasikan SPC dalam produk terbaru sesebuah syarikat yang memerlukan tahap ketepatan yang tinggi dalam produk yang dihasilkannya. Oleh kerana product terbaru syarikat ini merupakan produk yang memberi keuntungan paling lumayan, maka pengaplikasian SPC dapat memberi banyak manfaat kepada syarikat kerana penghasilan produk ini memerlukan pengawalan kualiti pada setiap masa. Fokus utama project ini dijalankan adalah untuk menjayakan pengaplikasian SPC dalam syarikat melalui penggunaan kaedah yang sesuai supaya kualiti produk yang dihasilkan memenuhi kehendak pelangan. Selepas selesai kaedah pengumpulan data dijalankan, data tersebut dianalisa dan digambarkan dalam bentuk graf kawalan dan kualiti graf dengan menggunakan Minitab Statistic Software. Melalui kaedah dalam methodologi, setiap kaedah bagaimana SPC diaplikasikan ditunjuk dengan jelas. Seterusnya dalam paparan keputusan, tahap kualiti yang dihasilkan oleh syarikat dibandingkan dengan spesifikasi kehendak pelangan dan didapati keputusannya adalah kualiti dihasilkan memenuhi kehendak pelangan maka dengan ini jelaslah bahawa pengaplikasian SPC dapat membantu dalam pegawalan kualiti secara berkesan. Akhir sekali, potensi untuk meningkatkan kualiti product turut dibincangkan pada akhir project ini.

ABSTRACT

Implementing SPC in a manufacturing company will help in monitoring and controlling the quality of the product. Hence through implementing SPC, product defects can be reduced and eventually contribute in cost saving to the company. Therefore this study is focused on SPC implementation on a new product in a high precision manufacturing company. Since the new product is one of the most profitable products to the company where high precision is emphasized, it is important to monitor and control the quality frequently and this is where implementing SPC will be a great help. The aim of this study is to implement the SPC tools and techniques on the new product to meet customer requirement regarding the quality. The data that is collected are analyzed and further translated into control charts and quality charts by using Minitab Statistical Software. The methodology presented shows the appropriate SPC tools used in sequence and step by step procedure on how SPC is implemented towards achieving this project's main goal. From the results and discussion, the process capability is compared with the customer specification. It can be concluded that the process is stable and in statistical control. The implementation of SPC is justified that it is indeed benefits the company. Other improvement options are also suggested to further improve the quality of the product.

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CNC	-	Computer Numerical Control
Cpm	-	Process capability index
Cp	-	Process capability index
Cpk	-	Process capability index
Cpk_l	-	Process capability of lower limit
Cpk_u	-	Process capability of upper limit
DPMO	-	Defects per million opportunities
FMEA	-	Failure mode and effect analysis
GB	-	Gigabyte
IEGB	-	Impressive Edge Group Berhad
LCL	-	Lower control limit
LSL	-	Lower specification limit
MNC	-	Multi National Cooperation
MRS	-	Manufacturing –Related Services
Pp	-	Process capability index
Ppk	-	Process capability index
PPM	-	Parts per million
R	-	Range
SME	-	Small and Medium Enterprises
SOP	-	Standard of Procedure
SPC	-	Statistical Process Control
TPM	-	Total Preventive Maintenance
TQM	-	Total Quality Management
UK	-	United Kingdom
UCL	-	Upper control unit
USL	-	Upper specification limit

X bar	-	Average chart
R Chart	-	Range chart
$\bar{x}$	-	Mean
$\bar{\bar{X}}$	-	Average mean
σ	-	Standard deviation
+T	-	Upper tolerance
-T	-	Lower tolerance

CHAPTER 1

INTRODUCTION

1.1 Background

The trend in the manufacturing industry is constantly changing. In order to stay competitive, to strive for success and to become a leader in the manufacturing sector, a company must embrace the idea of continuous improvement. Continuous improvement must be carried out step by step by using the right tools to lead the company on the right path towards achieving its goal.

Statistical Process Control (SPC) is a philosophy concerned with optimization of continuous process improvements using a collection of appropriate statistical tools for analyzing data of manufacturing process. Besides, it also can be used in making inferences about process behavior in order to predict significant deviations that may later result in rejected product, and as a guidance to help the company in decision making. The concept of SPC was a masterpiece by Walter A. Shewhart back in the early 1920s. W. Edwards Deming later made full use of SPC methods in the United States during World War II where he has successfully improved the quality in manufacturing of war supplies for example weapons, ammunitions and other strategically important products. W. Edwards Deming was also instrumental in introducing SPC methods to the Japanese industry after the war had ended. After the successful adaptation by Japanese industries, SPC has now been incorporated by organizations around the world as one of the primary tool to improve product quality by reducing process variations.

Two kinds of variations occur in all manufacturing processes which both of them cause subsequent variations in the final product. The first is known as natural or common cause variation and consists of the variation inherent in the process as it is designed. Common cause variation may include variations in temperature, properties of raw materials, strength of an electrical current etc. The second kind of variation is known as special cause variation, or assignable-cause variation, and happens less frequently than the first. With sufficient investigation, a specific cause, such as abnormal raw material or incorrect set-up parameters, can be found for special cause variations.

