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Review on Statistical Quality Control

Hima Tiby[1], Nandana S Nair[2], Siji Antony[3]
Student, Department of Computer Science, Santhigiri College, Thodupuzha, India[1, 2]
Faculty, Department of Computer Science, Santhigiri College, Thodupuzha, India[3]

Abstract: *Statistical quality control, the use of statistical methods in the monitoring and maintaining of the quality of products and services. The method, referred to as acceptance sampling, can be used when a decision must be made to accept or reject a group of parts or items based on the quality found in a sample. A second method, referred to as statistical process control, uses graphical displays known as control charts to determine whether a process should be continued or should be adjusted to achieve the desired quality.*

Keywords: Statistical Quality Control, SQC, Statistics, Quality, Product, Control Charts, etc.

I. INTRODUCTION

SQC was pioneered by Walter A. Shewart at Bell Laboratories in the early 1920s. Statistical quality control provides offline tools to support analysis and decision making to help determine if a process is stable and predictable. Shewhart developed the control chart of a state of statistical control. He consulted with Colonel Leslie E. Simon in the application of control charts to munitions manufacture at the Army's Picatinny Arsenal in 1934. Statistical quality control, the use of statistical methods in the monitoring and maintaining of the quality of products and services. It is the means of establishing and achieving quality specifications.

II. STATISTICAL QUALITY CONTROL

Statistica1 quality control (SQC) is the term used to describe the set of statistical tools used by quality professionals. Statistical quality control can be divided into three broad categories:

1. Descriptive statistics that are used to describe the quality characteristics and relationships. Included are the statistics such as the mean, the standard deviation, the range, and a measure of the distribution of data.
2. Statistical process control (SPC) involves inspecting a random sample of the output from a process and deciding whether the process is producing products with characteristics that fall within a predetermined range. SPC answers the question of whether the process is functioning properly.
3. Acceptance sampling is the process of randomly inspecting a sample of goods and deciding whether to accept the entire lot based on the results. Acceptance sampling determines whether a batch of goods should be accepted or rejected. The tools in each of these categories provide different types of information for use in analysing quality.

All three of these statistical quality control categories help measure and evaluate the quality of products or services. However, statistical process control (SPC) tools are used most frequently because they identify the quality problems during the production process.No production process is good enough to produce all items exactly alike.

Variation in the production process leads to quality defects and a lack of product consistency. The Intel Corporation, the world's largest and most profitable manufacturer of microprocessors, understands this. Therefore, Intel has implemented a program called"Copy-exactly" at all its manufacturing facilities. The idea is that regardless of whether the chips are made in Arizona, New Mexico, Ireland, or any of its other plants, they are made the same.

III. SOURCES OF VARIATION

A. Common Cause

If you look at bottles of soft drinks in a grocery store, you will notice that no two bottles are filled to the same level. Some are filled slightly higher and some are slightly lower. Similarly, if you look at blueberry muffins in a bakery, you will notice that some are slightly larger than others and some have more blueberries than others. These types of differences are completely normal. No two products are exactly alike because of slight differences in materials, workers, machines, tools, and other factors. These are called common, or random, causes of variation. Common causes of variation are based on random causes that we cannot identify. These types of variation are unavoidable and are due to slight differences in processing.

B. Assignable Cause

The second type of variation that can be observed involves those where the causes can be precisely identified and eliminated. These are called assignable causes of variation. Examples of this type of variation are poor quality in raw materials, an employee who needs more training, or a machine in need of repair. In each of these examples, the problem can be identified and corrected. If the variation is allowed to persist, it will continue to create a problem in the quality of the product. In the example of the soft-drink bottling operation, bottles filled with 15.6 ounces of liquid would signal a problem. The machine may need to be readjusted, an assignable cause of variation. We can assign the variation to a particular cause and we can correct the problem.

C. Descriptive Statistics

Descriptive statistics can help describe certain characteristics of a product and a process. The most important descriptive statistics are measures of central tendency such as the mean, measures of variability such as the standard deviation and range, and measures of the distribution of data.

The Mean: The arithmetic average, or the mean, is a statistic that measures the central tendency of a set of data. Knowing the central point of a set of data is highly important. To compute the mean, we simply sum all the observations and divide them by the total number of observations.

The Range and Standard Deviation: Two measures can be used to determine the amount of variation in the data. The first measure is the range, which is the difference between the largest and smallest observations. Another measure of variation is the standard deviation.

D. Techniques of Statistical Quality Control

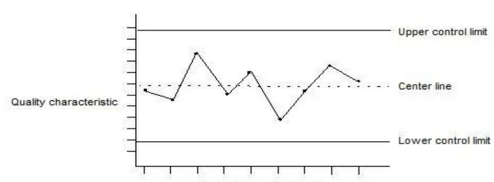
Statistical process control is done in two ways:

1. Process control
2. Product control

The main objective of any production process is to control and maintain a satisfactory quality level for its product. It should not contain a large number of defective items. This is termed as process control. Product control we mean controlling the quality of the product by critical examination at strategic points which is achieved through 'Sampling Inspection Plans'.

