



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**AN APPLICATION OF SAMPLING METHOD FOR QUALITY  
CONTROL: CASE STUDY ON ROLLER MANUFACTURING  
INDUSTRY**

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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**TAJUK: An Application of Sampling Method for Quality Control: Case Study on Roller Manufacturing Industry**

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## **ABSTRACT**

This report discussed the important of applying Sampling Method for quality control in ABC roller manufacturing industry. The purpose of this study is to identify the current weakness of 100 percent inspection applied in quality control in ABC Company and to propose a sampling plan that may improve ABC Company performance and customer satisfaction. The methodology of this study is conducted through the data collections that taken in industry based on the whole year QC reports in 2008. All the data collection taken is in attributes type, so this study is conducted by using the step-by-step procedure of Military Standard 105E (MIL STD 105E). There are a few of inspection tables to be used to support each step in the procedure. Results gains are analyzed in three categories of single sampling plan: normal inspection, tightened inspection and reduced inspection. Other than that, performance for each type of sampling methods also analyzed in an operating characteristic (OC) curve. From the result findings, a suitable sampling method is being chosen to improve the performance in quality inspection. In the end of this study, benefits and the limitations of sampling method are discussed. Other than that, some recommendations for future improvement and further explore in inspection operation are also discussed.

## ABSTRAK

Laporan ini akan membincangkan mengenai kepentingan dalam aplikasi suatu “Sampling Method” untuk pegangan kemutuan di dalam sebuah ABC kilang pembuatan roller. Tujuan kajian ini dijalankan adalah untuk mengenali kelemahan baru-baru dalam aplikasi 100 peratus keseliaan di pegangan kemutuan dalam kilang ABC dan mencadangkan suatu “sampling plan” yang akan meningkatkan prestasi di kilang ABC dan kepuashatian pelanggan. Cara digunakan dalam kajian ini adalah dengan mengendali kumpulan data melalui lawatan industri dengan mendapat tahunan laporan QC dalam 2008. Semua kumpulan data yang didapatkan adalah dalam jenis “attribute”, jadi kajian ini mengendali dengan menggunakan langkah-berlangkah kaedah Military Standard 105E (MIL STD 105E). Terdapat beberapa selia carta digunakan untuk menyokong setiap langkah dalam kaedah. Keputusan yang didapati dianalisis dalam tiga jenis “tunggal-sampling method”: “penyeliaan normal, penyeliaan tetapan dan penyeliaan. Ada beberapa perkiraan dikendalikan untuk membuat peratusan peningkatan masa perbandingan diantara 100 peratus penyeliaan dan ketiga-tiga jenis sampling penyeliaan. Daripada keputusan yang didapati, suatu sampling method yang sesuai telah dipilih untuk meningkatkan prestasi di mutu penyeliaan. Di akhir kajian ini, kebaikan dan keburukan dengan mengguna sampling method dibincang. Selain itu, ada beberapa cadangan untuk masa depan peningkatan dan perkembangn dalam prestasi di mutu penyeliaam dibincang juga.

## **DEDICATION**

*To my beloved father, mother, brother and sister*

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## LIST OF ABBREVIATIONS AND SYMBOLS

ANSI	-	American National Standards Institute
AQL	-	Acceptance Quality Level
ASQC	-	American Society of Quality Control
CSP	-	Continuous Sampling Plan
ISO	-	International Organization for Standardization
MIL STD	-	Military Standard
OC	-	Operating Characteristic
SPC	-	Statistical Process Control
QA	-	Quality Assurance
QC	-	Quality Control
%	-	Percent
$N$	-	Number of items in a given lot
$n$	-	Number of items in a sample
$M$	-	Number of defective items in a given lot of size $N$
$m$	-	Number of defective items in a given sample of size $n$
$c$	-	Acceptance number
$p_o$	-	Fraction defective
$P_a$	-	Probability of acceptance
$\beta$	-	Consumer's risk
$\alpha$	-	Producer's risk
$d$	-	The maximum number of defects

# CHAPTER 1

## INTRODUCTION

### 1.1 Background of Study

The study is about developing a Sampling Method in Quality Control (QC) Department. The study is carried out in a roller manufacturing industry.

