BIMBINGAN PERISIAN UNTUK CARTA KAWALAN

(TUTORIAL SOFTWARE FOR CONTROL CHART)

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Alhamdulillah, first of all I grateful to Allah because I have to accomplished my final year project successfully even it has some problem that interrupt since executing this project.

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ABSTRACT

This thesis is a study about tutorial software of control chart. This thesis contain the method to develop a control chart software begin from a data collection until programming process using Visual Basic (6.0). This thesis was focused to undergraduate student and especially for a worker in industrial sectors. The focus for undergraduate student embrace to acquaint them about a use of control chart and also how control chart are develop and construct to be control chart software. The focus for a worker in industrial sectors embraces how to use control chart software to improve their production quality. With using this software, they can safe their time and the quality of production can be improved. The tutorial software of control chart in this thesis was developed using Visual Basic (6.0) programming. With using this programming user can see an attractive interface and make this software user-friendlier.

ABSTRAK

Tesis ini merupakan satu kajian mengenai bimbingan perisian untuk carta kawalan. Tesis ini mengandungi kaedah bagaimana untuk membangunkan perisian carta kawalan bermula daripada pengumpulan data sehingga proses pengaturcaraan dengan menggunakan Visual Basic (6.0). Tesis ini memberi tumpuan secara umum untuk mahasiswa dan secara khusus untuk pekerja-pekerja di sektor industri. Tumpuan secara umum untuk mahasiswa merangkumi memperkenalkan kepada mereka mengenai kegunaan carta kawalan dan bagaimana carta kawalan dibangunkan serta pembinaannya untuk menghasilkan perisian carta kawalan. Tumpuan secara khusus untuk pekerja-pekerja di sektor industri pula merangkumi bagaimana cara untuk menggunakan perisian carta kawalan untuk meningkatkan kualiti pengeluaran mereka. Jika mereka menggunakan perisian ini, mereka dapat menjimatkan masa dan kualiti pengeluaran dapat ditingkatkan. Bimbingan perisian untuk carta kawalan yang dihasilkan dalam tesis ini telah dibangunkan menggunakan pengaturcaraan Visual Basic (6.0). Dengan menggunakan perisian ini pengguna dapat melihat antaramuka yang menarik dan menjadikan perisian ini lebih mesra pengguna.

CHAPTER 1

1.0 Introduction

1.1 Definitions of Quality

When the expression of "quality" is used, we usually think in terms of an excellent product or service that fulfills or exceeds our expectations. These expectations are based on the intended use and the selling price. For example, a customer expects a different performance from printed circuits board (PCB) than from an electronics device because they are a different grade. When the product surpasses our expectations we consider that quality. Thus, it is somewhat of an intangible based on perception.

According to ANSI / ASQC Standard A3-1987, quality is the totality of features and characteristics of a product and service that bear on its ability to satisfy implied or stated needs. Stated needs are determined by the contract, whereas implied needs are function of the market and must be identified and defined. These needs involve safety, availability, maintainability, reliability, usability, economics (price), and environment.

Conformance of the product or service to these specifications is measurable and provides a quantifiable and operational definition of quality. If the specifications do not satisfy the customer needs (fitness for use), they should be changed. Needs usually change over time, thereby requiring a periodic reevaluation of specifications.

Quality control is the use of techniques and activities to achieve, sustain, and improve the quality of the product or service. It involves integrating the following related techniques and activities:

1. Specifications of what is needed
2. Design of the product or service to meet the specifications
3. Production or installation to meet the full intent of the specifications
4. Inspection to determine conformance to specifications
5. Review of usage to provide information for the revision of specifications if needed

Utilization of these activities provides the customer with the best product or service at the lowest cost. The aim should be continued quality improvement. Statistical quality control (SQC) is the branch of quality control. It is the collection, analysis, and interpretation of data for use in quality control activities. Statistical process control (SPC) and acceptance sampling are the two major parts of SQC. A number of different techniques are needed.

All the planned or systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality is called “quality assurance”. It involves making sure that quality is what it should be. This includes a continuing evaluation of adequacy and effectiveness with a view to having timely corrective measure and feedback initiated where necessary.

1.1.1 History of Quality Control

The history of quality control is undoubtedly as old as industry itself. During the middle age the maintenance of quality was to a large extent controlled by the long periods of training required by the guilds. This training instilled in workers pride for quality of a product.

The concept of specialization of labor was introduced during the Industrial Revolution. As a result, a worker no longer made the entire product, only a portion. This change brought about a decline in workmanship. Because most products manufactured during that early period were not complicated and jobs more specialize, it became necessary to inspect products after manufacture.

In 1924, W.A Shewhart of Bell Telephone Laboratories developed a statistical chart for the control of product variables. This is considered to be the beginning of statistical quality control. Later in the same decade, H.F Dodge and H.G Romig (1924), both of Bell Telephone Laboratories, developed the area of acceptance sampling as a substitute for 100% inspection. Recognition of the value of statistical quality control became apparent by 1942. Unfortunately, American managers failed to recognize its value.