Process capability index (C_{pk}) is one of the tools used in SPC philosophy. Process capability compares the output of an in-control process to the specification limits by using capability indices or capability ratio. Process capability indices determine how much natural variation (process value) of a process to be studied that differs from its specification limits. The comparison can be shown clearly by forming a normal distribution graph by taking into consideration of ratio of the spread between the process specifications to the spread of the process value.

The comparison of process capability indices are valid only if the sample size taken is large enough which means the sample size taken must at least 50 independent data values. The C_{pk} statistic assumes that the population of the data values is normally distributed. The benefit of comparing the output of a natural variability of stable process with the process specification is to judge how well the process meets specification.

1.2 Project Background

This project is conducted at manufacturer of precision parts in Melaka called Impressive Edge Group Berhad (IEGB). The company was first established as a private company called Impressive Edge Sdn. Bhd on 9 January 2003 by its founder Mr. Ng Hai Teng with other cofounders. It started modestly in a small premise in Melaka located in the Cheng Industrial Zone and from there, it has grown steadily to be reputable supplier of precision tooling products to leading corporation such as Infineon (Malaysia) and Osram (Malaysia). Soon on December 2003, it was converted into Impressive Edge Group Berhad IEGB as a public limited company.

IESB's main business is manufacture high precision engineering product mainly for the semiconductor industry. Precision tools manufacturer by the case company can achieve an accuracy of ± 2 micron to ± 5 micron on precision parts with complex geometries. The products and services which the company offers are categorized as Precision Tooling and Parts, Degate Tools, Ultra Precision and Precision Pins and Punches, Die Inserts and Die Sets, Jigs and Fixture.

With successful marketing strategies to promote its products and services in the Klang Valley and its surrounding areas, IEGB has gained confident and support by its customer in its principle businesses mainly in lead frame stamping, semiconductor, connector mould and other electronics products. Besides that, the company receives support in term of technical knowledge as well as supply of primary products in the precision tools and parts categories from its subsidiary companies. For future plans, the company intends to venture its business globally by setting up overseas offices as a platform to service and support its overseas client and at the same time receive increasing orders and to source for other overseas clients.

1.3 Problem Statement

Recently, IEGB has successfully sealed a contract to do machining and fabricating a new product called Fabrication Machine Frame, 4GB Fibre Channel which is an aluminum external hard disk casing for computer data storage. Due to customer requirement for high precision on certain dimensions of the product, the company has just begun implementing SPC on this new product. The company is currently collecting data to calculate the C_{pk} value in order to meet customer requirements. However, the company did not employ adequate SPC techniques and tools. As basic tools such as control charts, histogram, cause and effect analysis, scatter diagrams, check sheets, histogram and Pareto analysis are not applied. The company merely provided C_{pk} value by taking measurements of the necessary dimensions of the product. As a result, the company does not yield the full benefits of implementing SPC concept.

The application of SPC is about emphasizing on "total quality" to reduce the defects by early detection by using problem solving techniques and tools. SPC is not about taking measurements in lump sum and calculating the C_{pk} value to meet customer requirement, but it must be a good practice of a company-wide adoption of total quality and act as the focal point of never ending improvement to stay competitive in the business.

1.4 Objectives

The objectives of this project are:

1. To study and understand the manufacturing processes in the case company.
2. To understand the concept, theories and tools of Statistical Process Control (SPC)
3. To implement appropriate SPC tools and techniques on the Fabrication Machined Frame, 4GB Fibre Channel Product in the company, with a statistical software.

1.5 Scope

The scope of this project can be elaborated as follows:

- **Take the appropriate measurements data from the dimensions of Fabrication Machined Frame, 4GB Fibre Channel Product.**

Since there are many types of product manufactured in the company, only the Fabrication Machined Frame 4GB Fibre Channel Product is studied in this report as this is one of the most profitable product for the company.

- **Develop the Quality Control Charts using Minitab software.**

Quality control charts will be developed to monitor the extent the product meets the required specifications by customer. Minitab software is used to develop and illustrate the charts.

- **Implementation of SPC tools that include process flowchart, check sheets, histogram, graph, Pareto analysis, cause and effect analysis scatter diagrams and control charts.**

Additional SPC tools and techniques are needed in order to determine the root causes of variations and low process capability as well as to provide ideas on how to improve the quality of the product.

CHAPTER 2

LITERATURE REVIEW

Statistical process control (SPC) is a set of procedures using statistical techniques which has been used in industry for decades long. However, widespread use of statistical process control declined throughout the 1950s, 1960s and 1970s (Amsden R.T *at al.*, 1998). The emphasis of most manufacturing organization during this period was typically on the quantity of production and not on the quality of the products or services being produced. In many cases, the demand for products was greater than the ability to produce. Few managers felt the importance and need to use any techniques designed to improve quality or even maintain a high level of quality in the products they manufactured. The word "quality" is often used to signify "excellence" of a product or service. When we hear talk about "Rolls-Royce quality" our mind will always relate to "top quality". In some manufacturing company quality may be used to indicate that a product conforms to certain physical characteristics which are already set down with a particularly "tight" specification. But if we are to manage the product quality, it must be defined in a way which recognizes the true requirements of the customer. Quality is defined simply as meeting the requirements of the customer and this has been expressed in many ways by other authors:

Quality is fitness for purpose or use (Juran);

Quality is the total composite product and service characteristic of marketing, engineering, manufacture, and maintenance through which the product and service in use will meet the expectation by the customer (Feigenbaum);

Quality is the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs (Oakland J.S 2003).