Developing the Control Charts

A control chart is a graph that shows whether a sample of data falls within the common or normal range of variation. A control chart has upper and lower control limits that separate common and assignable causes of variation. The common range of variation is defined by the use of control chart limits. We say that a process is out of control when a plot of data reveals that one or more samples fall outside the control limits.



E. Control Chart for Variables

Control charts for variables monitor characteristics that can be measured and have a continuous scale, such as height, weight, volume, or width. When an item is inspected, the variable being monitored is measured and recorded. For example, if we are producing candles, height might be an important variable, so we could take samples of candles and measure their heights. Two of the most commonly used control charts for variables monitor both the central tendency of the data (the mean) and the variability of the data. Note that each chart monitors a different type of information. When observed values go outside the control limits, the process is assumed not to be in control. Production is stopped, and employees attempt to identify the cause of the problem and correct it.

Mean (x-Bar) Charts: A mean control chart is often referred to as an x-bar chart. It is used to monitor changes in the mean of a process. To construct a mean chart, we first need to construct the centre line of the chart. To do this we take multiple samples and compute their means. Usually, these samples are small, with about four or five observations.

Range (R) Charts: Range (R) Charts are another type of control chart for variables. Whereas x-bar charts measure a shift in the central tendency of the process, range charts monitor the dispersion or variability of the process. The method for developing and using R-charts is the same as that for x-bar charts.

Using Mean and Range Charts Together

The mean and range charts are used to monitor different variables. The mean or x-bar chart measures the central tendency of the process, whereas the range chart measures the dispersion or variance of the process. Since both variables are important, it makes sense to monitor a process using both mean and range charts. It is possible to have a shift in the mean of the product but not a change in the dispersion.

F. Control Charts for Attributes

Control charts for attributes are used for quality characteristics that are counted rather than measured. Attributes are discrete in nature and entail simple yes-or-no decisions, for example, the number of non-functioning light bulbs, the proportion of broken eggs in a carton, the number of rotten apples, the number of scratches on a tile, or the number of complaints received. Two of the most common types of control charts for attributes are p-charts and c-charts.

P-charts: P-charts are used to measure the proportion that is defective in a sample. The computation of the centre line, as well as the upper and lower control limits, is similar to the computation for the other kinds of control charts. The centre line is computed as the average proportion defective in the population, this is obtained by taking several sample observations at random and computing the average value of p across all samples.

C-charts: C-charts are used to monitor the number of defects per unit. Examples are the number of returned meals in a restaurant, the number of trucks that exceed their weight limit in a month, the number of discolorations on a square foot of carpet, and the number of bacteria in a milli litre of water. Note that the types of units of measurement we are considering are a period, a surface area, or a volume of liquid. The average number of defects is the centre line of the control chart.

G. Process Capability

A critical aspect of statistical quality control is evaluating the ability of a production process to meet or exceed pre-set specifications. This is called process capability. Product specifications, often called tolerances, are pre-set ranges of acceptable quality characteristics, such as product dimensions. For a product to be considered acceptable, its characteristics must fall within this pre-set range. Otherwise, the product is not acceptable.

H. Advantages of Statistical Quality Control

1. Cost Reduction: In this method, only a fragmentary output is inspected to ensure the quality of the product, therefore probe cost would be reduced greatly.
2. Huge efficiency: Inspection of a fractional portion requires lesser time and tedium in comparison to the holistic investigation leading to a huge escalation in efficiency and production.

3. Easier to use: Pitching SQC not only reduces process variability but also makes the process of production in control. Even, it is much to apply by an individual without having such extensive specialized guidance.
4. Authentic anticipation: SQC is the most preeminent approach that can accurately predict future production. To ensure the degree of perfection and product performance, SQC provides great predictability.
5. Prior fault detection: Any deviation from standard control limits depicts signs of danger in the underlying production process that invites necessary corrective measures to be taken earlier. SQC is helpful in the early detection of faults.

I. Limitations of Statistical Quality Control

1. When a sample of the items drawn from the lot is not a true representative of the entire lot and does not have the same characteristics as the lot from which it is drawn. Then a good lot may be rejected and a bad one may be accepted. This is the main limitation of SQC.
2. SQC cannot be used mechanically for any production process without studying the process and without having adequate knowledge about the process.
3. SQC applied to a production process provides only the information that the process is under control or out of control. It cannot take any action for improvement.

J. Conclusion

Statistical quality control techniques are extremely important for operating the estimable variations embedded in almost all manufacturing processes. SQC has turned out to be a vital platform as a business operation that is deployed to enhance productivity and sustain competitive advantages. The method reflects a systematic approach of efficient statistically-oriented experimentation particularly in terms of characterization, optimization, and sample acceptance along with ensuring active determination/inspection of the deployment process concerning real-world applications.

IV. CONCLUSION

Statistical quality control techniques are extremely important for operating the estimable variations embedded in almost all manufacturing processes. SQC has turned out to be a vital platform as a business operation that is deployed to enhance productivity and sustain competitive advantages. The method reflects a systematic approach of efficient statistically-oriented experimentation particularly in terms of characterization, optimization, and sample acceptance along with ensuring active determination/inspection of the deployment process concerning real-world applications.

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