In 1946, the American Society for Quality Control was formed. This organization, through its publications, conference, and training session, has promoted to use of quality control for all type of production and service. In 1960, the first quality control circles were formed for the purpose of quality improvement. Simple statistical techniques were learned and applied by Japanese workers.

In the late 1980s the automotive industry began to emphasize SPC. Suppliers and their suppliers were required to use these techniques. Others industries and the Department of Defense also implemented SPC. In addition a new concept of continuous quality improvement (CQI) emerged, which required total quality management (TQM).

1.2 Problem Statement

Nowadays, in a global world we can see that there is so much software programming to build a system used for daily activities. Software programming is a quite new technology to assist human execute their work especially for a quality improvement.

Today, many company used software programming to build a system for improve their quality production. They had to implement a control charts to solve a process quality problem. But, the problem is they had to implement a control charts by manually whereas it takes time and the result is not accurate. Furthermore, even get control chart software in market, it's quite difficult to use and the interface is not user-friendly.

1.3 Objective

The purposes of this project are to acquaint undergraduate students about a use of control chart. This project also describes how controls charts are develop and construct to be control chart software.

Besides that, this project also to introduce to workers whereas work in an industrial sectors how to use control charts software to improve their production quality. With using this software, they can safe their time and the quality of production can be improved.

1.4 Scope Project

Following is the general scope that is used in developing this project:

1. *Microsoft Excel*

   I will use this software to collect a data and then using that data to construct control charts.
2. *Control Charts*

   I will explain a theory of control chart detailed with together the use.
3. *Visual Basic (6.0)*

I will use this programming to develop control chart software using a data from Microsoft Excel.

1.5 Arrangement of Thesis

This thesis consist five chapters. All chapters are following below:

1. *Chapter One*

   This chapter describes an introduction about quality, history of quality control, quality control tool, control chart and control charts software.
2. *Chapter Two*

   This chapter describes a literature review of a project such as about control chart, control chart software and how control chart approach to software.
3. *Chapter Three*

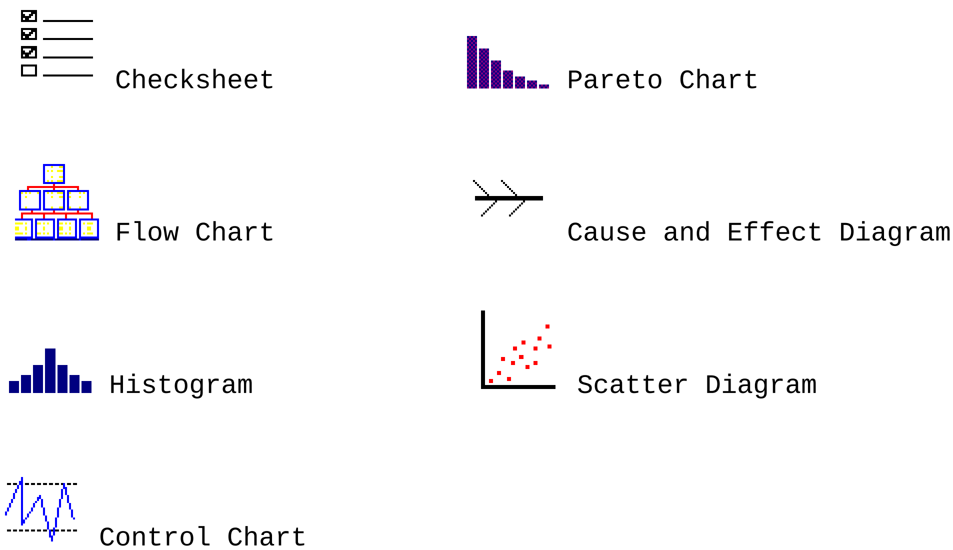
   This chapter describes a methodology of a project. It includes a project flow chart, data collection and control charts.
4. *Chapter Four*

   This chapter describes about software development and programming software chosen.
5. *Chapter Five*

   This chapter describes result and discussion about this project.

1.6 Quality Control Tools

Production environments that utilize modern quality control methods are dependant upon statistical literacy. The tools used therein are called the seven quality control tools. These include:



1.6.1 Checksheet

The function of a checksheet is to present information in an efficient, graphical format. This may be accomplished with a simple listing of items.

1.6.2 Pareto Chart

Pareto charts are extremely useful because they can be used to identify those factors that have the greatest cumulative effect on the system, and thus screen out the less significant factors in an analysis.

1.6.3 Flowchart

Flowcharts are pictorial representations of a process. By breaking the process down into its constituent steps, flowcharts can be useful in identifying where errors are likely to be found in the system.

1.6.4 Cause and Effect Diagram

This diagram, also called an Ishikawa diagram (or fish bone diagram), is used to associate multiple possible causes with a single effect. Thus, given a particular effect, the diagram is constructed to identify and organize possible causes for it.

1.6.5 Histogram

Histograms provide a simple, graphical view of accumulated data, including its dispersion and central tendency. In addition to the ease with which they can be constructed, histograms provide the easiest way to evaluate the distribution of data.

