UNIVERSITI TEKNIKAL MALAYSIA MELAKA

AN APPLICATION OF *P* CONTROL CHART TO A PAGER ASSEMBLY LINE

This report submitted 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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I hereby declare that this report entitled **"An Application of *p* Control Chart to a Pager Assembly Line"** is the result of my own research except as cited in the references.

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APPROVAL

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ABSTRACT

Quality control is an important part for ensuring the product produced meet or exceed customer requirements. This research is conducted at an electronic industry which produces Pager. The industry currently applies 100% inspections to control its quality of product. This is necessary as to comply with safety standard. However, the company has not yet applied any statistical quality control. The current method of process quality control of the company only emphasized on percentage of yield and provides no information on the process performance. The study proposes a *p* control chart for their production quality control. Thus, a suitable statistical control chart is selected as it accounts for measuring process performance. Process capability analysis is performs to measure the ability of the process to produce units that are "in spec" and predict the number of parts out-of-spec. The effectiveness of the implementation of this statistical tool is discussed in the report and additional recommendations are proposed as well.

ABSTRAK

Kawalan mutu memain peranan yang penting untuk memastikan produk yang dihasilkan mencapai atau melebihi prasyarat pelanggan. Penyelidikan ini dijalankan di elektronik industri yang mengeluarkan alat keluli. Demi mengawalkan produk kualiti, cara yang diamalkan oleh Industri ini adalah menjalankan 100% pemeriksaan atas produknya. Selain itu, ini juga adalah satu keperluan untuk mematuhi piawaian keselamatan yang ditentukan. Sehingga masa kini, industry ini belum melaksanakan kawalan produk quality dengan menggunakan mana-mana kawalan mutu berstatistik. Cara yang digunakan pada masa kini hanya menekankan membuat analisis tentang peratusan hasil dan cara ini tiada maklumat bagi proses prestasi.

Kajian ini telah mencadangkan mengguna satu *p* carta untuk mengawal mutu pengeluaran produk. Carta kawalan statistic yang sesuai telah dipilih untuk menjelaskan prestasi proses pengukuran. Selain daripada itu, lagi satu analisis bernama keupayaan proses analisis akan dijalankan untuk mengukur sama ada industry bermampu untuk mengeluarkan unit-unit yang "dalam spesifikasi" dan meramalkan jumlah unit yang akan gagal meluluskan spesifikasi. Keberkesanan pelaksanaan alat statistik ini dibincangkan dalam laporan dan member cadangan untuk meningkatkan mutu produk.

DEDICATION

To everyone I love and everyone who loves me

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I am deply appreciating to Multitone Communication Company for providing the chance to perform research study in their plant. I would like to express my gratitude to all the staff and operators in Multitone Company for providing the useful information when I was having doubts.

Last but no least, I would like to thanks my family and friends, who have supported and motivated me with their own way to lead me from the beginning of the project to the end of project submission.

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LIST OF ABBREVIATIONS

ASQC	-	American Society for Quality Control
B.C	-	Before christ
c	-	Number nonconformities
CL	-	Centerline
I	-	number of sample
ISO	-	International organization of Standardization
JUSE	-	Union of Japanese Scientists and Engineers
LCL	-	Lower control limit
n	-	Number inspection unit
np	-	Number defective
p	-	Percent defective
p_0	-	Reference *p* value for next period.
PCDB	-	Project Control Database Program
PPM	-	Part per Million
SPC	-	Statistical process Control
SQC	-	Statistical Quality Control
u	-	Number nonconformities per units
UCL	-	Upper control limit
σ	-	Sigma
z	-	Standard deviation

CHAPTER 1
INTRODUCTION

1.6 Background of Study

In recent years, most manufacturing companies have focused on the manufacture of higher value added products with low production costs. Therefore, quality has become an important success criterion for the manufacturing process. Process quality control is an inspection procedure which able to help companies produce high quality product easily and effectively.

Many industries implement quality control test time before release finished products to customer to eliminate quality problems. Quality control process includes raw material inspection, initial product confirmation, spot-checking equipment, in-process checking, inspection of finished products and quality audit.

