



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**EFFECTIVE IMPLEMENTATION OF PROCESS CAPABILITY
INDEX C_{PK} IN MINIMIZING REJECT RATE FOR BATCH
PRODUCTION**

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

by

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FACULTY OF MANUFACTURING ENGINEERING

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ABSTRACT

Process Capability Index (C_{pk}) has been used at some manufacturing companies to enable them to exactly monitor and getting feedback from process capability of their production department. This report includes the effective implementation of Process Capability Index (C_{pk}) in minimizing reject rate for batch production. Hicom Engineering Sdn Bhd, which located in Shah Alam, Selangor was selected for this project. This project also covered the present application of process Statistical Process Control (SPC) that applied at Hicom Engineering Sdn Bhd. SPC is used for data-gathering and to investigate problem the trends over time for the automotive part in the production line of this company. This project is also aimed to design and recommend new software for calculating C_{pk} called Operator Friendly Software (OFS). This software is designed for evaluation of one aspect of product quality which is process capability that can be used easily by production and quality control operators in order to minimize the reject rate in the line production. The developed software was not tested to check its effectiveness due to time constraint. However, the initial feedback obtained from the staff through the survey showed it is potentially effective because the time taken to set the result is very shorter compared to present practice.

ABSTRAK

Syarikat pembuatan telah menggunakan 'Process Capability Index' (C_{pk}) dalam membuat penilaian dan mendapatkan tindak balas dalam proses pengeluaran produk mereka. Laporan ini melibatkan tentang keberkesanan penggunaan C_{pk} dalam mengurangkan kadar produk yang rosak atau produk yang tidak memenuhi keperluan pelanggan dalam suatu proses pengeluaran. Hicom Engineering Sdn Bhd yang terletak di Shah Alam Selangor dipilih sebagai lokasi untuk menjalankan projek ini. Projek ini merangkumi pemerhatian tentang penggunaan 'Statistical Process Control' (SPC) yang digunakan oleh Hicom Engineering Sdn Bhd pada masa sekarang. SPC ini digunakan dalam pengumpulan data dan penyelidikan masalah yang timbul dalam proses pengeluaran syarikat ini. Projek ini juga bertujuan untuk mereka dan mencadangkan satu perisian untuk pengiraan C_{pk} iaitu 'Operator Friendly Software' (OFS). Perisian ini direka untuk memudahkan pekerja kawalan kualiti dalam menilai satu aspek kualiti produk iaitu 'process capability' dengan bertujuan untuk mengurangkan kadar produk yang rosak. Keberkesanan perisian ini tidak diuji kerana disebabkan masa yang terhad. Walaubagaimanapun, tindak balas awal diperolehi daripada pemerhatian yang dijalankan di kalangan pekerja. Hasil daripada pemerhatian ini menunjukkan perisian ini lebih berkesan berbanding dengan teknik yang sedia ada kerana kadar masa yang diambil untuk menyelesaikan suatu masalah adalah lebih singkat.

DEDICATION

For My beloved family and friends

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LIST OF ABBREVIATIONS

C_p	-	Potential Process Capability Index
C_{pk}	-	Process Capability Index
OFS	-	Operator Friendly Software
QA	-	Quality Assurance
QC	-	Quality Control
SPC	-	Statistical Process Control
SQC	-	Statistical Quality Control
TQC	-	Total Quality Control
TQM	-	Total Quality Management

CHAPTER 1

INTRODUCTION

This section included the introduction of Process Capability Index (C_{pk}) and identification of problem statement, objective and scope.

1.1 Background

1.1.1 History of Process Capability Index (C_{pk})

Process Capability Index has been used in manufacturing industry as decision making tools and to provide quantitative measures on process potential and performance. Process Capability Index is first introduced by Juran, the values of the index is estimated from a sample and should be qualified. Qualification of an estimate is provided in a form of a confidence interval for the estimate. In process improvement efforts, the Process Capability Index or Process Capability Ratio is a statistical measure of process capability. Specifically on the ability of a process to produce output within specification limits. The concept of process capability only holds meaning for processes that are in a state of statistical control.

The formula for this index is easy to understand and straightforward to apply. The sample data must be collected first in order to calculate this index. If a process is not centered, a slightly different measure is used to compute its capability. This ratio is represented by the symbol C_{pk} .

