Process Capability

Your process is in statistical control with respect to a key output variable. It could be purity of a chemical, hardness of a steel tube, or a key part dimension. You have worked hard at getting rid of the special causes of variation. Now only common causes are present most of the time. Your process is consistent and predictable. Now for the key question:

Is your process capable of meeting specifications?

Specifications most often come from a customer. They are often, but not always, two sided - an upper specification limit and a lower specification limit. The customer assumes they will be happy as long as the product is within the specifications. But a specification could also be an internally assigned specification or target. For example, maybe your company's goal is to close the books within three days of month-end. That is a specification. This module introduces process capability. Process capability is designed to answer the question posed above.

Purpose

The purpose of this module is to introduce process capability including the definition of process capability for attributes data, the definition of process capability for variables data, and how to calculate process capability (Cp, Cpk, Pp and Ppk). Process improvement is not bringing a process into statistical control.

Bringing a process into statistical control is putting the process where it should be. Once the process is in statistical control, real efforts at process improvement can begin. Process capability is one method of measuring the effectiveness of a process in meeting standards or customer specifications as well as measuring process improvement efforts.

Types of Data Review

Control charts and process capability go together. You can't perform a process capability analysis unless your process is in statistical control, i.e., consistent and predictable. If your process in not in statistical control, you can't be sure of getting similar results for process capability in the future. The type of control chart you use and process capability you calculated depend on the type of data you have. So, we start with a review of types of data.

Attributes Data

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

With yes/no data, you are examining distinct items. 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 usually in an area. 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 stays constant from sample to sample; the u control chart is used if the area did not stay constant.

Variables Data

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. With variables data, you will usually use $\overline{X}$-R control charts, $\overline{X}$-s control charts or X-mR control charts.

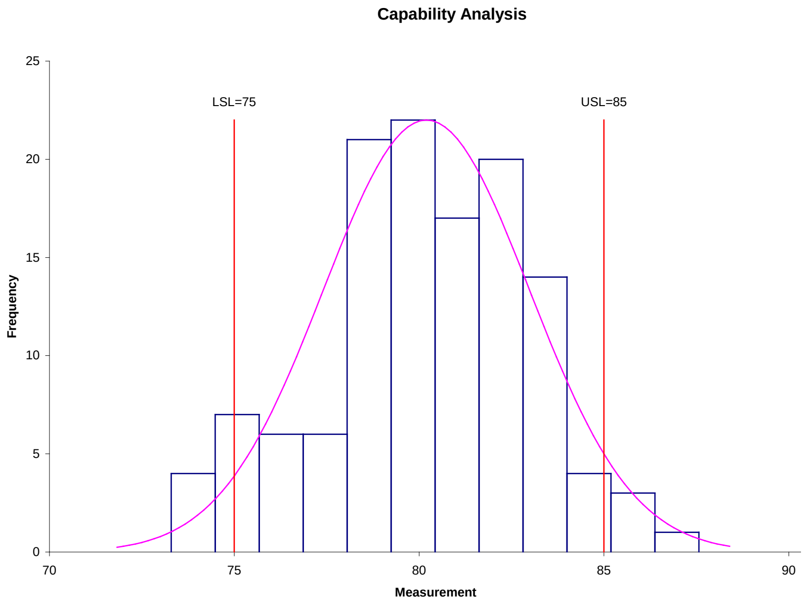
Process Capability for Attributes Data

For attributes data, the process capability is defined as the average on the control chart.

For the p chart, the average fraction defective is the process capability (assuming the process is in control). For example, if you are monitoring the percentage of on-time deliveries and the average percentage on time ($\overline{p}$) is 95%, then your process is capable of 95% on-time deliveries. If you are monitoring the number of customer complaints per month using a c chart, the process capability is defined as the average number of complaints ($\overline{c}$) per month. If $\overline{c}$ is 3, then your process is capable of producing 3 customer complaints per month.

When dealing with attributes data, there must always be defective items or defects. If there are never any defective items, late shipments for example, attribute control charts will not help you continuously improve. As the quality of processes improves, the real challenge is how to use variables data where

PROCESS CAPABILITY

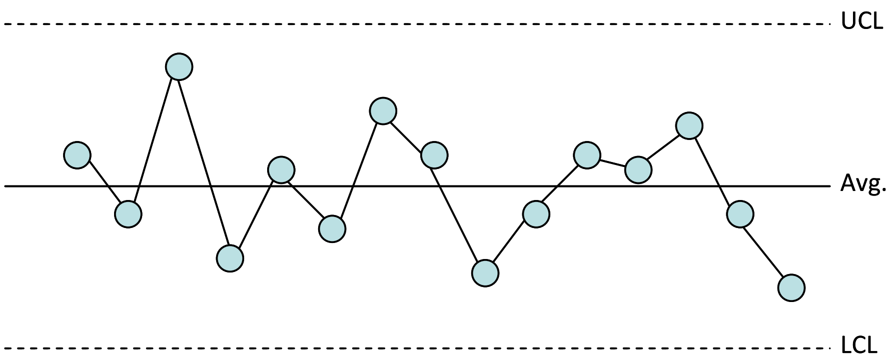


Quality is for the Customer

-W. Edwards Deming

Introduction

- Process in control
- Only common causes present
- Consistent and predictable
- Question:



Is your process capable of meeting specifications?