1.6.6 Scatter Diagram

Scatter diagrams are graphical tools that attempt to depict the influence that one variable has on another. A common diagram of this type usually displays points representing the observed value of one variable corresponding to the value of another variable.

1.6.7 Control Chart

The control chart is the fundamental tool of statistical process control, as it indicates the range of variability that is built into a system (known as common cause variation). Thus, it helps determine whether or not a process is operating consistently or if a special cause has occurred to change the process mean or variance.

1.7 Introduction to and Interpretation of Control Charts

What is a control chart?

Control charts are an outstanding technique for problem solving and the resulting quality improvement. Quality improvement occurs in two situations. When a control charts is first introduced, the process usually is unstable. As assignable causes for out-of-control conditions are identified and corrective action taken, process becomes stable, with a resulting quality improvement. The second situation concerns the testing or evaluation of ideas. Control charts are excellent decision makers because the pattern of the plotted points will determine if the idea is a good one, poor one, or has no effect on the process.

1.7.1 Quality and Statistical Process Control

The concept of quality has been with us since the beginning of time. Artisans' and craftsmen's skills and the quality of their work are described throughout history. Typically the quality intrinsic to their products was described by some attribute of the products such as strength, beauty or finish. However, it was not until the advent of the mass production of products that the reproducibility of the size or shape of a product became a quality issue.

Quality, particularly the dimensions of component parts, became a very serious issue because no longer were the parts hand-built and individually fitted until the product worked. Now, the mass-produced part had to function properly in every product built. Quality was obtained by inspecting each part and passing only those that met specifications. This was true until 1931 when Walter Shewhart, a statistician at the Hawthorne plant at Western Electric, published his book Economic Control of Quality of Manufactured Product (Van Nostrand, 1931). This book is the foundation of modern statistical process control (SPC) and provides the basis for the philosophy of total quality management or continuous process improvement for improving processes. With statistical process control, the process is monitored through sampling. Considering the results of the sample, adjustments are made to the process before the process is able to produce defective parts.

1.7.2 Statistical Process Control (SPC)

Statistical process control or (SPC) is a methodology for charting the process and quickly determining when a process is out-of-control. The process is then investigated to determine the root cause of the out-of-control condition. When the root cause of the problem is determined, a strategy is identified to correct it. The investigation and subsequent correction strategy is frequently a team process and one or more of the TQM process improvement tools are used to identify the root cause.

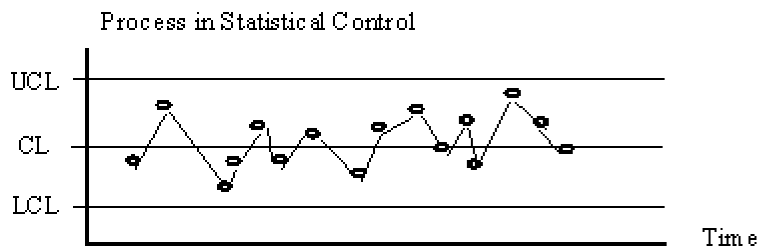


Figure 1: Process in Statistical Control

The process above is in apparent statistical control. Notice that all points lie within the upper control limits (UCL) and the lower control limits (LCL). This process exhibits only common cause variation.

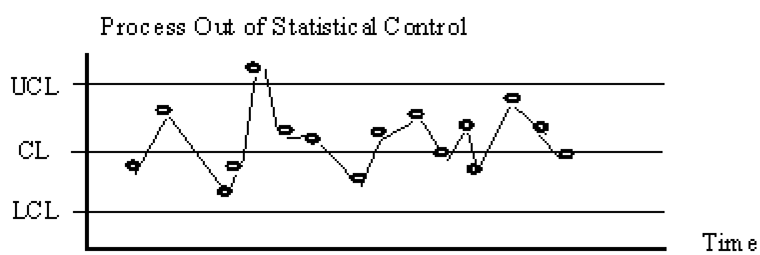


Figure 2: Process is Out-of-Statistical Control

The process above is out of statistical control. Notice that a single point can be found outside the control limits (above them). This small probability means that when a point is found outside the control limits that it is very likely that a source of special cause variation is present and should be isolated and dealt with.

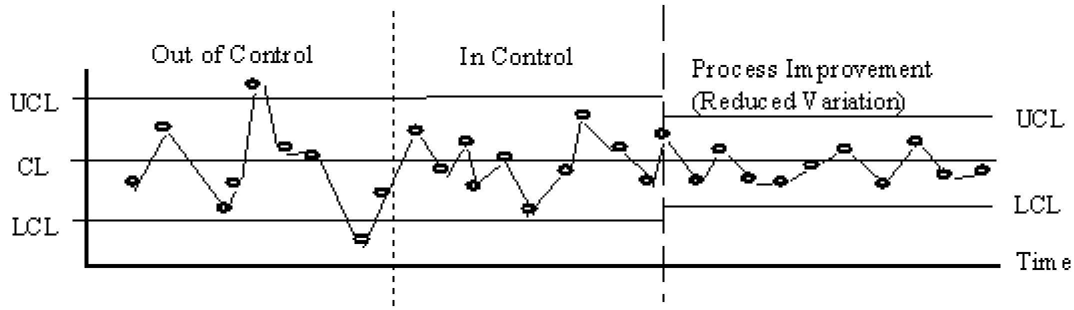


Figure 3: Illustrates the typical cycle in SPC

The graphic above illustrates the typical cycle in SPC. First, the process is highly variable and out of statistical control. Second, as special causes of variation are found, the process comes into statistical control. Finally, through process improvement, variation is reduced. This is seen from the narrowing of the control limits.