To provide a quality product, inspection is needed. Inspection is the function of comparing or determining the conformance of product to specifications or requirements. Normally, inspection is applied in quality control department to check the quality level of products. Deming (1986) has pointed out that dependency on inspection to correct quality problems is ineffective and costly and hence inspection should not be used as a long term strategy for quality improvement. It is now well accepted that dependence on inspection is ineffective in the long run and will not built quality into the product, but will only remove defective items. These lead researchers to focus more on process control. Inspection will also be utilized at early stages until data and means for process control are in place. Therefore, inspection in general and in particular lot-by-lot acceptance sampling will be a part of any quality control program.

In last century, people used traditional way that is 100 percent inspection on every product produced to check the quality of product. Nowadays, market is changing fast, it seem a great changes in the development and application of inspection methods. Sampling method is one of the QC tool or technique to inspect product quality. Sampling means the act, process, or technique of selecting a suitable sample for inspection or analysis. It is distinct from 100 percent inspection. Sampling plan make

a reductions in the amount of inspection. Acceptance sampling is one of the sampling methods which concern on decision making about a given lot.

Harold Dodge (1969), as the founding father of acceptance sampling, was always a proponent of the full and proper use of acceptance sampling plans that involves the feedback of results for action on the process or product improvement. For example, Dodge (1948) has states the following two purposes of inspection:

- To provide a basis for action on the product as it comes to the inspector whether is accept, reject or rework.
- To provide a basis for action on the process in the interests of future product whether leave the process alone or correct the process.

Acceptance sampling procedures can be used as part of the quality system to achieve better quality at lower cost, increased productivity, and improved control. An acceptance-sampling method plays an important role in designing quality-assurance (QA) specifications. It applies statistics to specify the requirements of how many measurements are needed and how to make an acceptance or rejection decision based on measured data. The quality balance of acceptable versus unacceptable data in a product, or component is the responsibility of the inspector. The inspections that take place must be in standard requirements or specifications.

This assessment is regarding the application of a suitable acceptance sampling plans based on the data collected on a roller manufacturing industry. This application can be applied by company in Quality Control Department in future. In judging various acceptance sampling plans, it is desirable to compare their performance over a range of possible quality levels of measured product. The performance can be show clearly by the operating characteristic curve which is commonly referred as OC curves. All these interesting procedures and excellent picture in OC curves regarding to different acceptance sampling plans will be present in the coming chapter.



## 1.2 Problem Statement

*Due to private and confidential purposes and company information must not be disclose, the roller manufacturing company name have been changed to ABC Company.*

Case study of sampling methods has been carried out in ABC Company because they needed such methods to solve the current problems that occurred in QC Department

Roller inspection in QC Department of ABC Company worked based on conventional inspection operation. Inspectors needed to do 100% inspection on every unit rollers to decide whether accept, reject or rework the lot. Current research observed that company faces some threats while doing 100% inspection:

- Huge investments in time and manpower are needed because 100% inspections take long time to finish and more inspectors are involved. For roller lot sizes that are more than 1000 units, four inspectors are involved and they spend almost three working days to complete the whole lot inspection work. When the inspection take long time to finish, waiting time in production line for the finished roller to continue the next process is increased. Time and manpower are wasted a lot in doing 100% inspection.
- The cost of inspection is high because more inspectors are employed to involve in the inspection work and more equipments are needed to provide to do the inspection.
- When the population is large, it would be impracticable to inspect each unit. Inspectors felt tired and not compatible to do the inspection work after long time involved in the inspection. Finally, performance of them is affected and inspection error occurred.

Due to nowadays fast-changing market, ABC Company is needed to change its way of work for continuous improvement. Hence, acceptance sampling procedure is proposed to be the most appropriate application to be used in ABC Company. There are a few types of acceptance sampling plans be proposed. All the expected objectives are achieved by the final acceptance sampling plan that proposed.

### 1.3 Objectives

This case study has three (3) main objectives, which are:

- a) To identify problem in current Quality Control method applied in ABC Company.
- b) To analyze the advantages and disadvantages of sampling application.
- c) To propose a satisfactory sampling method that may reduce time of roller inspections at the same time maintain product quality and customer satisfaction.

