c and u Control Charts

On occasion, there is a customer complaint. Sometimes someone gets injured on the job. Sometimes hospital patients get infections.   These situations are examining counting type attributes data. Each count (customer complaint, injury, or infection) is considered a defect. These types of situations are often governed by attributes data. c and u control charts are two types of attribute control charts that can be used to monitor and improve these types of processes. Both these charts track the variation in counting type attributes data.

Purpose

The purpose of this module is to introduce c and u control charts - what they are, when they can be used, how to construct them and how to interpret both charts. In addition, the small sample case for c and u control charts is introduced. The c and u control charts tell you if the process is in statistical control or if there are special causes present.

Attributes Data and Control Charts

We sometimes collect data that involves counts; for example, the number of injuries in a plant, the number of mistakes on an invoice, whether a delivery is on-time or not or whether a product is in specification or not. These types of data are called attributes data. There are two types of attributes data: *yes/no* and *counting* type. With yes/no data, you are examining distinct items (such as invoices, deliveries, or phone calls). With counting type data, you are usually examining an area where a defect has an opportunity to occur. Both types of data are explained below.

Yes/No Data

For each item, there are only two possible outcomes: either it passes or it fails some preset specification. Each item inspected is either defective (i.e., it does not meet the specifications) or is not defective (i.e., it meets specifications). Examples of the yes/no data are phone answered/not answered, product in spec/not in spec, shipment on time/not on time and invoice correct/incorrect.

If you have yes/no data, you will use either a p or np control chart to examine the variation in the fraction of items not meeting (or meeting) a preset specification in a group of items. You would use a p control chart if the subgroup size (the number of items examined in a given time period) changes over time. You would use the np control chart if the subgroup size stays the same.

Counting Data

With counting data, you count the number of defects. A defect occurs when something does not meet a preset specification. It does not mean that the item itself is defective. For example, a television set can have a scratched cabinet (a defect) but still work properly. When looking at counting data, you have whole numbers such as 0, 1, 2, 3; you can't have half of a count.

If you have counting data, you will use a c or u control chart. The c control chart is used if the area stayed constant from sample to sample; the u control chart is used if the area did not stay constant.

If you don't have data based on counts, you have variables data. Variables data are taken from a continuum and are often referred to as continuous. Variables data can, theoretically, be measured to any precision you like. Examples of variables data include time, length, width, density, dollars, and height.

Understanding c and u Control Charts

Both the c and u control charts are used to look at variation in counting type attributes data. They are used to determine the variation in the number of defects in a subgroup. The subgroup size usually refers to the area being examined. For example, a c control chart can be used to monitor the number of injuries in a plant. In this case, the plant is the subgroup. If the subgroup size remains constant, the c control chart is used. If the subgroup size varies, the u control chart is used.

You will often use a c or u control chart if the item is complex in nature. For example, it does not make much sense to characterize something like a television set, a car, or a computer as being defective or not defective. For example, a television set may have a scratch on the surface, but that defect hardly makes the television set defective. The real issue here is how many defects there are on the television set.

Rating items as defective or not defective is also not very useful if the item is continuous. For example, suppose you are making a plastic sheet. The fact that the sheet has a small defect such as a bubble or blemish on it does not make it defective. However, if there are too many bubbles, the sheet may not be useful for its intended purpose.

For example, suppose you make plastic sheets that are used for sheet protectors. Bubbles on the plastic sheet are considered defects. You can monitor the number of bubbles over time by counting the number of bubbles on one plastic sheet. The plastic sheet is the area of opportunity for defects to occur. The number of bubbles is the number of defects (c).

A defect occurs when something does not meet a preset specification. It does not mean that the item itself is defective. When looking at counting data, you end up with whole numbers such as 0, 1, 2, 3; you can't have half of a defect. Thus, with the plastic sheet example, you will have 1 bubble, 2 bubbles, etc.

There are two ways to track this counting type data, depending on what you are plotting and whether or not the area of opportunity for defects to occur is constant.

The c control chart plots the number of defects (c) over time. The area of opportunity must be the same over time. This means that you use the same size sheet each time you are counting the bubbles in the sheet.

The u control chart plots the number of defects per inspection unit (c/n) over time. The area of opportunity can vary over time. This means that you can vary the number of sheets or the area examined for bubbles each time.

There are four conditions that must be met to use a c or u control chart. These are listed in Advanced Topics in Statistical Process Control (Dr. Wheeler, www.spcpress.com) as follows:

Counting Data
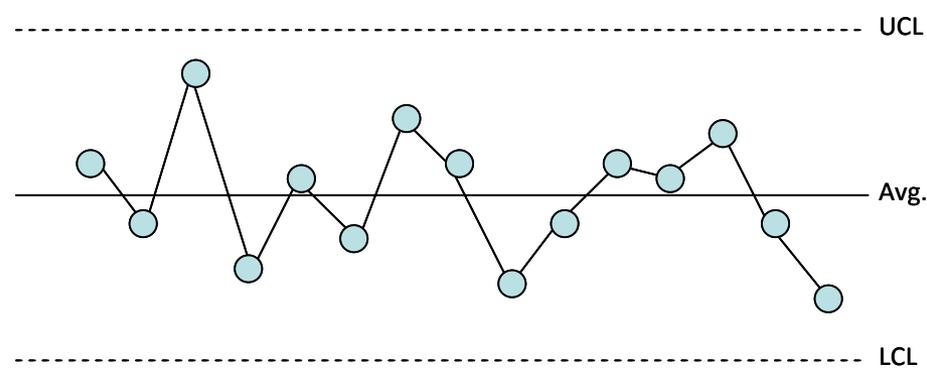
c and u Control Charts

"Our customers should take joy in our products and services."

- Dr. W. Edwards Deming

c and u Control Charts

- Rare Events
  - Customer complaints
  - Injuries
  - Infections

- Defects

- Attributes Control Charts
  - c and c control charts
  - Counting data

Counting
Attributes Data

c or u
Control Chart