1.8 Types of Out-of-Control Conditions

Several types of conditions exist that indicate that a process is out of control. The first of these have seen already having one or more points outside the 3 limits as shown below:

1.8.1 Extreme Point Condition

This process is out of control because a point is either above the UCL or below the UCL.

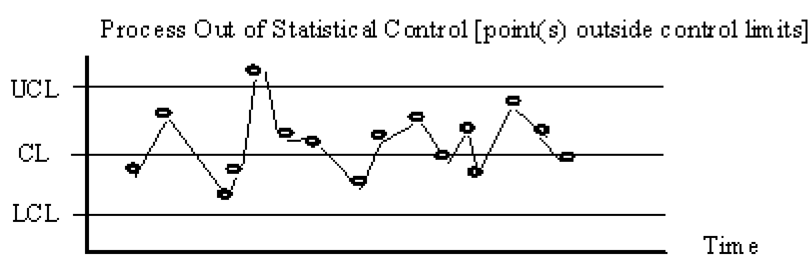


Figure 4: Extreme point condition

1.8.2 Control Chart Zones

Control charts can be broken into three zones, a, b, and c on each side of the process center line.

A series of rules exist that are used to detect conditions in which the process is behaving abnormally to the extent that an out of control condition is declared.

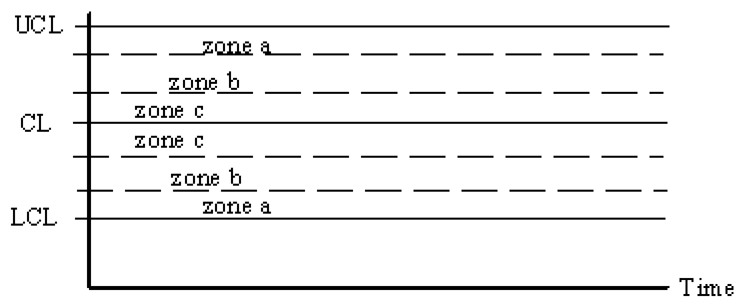


Figure 5: Three consecutive points in zone A or outside zone A

The probability of having two out of three consecutive points either in or beyond zone A is an extremely unlikely occurrence when the process mean follows the normal distribution. Thus, this criteria applies only to $\bar{x}$ charts for examining the process mean.

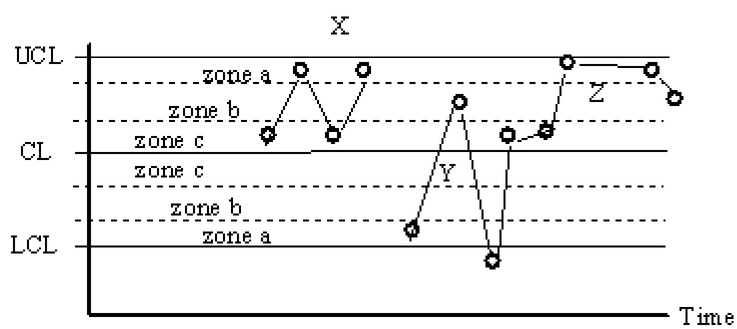


Figure 6: X, Y, and Z are all examples of these phenomena

1.8.3 Four of five consecutive points in zone B or beyond

The probability of having four out of five consecutive points either in or beyond zone B is also an extremely unlikely occurrence when the process mean follows the normal distribution. Again these criteria should only be applied to a $\bar{x}$ chart when analyzing a process mean.

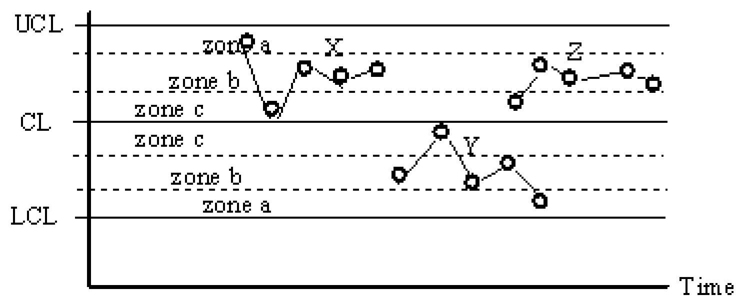


Figure 7: X, Y, and Z are all examples of these phenomena

1.8.4 Runs above or below the centerline

The probability of having long runs (8 or more consecutive points) either above or below the centerline is also an extremely unlikely occurrence when the process follows the normal distribution. This criteria can be applied to both $\bar{x}$ and r charts.