### 1.4 Scope of Study

Other than objectives, there are different scopes that will cover after this study. All these scope of study are set to cover to ensure company can achieve improvement in their inspection performance. Those scopes for this study are explained as follow:

- **An inspection study (case study) in QC Department of ABC Company.**

A case study will be conduct in QC department of ABC Company. This study start with observe the current QC inspection method used in company. Then, identify the problems caused by the used of current QC inspection method. Data collection is an important part to carry out on this study. Primary resources is the data on QC inspection result and taken from visit to ABC Company.

- **Distributing an effective plan for the inspection operation.**

After this study, an effective sampling plan will be choose and distribute to ABC Company for the future use in inspection operation.

- **Developing a before and after comparison list regarding to the application of sampling plan**

Application of sampling plan will bring out an improvement in the inspection performance to ABC Company. So, in the end of this study, a before and after comparison list regarding to the improvement can be develop.

- **Analyzing performance of each sampling plan in an OC curve.**

In result finding, each of the sampling plans is analyze in OC curve to discuss the effectiveness of its application. Selection is made based on the effectiveness shows in OC curve.

- **Discussing the reduction in manpower and inspection time.**

Sampling application will help company to reduce the inspection time and number of manpower involve in the inspection. Analyze it in percentage of reduction.

- **Focus on further improvement in company.**

In the end of this study, there are some discussions and recommendations that will focus on further improvement in company.

## **1.5 Potential Benefit**

Benefits that can be obtained by ABC Company after introducing a sampling plan into Quality Control Department are as follow:

- Help company to save handling time in Quality Control Department.
- Reduce manpower in inspection operation.
- Saving in measuring instruments maintenance.
- Company can achieve better quality at lower cost, increased productivity and improved process control.

## **1.6 Structure of Report**

Overall, the structure of report is divided into six chapters, which are Introduction, Literature Review, Methodology, Results, Discussion, Conclusion and Recommendations for future improvement. Each chapter will focus on what have explained as follow:

- **Chapter 1 : Introduction**

This chapter contains the background of study, problem statement, objectives, scope, potential benefit, and the structure of report. In this chapter, it concludes the progress of study and describes the plan to accomplish the study.

- **Chapter 2 : Literature Review**

The literature will explain regarding type of acceptance sampling, and its development from past until current and future improvement. In chapter 2, relevant information that is methods and findings are studied and summarized. The source of information is from journals, books, articles, internet and etc.

- **Chapter 3 : Methodology**

Methodology will talk about how the data is collected, and the step-by-step procedure involve in the planning of study. This planning of study is analyzed in a flowchart. Each step in the flowchart is described deeply.

- **Chapter 4 : Results**

This chapter will show all the results including calculation, graph, and table obtain from different acceptance sampling methods. An analysis can be make according to the result obtain.

- **Chapter 5 : Discussion**

Discussion chapter will analyze the benefit and limitation that cause by different type of sampling methods.

- **Chapter 6 : Conclusion and Recommendations**

Conclusion section will summarize all the relevant findings and talk about whether achievement of acceptance sampling on QC department has been reach or not. Besides, some recommendations and suggestions are given in this chapter.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Sampling

*“One trouble with 100% inspection, where it is practicable, is that the inspector merely cleans up the faults of others, sorting the good from the bad, and the production man takes it as a matter of course if just individual articles are returned to him for repair. But if a whole lot is returned to him, as when lot sampling is used, and he is required to undertake the entire corrective action, the steady outward flow of product is interrupted. If there are many lot rejections, he must get busy to find the cause and eliminate it in order to avoid further lot rejections. This is an indirect power of sampling- it forces correction of the process, where the fault lies.”- H.F.Dodge*

H.F.Dodge has explained the power of sampling plan as above and how the sampling plan can help the production man to improve his performance. Sampling means a small part selected as a sample for inspection or analysis. Items or components are often delivered in lots or batches of a given number and it is often impossible or uneconomic to test every single item in the lot. With a practical sampling method, random samples are taken from the lot and test each item in the sample. Individual sampling plans are used to protect against irregular degradation of levels of quality in submitted lots below that considered permissible by the consumer. A good sampling plan will also protect the producer in the sense that lots produced at permissible levels of quality will have a good chance to be accepted by the plan.