Statistical process control techniques were used mainly to help solve severe production problems. Although quality engineers were ready with statistical process solving techniques, but mostly production managers neither wanted nor needed the techniques.

Then, in the late 1970s a grave problem faced by the American industry. Globalization occurred and companies encountered tough competition from manufacturers located all over the world. This globalization pioneered for increased efficiency in the manufacture of products. The United States had long been the world's largest producer of manufactured products and goods. Previously there was little competition from other countries. It becomes apparent however, that other countries had now acquired the ability to produce many products at a lower cost and at a better quality than similar products being produced in the United States. Many manufacturing operation were studied in various companies around the world especially in Japan. One thing learned was that in Japan many people on the production floor were making decisions concerning their operations as a normal part of their daily task. By contrast, operators in United States had very little control and were seldom allowed to make decisions concerning their operations. Based on theory, management took all the responsibility for the quality of the product. On rare occasions operators or line supervisors were asked to collect information or data and record it on a chart, but a quality engineer held the "secrets" of statistic process control. Even in such a situation, when the product did not meet standards, manager generally blamed the poor quality on lack of care on the part of the production operators.

Over the years, a good manager has learned that each and everyone held responsible for maintaining quality. Associates on the production floor are encouraged to monitor their operation and take corrective action immediately when needed. Manager has realized that if so much is expected of the production floor operators, they must be equipped with training, tools, and environment to do their job well. By experience, companies have concluded that the best ways to become efficient and competitive is to prevent defects. On the other hand, production associates are assigned to take responsibility for their operations. If the "first hand" people who "make it happen" on the production floor are to be successful, they must be supplied with the necessary tools and know-how to do their job. Hence the best way adopted by companies for decades is implementing the SPC concept.

2.1 Concept of Statistical Process Control

Although statistic process control is only an element of total quality management (TQM), it is nevertheless a major one. According to Duffuaa S.O and Daya M. B (1995), "SPC is the use of statistically-based methods to evaluate and monitor a process or its output in order to achieve or maintain a state of control". There are six principles or basic ideas behind the concept of SPC and techniques according to Amsden R.T *et al* (1998) as follow:

1. No two things are exactly alike.

Experience has shown that things are never exactly alike. When two things seem to be alike, we often say that they're "like two peas in a pod." But when we open a pea pod and take a closer look at the peas, we see slight differences in size, shapes, or freedom from blemish. Same goes in production situation where manufacturing parts are concerned; there is no two manufactured parts are exactly alike either. In one way or another, the parts will be slightly different in size, shape, or finish no matter how alike they are. We often want to make parts interchangeable. To do this, we want to make them identical, but no two things are exactly alike. Therefore, we want to keep the variation between parts as small as possible. To help ourselves with this, a second basic principle is used.

2. Variation in a product or processes can be measured.

Some variation is normal in the process, and this variation tends to increase. If no effort to measure or monitor the variation normally expected in the process, it will invite troubles. This means, all processes that are not monitored declined or "go downhill." Therefore, it's necessary to measure the output of any process or operation to know when trouble is brewing. When the output of a process or operation is checked, one feature can be identified immediately. This feature provides a basis for the third principle:

3. Things vary according to definite pattern.

A simple way to demonstrate this principle is to roll a pair of dice fifty or more times and record the total numbers of spots that came up on each throw. After a while a pattern begins to form. This pattern is sometimes called a frequency distribution, and is shown in Figure 2.1. A frequency distribution curve is formed by enclosing tally marks in a curve line. This curve shows that there are more measurements or numbers in the middle and fewer as u go away from the middle. As the curve is shaped like a bell is shown in Figure 2.2. A frequency distribution curve will repeat itself whenever you take groups of measurements. This fact leads to the fourth basic principle:

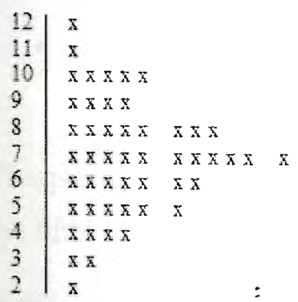

Figure 2.1: Tally chart.

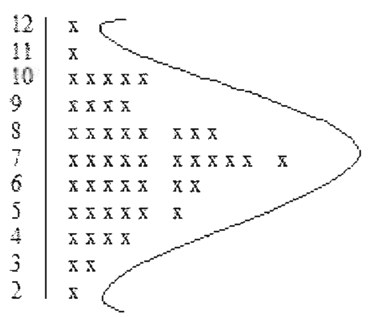

Figure 2.2: Frequency distribution curve 1.

4. Whenever things of the same kind are measured, a large group of the measurements will tend to cluster around the middle.