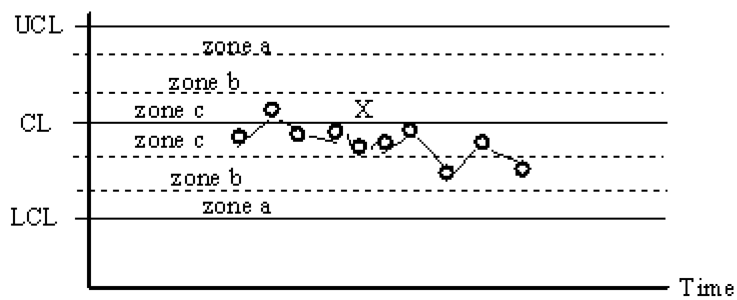


Figure 8: Example X above shows a run below the center line

1.8.5 Linear trends

The probability of 6 or more consecutive points showing a continuous increase or decrease is also an extremely unlikely occurrence when the process follows the normal distribution. This criteria can be applied to both $\bar{x}$ and r charts.

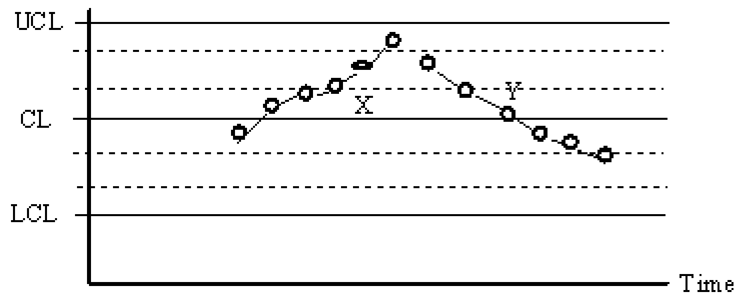


Figure 9: X and Y are both examples of linear trends

X and Y are both examples of trends. Note that the zones play no part in the interpretation of this out of control condition.

1.8.6 Oscillatory Trend

The probability of having 14 or more consecutive points oscillating back and forth is also an extremely unlikely occurrence when the process follows the normal distribution. It also signals an out of control condition. This criteria can be applied to both $\bar{x}$ and r charts.

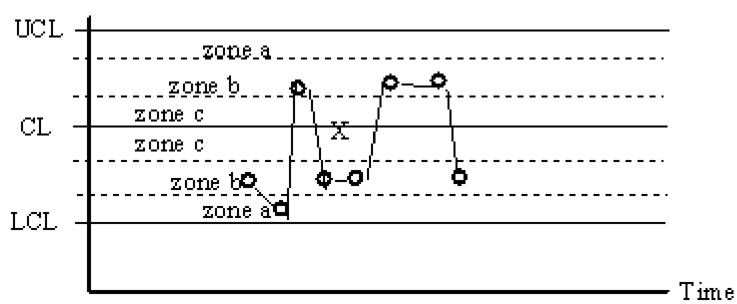


Figure 10: X is an example of this Out-of-Control condition

1.9 Control Charts Software

Control charts software is well known as a way to determine the conditions of a production. Using control charts software, we can determine either a productions is in-control or out-of-control condition. Before this, people had to calculate manually to produce a control chart. Its will take time and but when a control charts software introduced, people can save their time and easy to learn this technology.

On first thought, it would appear that control charts cannot be applied to software because, software cannot be measured. But, when used appropriately in software development process, control charts can indicate potential process problems, although it cannot produce absolute scores and goodness ratings. Control charts is founded on the principle that adhering consistently to the process will produce consistent results in the measurements such as productivity, error rate and cycle time.

Software development is also different from other manufacturing processes, in that the same and identical products are not delivered repeatedly. However, it has to be noted that control charts applies to the process, and not the end product. In any case, non-identical software products require the development of constituent software components that require a common process to build. Hence, the application of control charts as a method for process improvement is justified.

Since software cannot be measured, the fact that there is no perfect measure of the attributes that need to be rated is often a concern. However, since a control chart does not rely on having a perfect measure, the concern is not completely justified. The analysis is meant only to give some insight into how the process is functioning control charts does not have to produce complete visibility.

CHAPTER 2

2.0 Literature Review

2.1 Control Charts

The main purpose of statistical process control (SPC) is to improve the quality and productivity. Statistical process control (SPC) includes control charts, which monitor a process performance, and process capability studies, which measure the process ability of producing items according to specifications (Menezes, 2000). One of the instruments that form quality tool set is the control chart (Felipe, 2004). The Shewhart (or classical) control charts are one of the most efficient statistical process control tool (Laura, 1999).

Control charts are efficient instruments for checking changes or variations in the process. Throughout this tool is intended to get the model, which detects better the variations in the average, when it is necessary to control more sensitive processes (Vera, 2004). There are three kinds of control charts the normal control charts, the parametric control charts as developed for the normal power family and nonparametric control charts (Nurdiati, 2004).

For each type of control charts can be used specific algorithms with respect to the character of data distribution (Clupek, 2004). Simple out of control mechanism are explore by implementing an interactive capability which allows the process to go out of control by a combination of assignable causes such shift or drift of the location (mean), or spread (standard deviation) (Speeding, 2002). Control charts are able to visualize trends and modification and also to compare mutually various data sets, which can be useful in many quality control studies (Volka, 2004).