### **2.1.1 Random Sampling Concept**

The random-sampling concept is extremely important in acceptance sampling. Random sample means each item in the lot is assumed to have an equal chance to be selected in the sample. The items selected for inspection from the lot should be chosen at random, and they should be representative of all the items in the lot.

## **2.2 What is Acceptance Sampling?**

Acceptance inspection is a necessary part of manufacturing that applied to incoming materials, semifinished products, or finished products. When inspection is for the purpose of acceptance or rejection of a product, based on a given standard, the type of inspection procedure is called acceptance sampling. Acceptance sampling inspection has a number of advantages over 100% inspections. One of the advantages is 100% inspection often impracticable and uneconomical.

As H. F. Dodge has pointed out:

*Using inspection results as a basis for action on the product at hand for deciding whether to accept or reject individual articles or lots of product as they come along is, of course, an immediate chore that we always have with us. However, inspection results also provide a basis for action on the production process for the benefit of future product, for deciding whether the process should be left alone or action taken to find and eliminate disturbing causes.*

This is the true nature of acceptance sampling, the active use of sampling plans as a vehicle for process improvement. H.F.Dodge has described that acceptance sampling used in inspection not only can decide whether the lots of product should accept or reject, but also decide whether the process should be left alone or take action to find and eliminate defects cause.

### **2.2.1 Current Development of Acceptance Sampling**

Acceptance sampling procedures can be used as part of the quality system to achieve better quality at lower cost, increased productivity, and improved control. This section presents an overview of use of modern acceptance sampling plans in applications involving unique lots or a steady flow of product from the producer.

One of the important developments in the field of quality control is the use of sampling procedures wherein the amount of inspection or sample size depends upon the extent to which quality of product is satisfactorily controlled. Under these procedures, inspection results obtained on samples from successive lots of product are summarized to obtain a measure of the general level of quality and its uniformity from lot to lot. Whenever such summaries indicate a satisfactory state of control, reductions in the amount of inspection can safely be made.

Acceptance sampling is one of the oldest aspects of quality assurance which concerned with inspection and decision making regarding products. In the 1930s and 1940s, acceptance sampling was one of the major components of the field of statistical quality control, and was used primarily for incoming or receiving inspection. In more recent years, it has become typical to work with suppliers to improve their process performance through the use of SPC and designed experiments, and not to rely as much on acceptance sampling as a primary quality assurance tool.

Other than receiving inspection activity, sampling methods also uses for other purpose. For example, frequently a manufacturer will sample and inspect its own product at various stages of production. Lots that are accepted are sent forward for further processing, and rejected lots may be reworked or scrapped. Furthermore, acceptance sampling is required in current good manufacturing practice in pharmaceutical research and development.

### 2.2.2 Application of Acceptance Sampling

In general, the selection of an acceptance-sampling procedure depends on both the objective of the sampling organization and the history of the organization whose product is sampled. Harold Dodge, as the founding father of acceptance sampling, was always a proponent of the full and proper use of acceptance sampling plans that involves the feedback of results for action on the process or product improvement.

Acceptance sampling is most likely to be useful in the following situations:

- When testing is destructive.
- When the cost of 100% inspection is extremely high.
- When there are many items to be inspected.
- When 100% inspection is not technologically feasible or would require so much time that production scheduling would be seriously impacted.
- When there are many items to be inspected and the inspection error rate is sufficiently high that 100% inspection might cause a higher percentage of defective units to be passed than would occur with the use of a sampling plan.

Proper application of such plans involves recognition of the potential for quality improvement that can be attained by working with a supplier in the utilization of the process control techniques necessary to assure acceptance of product against a process oriented sampling plan. Such an approach involves not only the sampling plan, but various political, psychological and economic means to assure that quality improves to prescribed levels. In this way, acceptance sampling plans can be used, with process control, as a means for continual quality improvement.