Generally quality control defined as *a system that is used to maintain a desired level of quality in a product or service*. This task may be achieved through different measures such as planning, design, use of proper equipment and procedures, inspection, and taking corrective action in case a deviation is observed between the product, service, or process output and a specified standard (ASQC 1983).

Quality control is process monitoring and elimination of root cause of unsatisfactory product or quality performance. It is more to do with the actions on the production floor to control quality level and all these operational techniques necessary to satisfy all quality requirements (Mitra, 2008).

The best companies emphasis designing quality into the process, thereby greatly reducing the need for inspection or control efforts. Different business organizations are in different stages of this revolutionary process:

- The least progressive rely heavily on inspection.
- Many occupy a middle ground that involves some inspection and great deal of process control.
- The most progressive have achieved an inherent level of quality that is sufficiently high that they can avoid wholesale inspection activities and process control activities by mistake prevention.

Figure illustrates these phases of quality assurance.

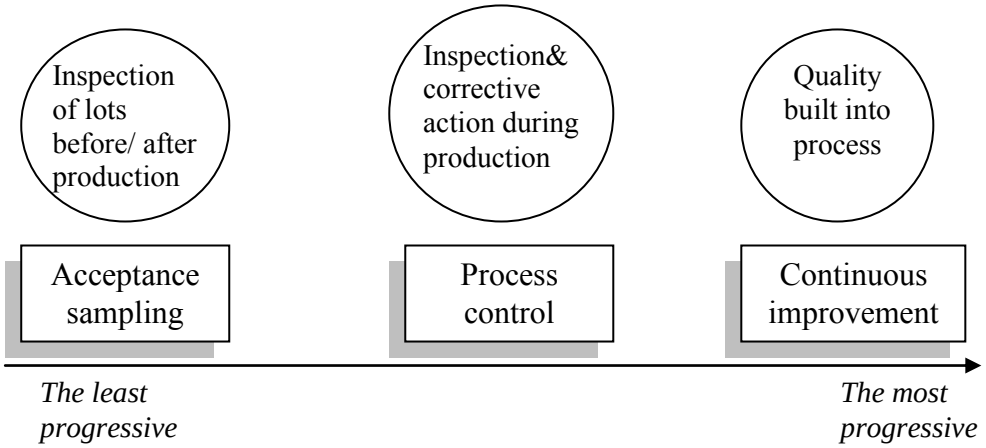

Figure 1.1: Phases of quality assurance (Stevenson, 2009).

The advantages of a quality control system become obvious in the long run. First and foremost is the improvement in the quality of products. Production improves because a well-defined structure for achieving production goals is present. Second, the system is continually evaluated and modified to meet the changing needs of the customer. Therefore, a mechanism exists to rapidly modify product or process design, manufacture, and service to meet customer requirements so that the company remains competitive.

Thirdly, a quality control system improves productivity, which is a goal of every organization. It reduces the production of scrap and rework, thereby increasing the number of usable products. Fourth, such a system reduces costs in the long run. The notion that improved productivity and cost reduction do not go hand in hand is a

myth. On the contrary, this is precisely what a quality control system does achieve. With production of fewer nonconforming items, total costs decrease, which may lead to a reduced selling price and thus increased competitiveness.

Fifth, with improved productivity, the lead time for producing parts and subassemblies is reduced, which results in improved delivery dates. Once again, quality control keeps customers satisfied. Meeting their needs on a timely basic helps sustain a good relationship. Quality control system maintains an "improvement" environment where everyone strives for improved quality and productivity (Montgomery, 2005).

This study is conducted in one of the communication company that located in Malacca, Malaysia. This factory in Malacca is a site factory for assembly pocket paging factory. In 1955, the company becomes the first company in the world to develop a new type of radio-based staff location system known as paging. This company is specializes in delivering wireless voice and messaging systems to a variety of sectors, including healthcare, emergency services and hotels across the world.

The site factory is use one assembly line to produce several products in batches. Batch production is a method used to produce product in group. Once company receives order from customer, they will place and process the order. There have three in-process inspections in an assembly line which is decoder test, alignment process and final test. The process of production starts with an inspection using sampling methods on the in-coming raw materials before labor work on.