2.2 Unvaried Control Charts

Control charts can be used to estimate the parameters of the production process and through this information can determine the process capacity (Vaughn, 1990). The goal of statistical process control is to reduce the variability and the control charts are efficient tool to reduce this variability as much as possible (Sauza, 2004).

There is some highlighted reason for the control charts popularity (Vargas, 2004):

- Control charts are proven technique for the improving productivity. A program that uses control charts can reduce waste and the rework, which harm productivity in any operation.

- Control charts prevent unnecessary process adjustment and can distinguish between the common causes and special causes of variation. Unnecessary adjustment can result in a deterioration of the process development.

- Control charts are efficient in preventing faults, helping to keep the process in control. If there is not efficient process, somebody is being paid to produce items of no good quality.

- Control charts provide diagnosis information. The point drawing shape that the control charts gets, will often contain information with diagnosis value for an experienced operator or engineer.

- Control charts produce information about the process capacity, through the value of their parameters and stability about the time. This allows an estimate of the process capacity.

2.3 Cumulative sum Control Charts (cuSum)

The cumulative sum control chart was initially proposed in England and has been studied by many authors. Some of the author outlined many schemes of control charts and the type of process, which the cuSum charts are most appropriate (Ewan, 1963).

Bissle (1969) considered the cuSum method and its relevance to quality control. He proposed extensions of this technique to facilitate its application to practical situations. Dias (2004) presented an approximation of the average run length for cuSum chart to signalize the points out of control. He used an analogy between the procedure of cuSum control charts with independent and identically distributed normal random variables and the procedure for cuSum control charts which did not require the normality assumption.

Hawkins (1981) presented a technique for employing the same cuSum procedure used on mean control for controlling the variance. Beside, Woodall (1985) presented a method for projecting quality control charts on the basis of their statistical performance over specified in control and out of control region of parameter values.

2.4 Statistical Process Control (SPC) Software

During recent years there has been a growing interest and debate in the application of statistical process control (SPC) for improving the quality of software product (Nigel, 1999). Statistical process control has been an area whose fundamentals have not significantly change throughout the years. Although the fundamental of statistical process control did not change, the methodology and technique used to implement statistical process control has been changing due to the developments in computer technology software (Dogdu, 1998).

During the past few years there has been an accelerating interest in the applications of statistical process control (SPC) for improving the quality of software product. However, despite frenzied activity at the analytical advocacy level, with claim and counter claim being made about its use and effectiveness for a software quality improvement to date there have been only a few isolated case studies published on its implementation in the software environment (Nigel, 1999).

Software defects occur throughout the software development life cycle. Defect in the context of software can cause the deviation of a piece of software from customer expectation (Xie, 1999). The quest for solutions to stay competitive in the marketplace brings software industries to take steps to control their products and processes by introducing metrics as part of their quality system and setting triggers for action when their capability limits are exceeded (Hong, 1999).

There are two ways of modeling software defects. One is the statistical process control (SPC) model that involves counting techniques, comparison of historical data and detecting special causes. The other is the cause analysis model that investigates the detail of a few defects (Shanmugan, 1999). These models have the programmers' perspective and are applicable to a wide range of domains, but are human-incentive and lack of integrity (Xie, 1999).

2.5 Statistical Process Control (SPC) Approach to Software

Stott's(1991), discussed the use of Shewhart(classical) control charts for monitoring the defect density (the number of defects discovered in 1000 line of codes) at each stage of the software development process. He also claims that Shewhart control charts are effective tool that can help ensure that software development projects will have a successful conclusion.

Haworth (1996), investigates the used of regression control charts for software maintenance in a medium sized manufacturing firm. Maintenance time, recorded in programmer hours, was identified as the key quality attribute to be monitored. He also suggests maintenance time (MT) is some function of task, skill and the maintainability of source code.

Although statistical process control (SPC) has proved a powerful tool for process understanding and quality improvement in the manufacturing process industries, it is not panacea. For it to be effective in the software environment it need to be operated within a culture of continual improvement driven by measurement (Lewis, 1999).