The Process Capability Index:

1. Considers only the spread of the characteristic in relation to specification limits
2. Assumes two-sided specification limits

The product can be bad if the mean is not set appropriately. It is computed by finding the difference between each of the specification limits and the mean, identifying the smaller difference, and dividing that difference by three standard deviations of the process. The process performance index takes account of the mean (μ) and is defined as:

$$C_{pk} = \min [(USL - \mu)/3\sigma \text{ or } (\mu - LSL)/3\sigma]$$

The process performance index can also accommodate one sided specification limits

1. For upper specification limit:

Upper specification – Process mean

3σ

$$C_{pk} = (USL - \mu)/3\sigma$$

2. For lower specification limit:

Process means – Lower specification

3σ

$$C_{pk} = (\mu - LSL)/3\sigma$$

Process Capability Index is constructed to express more desirable capability with increasingly higher values. The higher of C_{pk} value, the more capable the process is in meeting the customer requirement. A good target value for C_{pk} is 1.33, a more desirable C_{pk} is 2.00 and an excellent C_{pk} value is 5.00 or greater.

1.1.2 The Importance of Project

The important of this project are:

1. To know whether the process is stable or not.
2. To identify the main factor that causes the problem in batch production.
3. To illustrate the use of process capability analysis in a production of the product.
4. To take an action to solve the problem in production and automatically can improve the quality of product.

1.1.3 Company Background

Hicom Engineering Sdn Bhd is selected as observation for this research. This company is a subsidiary of Hicom Holding Berhad, a member of DRB-Hicom Group of Companies, offering state-of-the-art manufacturing capabilities to their customers. Hicom Engineering Sdn Bhd manufactures machine precision castings and assembles components for automotive and general engineering purposes. This company is located in Shah Alam, Selangor, Hicom Engineering Sdn Bhd began its commercial operation in 1991.

As one of Malaysia's leading manufacturers of cast-iron automotive components, Hicom Engineering Sdn Bhd have a strong commitment to constantly improve the quality of their products. The ISO/TS 16949 certification has only enhanced their commitment. Hicom Engineering Sdn Bhd utilizes the latest technological advances in support of their commitment to continuous improvement and provides the highest quality castings.

1.2 Problem Statement

Process Capability Index (C_{pk}) is being used in manufacturing industry. It is employed to provide an indication of the variability associated with a process and how a process has conformed to its specification. However, normally evaluation of Process Capability Index (C_{pk}) is not continuously implemented in the production. It is only used during test cut when approving a new product or after major repair was done to any section of production line.

In Hicom Engineering Sdn Bhd, as other companies' normal production standard, reject parts do occurs in their batch production. The reject parts are normally identified at the end of production line and this is too late to make any rectification to the process setting. This part reject occurs because of some factors such as the material used, in-line measurement, machine problem, and personnel involved in producing the parts. Ultimately, this Process Capability Index (C_{pk}) concept will be used to tremendously minimize this reject rate by obtaining early detection of the process capability.

1.3 Objective

1. To study the present application of process Statistical Process Control (SPC) and apply the implementation of Process Capability Index (C_{pk}) at Hicom Engineering Sdn Bhd.
2. To design and recommend Operator Friendly Software (OFS) for evaluation of product quality, which is the process capability, that can be used easily by production and quality control operators.
3. To minimize reject rate and improve the quality of product for batch production in Hicom Engineering Sdn Bhd using C_{pk} as tool.

1.4 Scope

The scope of this project is to study the present application of Statistical Process Control (SPC) and apply the implementation of Process Capability Index (C_{pk}) at Hicom Engineering Sdn Bhd. It uses in data-gathering and to investigate the problem trends over time for the automotive part in the production line of this company. This project will merely focus on batch production of Brake Disc production line. A batch production is a manufacturing method where products are produced in batches, as opposed to a continuous production process, or a one-off production. The primary characteristic of batch production is that all components are completed at a workstation before they move to the next one. In this project, a new Operator Friendly Software (OFS) using the Microsoft Excel Software will be designed and recommended for evaluating product quality that can be used easily by production and quality control operators.

CHAPTER 2

LITERATURE REVIEW

This chapter covers the literature review in the field of Process Capability Index that is gathered from some of resources such as journals, articles and books. From this finding, all the theory concepts and ideas relate to this project are gathered and summarizes in this chapter.