1.7 Problem Statements

Pursuing to achieve a high standard quality becomes one of the basic strategic and operative intentions of modern company. Quality issues that occurred frequently will reduce the rate of return or profitability by decreased productivity, increased scrap, and reworks cost for the materials, labour and overhead that associated with production. In this study we are concerned on reduce the internal failure of product

by controlling the in process product quality. Internal failure is incurred when product or components fail to meet quality requirement prior to the transfer of ownership to the customer. Less scrap and rework will result as problems are prevented.

Inspection is a process of elimination before expedition of the proceedings process of nonconforming products. The company applies hundred percent inspections. However, company still facing certain level of reject products. Currently, the company has never introduced any SPC tools for controlling quality product. This study will perform a quality estimation of process with usage of control chart and capability of process. The control chart helps in checking the existence of uncontrolled variation parameters in the process where process capability wills statistically measure the process variability. Statistical quality control allows the usage of statistical techniques for measuring and improving the quality of processes.

1.8 Objectives of Study

1. To apply statistical process control chart techniques and process capability in pager production line.
2. To fully understand the usage of *p* control chart in monitoring process.
3. To utilize a statistical software to construct control chart and perform capability analysis.

1.9 Scopes of Study

The scope of this study will be focusing on in-process product quality in the assembly line. Statistical techniques of SPC tools will be applied to all inspection stations of the assembly processes to measure and analysis the variation of process. Control chart and process capability analysis is used for quality estimation of process. Data collected from company is count data and thus attributes control chart will be use.

This study will determine whether process has out-of-control conditions or high product nonconformance as earliest as possible in the production phase. Technique to use to construct control chart will be present and a new template will be developed for future use in the company. Product's current process will be evaluated and discussed for improving the process based on the result obtained by using statistical quality control investigation. Lastly, as evaluation on usage of SPC tools used in this, a study will be carried out and determine whether these tools are valuable for further research or not.

1.10 Organization of Chapter

This project is divided into five chapters which are shown in below:

Chapter 1: Introduction

This chapter gives an overview concept of the quality control and related with fundamentals of quality, the use of quality control in industry. It involves the objective, problem statement and scope of study which pursued. The scope maps out the limitation and set the boundaries of the areas to be studied.

Chapter 2: Literature review

This chapter discusses published information of quality control such as issue come from, concept of quality control and methods approach. The focus of this chapter is to summarize and synthesis arguments and ideas about quality control concept of others had approach within a certain time period.

Chapter 3: Methodology

This chapter describes the procedures followed in order to pursue the study in the industry. It may include the step-by-step account of the procedures carried out during do the research in the industry.

Chapter 4: Result and Discussion

This chapter will present the study finding in the form of figures and tables. It includes make some comment on the result to evaluate the results with regards to the

hypothesis and available theories. This discussion section will explain whether the results obtained are expected or different from the result of the study. It also will discuss implications about the present and future consequences of the result.

Chapter 5: Conclusion and Recommendation

This chapter is important as it evaluate the study work based on the results obtained. It consists of justification on study's objectives, review significant findings and recommendation for future studies. This chapter will also include suggestions of some ideas and methods to improve the current situation based on the research done.

CHAPTER 2
LITERATURE REVIEW

2.1 Manufacturing System

The basic foundations of a manufacturing system are input, output and transformation of process. A measurement system constructed for loop back the non-compliance part to maintain high quality of product. Action will taken in measurement system includes detect assignable cause, identify root cause of problem, implement corrective action, and verify follow up.

Inspections of product take place during and at the end of the operations process to guarantee that no defective output would be produced. Quality control is concerned with checking and reviewing output quality to make sure output being produced is meeting the required standard. Following figure present a simple manufacturing system.