CHAPTER 3

3.0 Methodology

3.1 Introduction

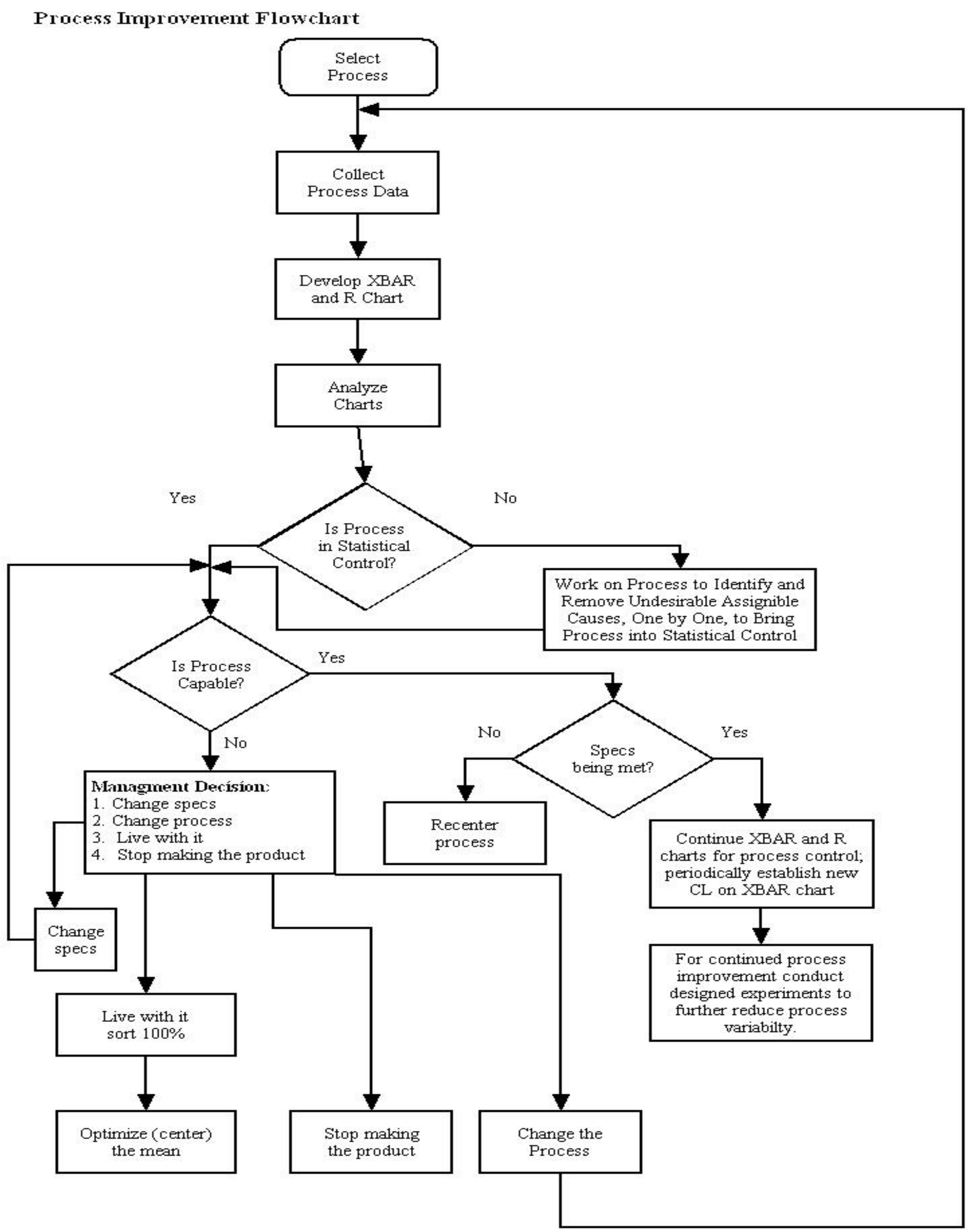
This thesis is introduced how a control charts can be construct to a software programming. First of all, I have to collect a data from experiments or surveys existed in industries. Then, from that data I can construct to a control charts.

In this thesis, I have used Microsoft Excel to construct a control charts and from that control charts I have used Visual Basic 6.0 programming to developed control charts software. Actually, there is many programming software can be use to developed a control charts software, but in this thesis I have choose a Visual Basic 6.0 programming. Users easy to use this software compare if this software is coding in another programming software such as, Matlab, C++, Lab View, Java, Cobol, Fortran and so on.

Besides, this software is easier to develop and the interface of this software is more users friendly. Users can just click a button to go anywhere in an interface and also can make a choices what they want in an interface.