2.1 Introduction of Quality Concept

Quality is referred to the ability of a product to consistently meet or exceed customer requirements or expectations. Quality plays an important role in manufacturing organizations in gaining competitive advantage. Today's consumer markets experience an ever increasing demand for better quality products. It is widely accepted that the quality of a product is generally thought of as the ability to fulfill or conform to customer needs.

Quality can be classified into three types such as quality of design, quality of conformance, and quality of performance. The quality of design means that the product has been designed to successfully fill a consumer need, real or perceived and for the quality of conformance is conformance to requirements that refers to the manufacture of the product or the provision of the service that meets the specific requirements set by the consumer. Meanwhile, the quality of performance means that the product or service performs its intended function as identified by the consumer (Summers, 2000).

Quality has been defined differently by different people. From these definitions, it can be seen that the emphasis of quality has been broadened to focus on customers' needs. Now, it is quite common for organizations to publicize their slogans such as "Customer First" and some have even established customer care units just to provide the voice of customer. Actually, the customers want the solutions for their needs and not only quality product.

According to Dr. Joseph M. Juran, the costs of quality can be classified into four categories which are:

1. Internal Failure Costs: these costs are defined by Dr. Juran as the costs incurred with defective products, inclusive of scrap, rework, and downtime.
2. External Failure Costs: these costs are incurred after the product has left the company and is received by the customer, inclusive of warranty costs, complaints, returned products, and rectification of the products
3. Appraisal Costs: this classification encompasses the costs associated with finding the faulty product before it leaves the company, such as inspection and test, incoming inspection tests for vendors or supplier materials, and sustaining accurate and precise test and evaluation equipment.
4. Prevention Costs: Dr. Juran identified these costs as those resulting from keeping the defects to a minimum, including statistical process control, planning and organizing for quality, and training.

Based on Armand Feigenbaum, the author of Total Quality Control stated that the quality is a customer determination which is based on the customer's actual experience with the product or service, measured against his or her requirements, stated or unstated, conscious, technically operational or entirely subjective and always representing a moving target in a competitive market.

There are several key words stand out in this definition:

1. Customer determination: Only a customer can decide if and how well a product or service meets his or her needs, requirements, and expectations.
2. Actual experience: The customer will judge the quality of a product or service not only at the time of purchase but throughout usage of the product or service.
3. Requirements: Necessary aspects of a product or service called for or demanded by the customer may be stated or unstated, conscious or merely sensed.
4. Technical operational: Aspects of a product or service may be clearly identified in words by the consumer.
5. Entirely subjective: Aspects of a product or service may only be conjured in a consumer's personal feelings.

Table 2.1: Definitions of Quality

Quality Gurun	Definition
Juran	Fitness for use (1964), conformance to specifications.
Crosby	Conformance to requirements.
Fegienbaum	Total composite...will meet the expectations of customers.
Deming	Aims at the needs of the customer, present and future.
Taguchi	Loss to society.
ISO 9000	Totality of features and characteristics of a product or service...to stratify stated or implied need.

2.2 The Evolution of Quality

Quality principles have evolved over time. Up until the advent of production, artisans completed individual products and inspected the quality of their own work or that of an apprentice before providing the product to the customer. If the customer experienced dissatisfaction with the product, he or she dealt directly with the artisan. In a production setting, the steps necessary to create a finished product are divided among a number of work stations, which each performs a single repetitive operation. In order to be interchangeable, the parts must be nearly identical. This allows the assembler to randomly select a part from a group of parts and assemble it with a second randomly selected part. For this to occur without problems, the machines must be capable of producing parts with minimal variation, within specifications set by the designer. If the parts are not made to specification, during assembly a randomly selected part may or may not fit together easily with its mating part. This situation defeats the idea of interchangeable parts.

2.2.1 Inspection

As the variety of items being produced, a need for monitoring the quality of the parts produced by those processes arises. The customer no longer directly with the individuals responsible for creating the product, and industries needed to ensure that the customer received a quality product. Inspection is refers to those activities designed to detect or find nonconformance existing in already completed products and services. Inspection involves the measuring, examining, testing, or gauging of one or more characteristics of a product or service. Inspection results are compared with established standards to determine whether or not the product or service conforms.

In a detection environment, inspection, sorting, counting, and grading a product comprise the major aspect of a quality professional's position. This results in general feeling that the responsibility for quality lies in the inspection department. Inspection,