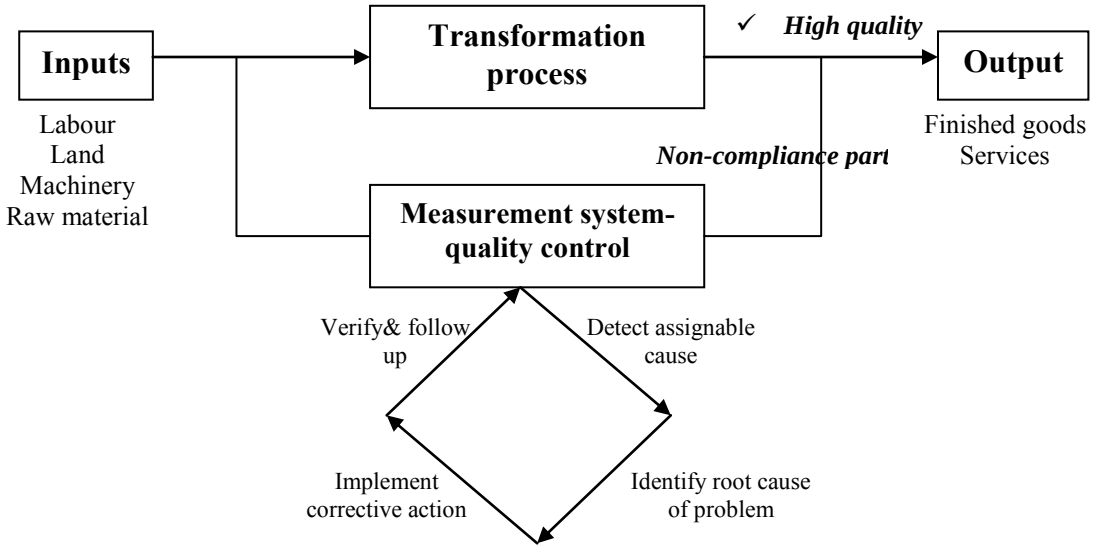

Figure 2.1: Simple manufacturing system (Stevenson, 2009).

2.1.1 What is Transformation Process?

A process is a transformation of a set of inputs, which can include materials, actions, methods and operations into desired outputs, in the form of products, information, services or results. It is an integrated set of responsibilities between engineering design, production and warehouse managers, and logistics team. Each plays its part in producing quality products and delivering it to customers (Oakland, 1999). How well of an organization success is determined by undertaking of the transformation process. The output of the process is transferred to customers. Thus, to produce an output which meets the customer requirements, it is necessary to define, monitor and control the inputs of the process (Ei-Tayeb *et al.*, 2006).

2.1.2 What is Control?

A general definition of control is "a standard of comparison for verifying or checking the findings of an experiment". Juran has define the control is *the process of measuring quality performance, comparing it to requirement, and acting on the difference.*

Feigenbaum defines control as a *process for delegating responsibility and authority for a management activity while retaining the means of assuring satisfactory results.* Feigenbaum's definition is sufficiently generic to apply to any activity, no only can apply on the quality control. He proposed that the four steps of control which is setting standards, appraising conformance, acting when necessary and planning for improvement (Pyzdek, 1989).

2.1.3 What is Process Quality?

Product will produced according to the specification set by the design function once the design quality is determined. "Process quality" or "quality of conformance" is determined by how well of the product can be done and this is duty of production.

Production is responsible for build product to the standard set by design. Process quality is the true measure of firm's ability to produce a quality product. The measurement and determination of this concept can be evaluated by using quality control or SPC (Statistical Process Control). In fact, process quality is always presented as a simple statistical, percent defective which is frequently expressed as the symbol *p* (a *p* of 0.05 means a process quality or process defective of 5%) (Doty, 1996).

2.2 Definition of Quality

Quality is defined simply as *meeting the requirement of customer* and this has been expressed in many ways by other authors:

- Fitness for purpose or use –*Juran (1974)*
- Conformance for requirement- *Crosby (1979)*
- Reducing variation- *W.Edwards Deming*
- The total composite product and service characteristics of marketing, engineering, manufacture, and maintenance through which the product and service in use will meet the expectation by the customer- *Feigenbaum.*
- Quality as the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs- *ISO standard 8402*
- Quality as degree to which a set of inherent characteristics fulfill requirements- *ISO 9000:2000*

The notion of quality has been defined in different way by various authors. In, 1974, general definition proposed by Juran is *quality is fitness for use*. Furthermore, Crosby (1979) define the *quality is conformance to requirement or specifications*. Garvin (1984) divides the definition of quality into five categories which is transcendent, product-based, user-based, manufacturing based, and value based (Johnson and Weinstein, 2004).