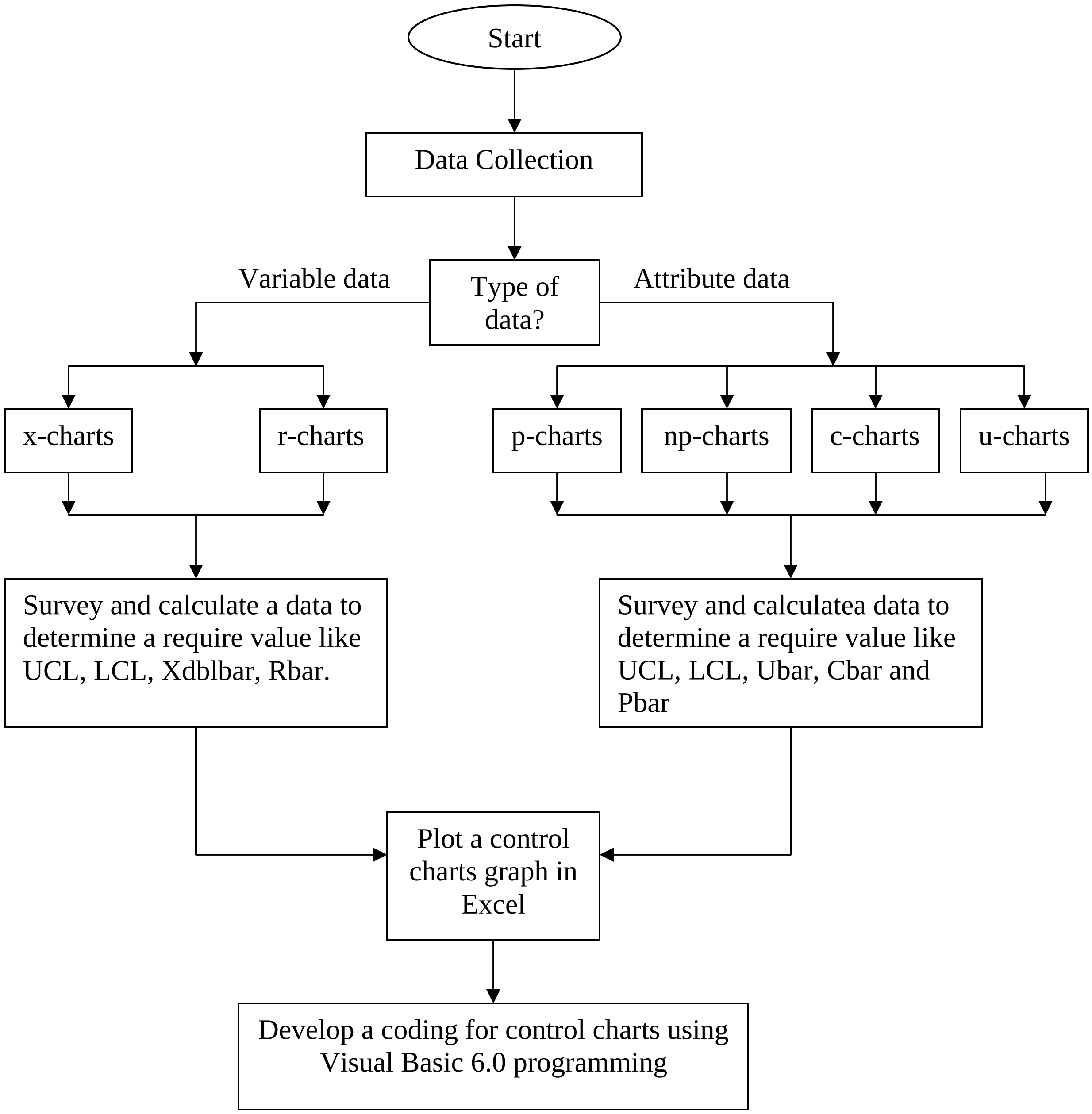
3.2 Flow Chart

Flow chart is an important diagram if we need to execute any process. Flow chart show the flow of a product or services as it moves through the various processing stations. Below is an example of process improvement flow chart:



3.2.1 Project Flow Chart

In this thesis, I am following below flow charts to develop software of control charts. This flow chart describe how the software of control charts can be construct from a data collection until a software development:



3.3 Data Collection

In this thesis, I have use a data were it is collect from experiments and surveys existed in industries. This data was collected by Prof. Sid Sytsma (1999) from Ferris State University. All the data then I construct to a control charts using a Microsoft Excel.

Actually there are two types of control charts. Firstly is a variable control chart and secondly is an attribute control chart. Below is a data for variable and attribute control charts.

3.4 Variable Control Charts

There is some type of variable control charts such as median chart, individuals chart and exponentially weighted moving average (EWMA) chart. But what I focus in my thesis is R-chart and XBAR-chart. It is because this control chart is very familiar and the common chart that used for variable control chart.

Although theoretically possible, since we do not know either the population process mean or standard deviation, these formulas cannot be used directly and both must be estimated from the process itself. First the R-chart is constructed. If the R-chart validates that the process variation is in statistical control, the XBAR-chart is constructed.

Theoretical control limits for XBAR-charts:

$$UCL = \mu + \frac{3\sigma}{\sqrt{n}}$$

$$LCL = \mu - \frac{3\sigma}{\sqrt{n}}$$

3.4.1 R-chart

Steps for constructing an R-chart:

1. Select k successive subgroups where k is at least 20, in which there are n measurements in each subgroup. Typically n is between 1 and 9. 3, 4, or 5 measurements per subgroup are quite common.
2. Find the range of each subgroup R(i) where R(i)=biggest value - smallest value for each subgroup i.
3. Find the centerline for the R-chart, denoted by

$$RBAR = \frac{1}{k}\sum R(i)$$

4. Find the UCL and LCL with the following formulas: UCL= D(4)RBAR and LCL=D(3)RBAR with D(3) and D(4) can be found in the following table:

Table 1: Table of D(3) and D(4)

n	D(3)	D(4)	n	D(3)	D(4)
2	0	3.267	6	0	2.004
3	0	2.574	7	0.076	1.924
4	0	2.282	8	0.136	1.864
5	0	2.114	9	0.184	1.816

5. Plot the subgroup data and determine if the process is in statistical control.

6. Once the R-chart is in a state of statistical control and the centerline RBAR can be considered a reliable estimate of the range, the process standard deviation can be estimated using:

$$\hat{\sigma} = \frac{RBAR}{d(2)}$$