SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

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DEPARTMENT OF COMPUTER SCIENCE AND TECHNOLOGY

COURSE NAME : 19OE114 –TOTAL QUALITY MANAGEMENT

III YEAR / VI SEMESTER

Unit 4 - TQM TOOLS & TECHNIQUESII

PROCESS CAPABILITY

Process capability

Specification & Control (tolerance) limits

:- they are often used interchangeably

Defined as :

Limits that defines conformance boundaries for an individual unit of a manufacturing or service operations.

Specification limit	Control (tolerance) limit
They are more appropriate for categorizing materials ,products or services in terms of stated requirements	generally preferred in evaluating the manufacturing or service requirements
They are influenced by need of the customer	They are determined by condition of process and its natural variability
Specifications includes all requirements	Tolerances pertains to physical requirements

e.g. one specification for building crane is a hoist load of 5000 +300kg. to satisfy this criterion the diameter of steel cable has to be 4 ± 0.2 cm
When cable is manufactured then capability of process decides the tolerances like 4.01 ± 0.21cm
General tolerance are of subset of specification

Process capability

Presents

1) Performance of a process in a state of statistical control
2) It is measure of uniformity of a quality characteristics of interests
3) a common measure of process capability is given by $\sigma 6$, which is also called the process spread

Benefits of process capability analysis:

1) Uniformity of output
2) Maintained or improved quality
3) Product or process design facilitated
4) Assistance in vendor selection and control
5) Reduction in total cost.

Process capability indices

1) They used to determine whether the given natural variation is in capable of meeting standard specification or not
2) It is also measure of manufacturability of the product with the given process
3) They can be used to compare product /process matches and identify poorest which can be later targeted for improvement.

Cp Index

A common measure for describing the potential of a process to meet specifications.

It relates the allowable spread of the specifications limits(difference between USL & LSL) to the measure of actual or natural variation of process, represented by six sigma

$$\text{Process capability index} = \frac{USL - LSL}{\sigma\, 6}$$

Processes are evaluated by using Cp as given

Cp value	Evaluation	Action
Cp < 0.67	Very insufficient capability	Quality not satisfactory , standards and process needs immediate review
0.67 < Cp < 1.00	Insufficient capability	Rejection presents,100 % inspection ,process needs improvement
1.00 < Cp < 1.33	Moderate capability	Process control has to be firm, when Cp is less than one rejection occur
1.33 < Cp < 1.67	Sufficient capability	Ideal condition , maintain it
1.67 < Cp	Too much capability	No concern of measure in product variation , consider process simplification & cost reduction.

Upper & Lower capability indices

Suppose only a single specification limit is given indices can be derived that measure the shifts in the process mean relative to process spread

For a given upper specification limit

Upper capability index = CPU = $\frac{USL - Xbar}{3\sigma}$

It is desirable to have CPU ≥ 1

For CPU =1, only 0.13 % products fall above USL, similarly

For lower specification limit

CPL= $\frac{Xbar - LSL}{3\sigma}$

It is desirable to have CPL ≥ 1

For CPL =1, only 0.13 % products fall below USL

CPU & CPL :

They are useful in evaluating the process performance relation to the specification limlits.

Cpk index: -

The process variability is not the only measure of ability to produce a conforming product , the location of process mean is another parameter the index that accounts for this location is the Cpk index.

is used when process is not at the target value.

Cpk incorporates both the mean & standard deviation to measure the process performance.

$$Cpk = \min\left\{\frac{USL - Xbar}{3\sigma}, \frac{Xbar - LSL}{3\sigma}\right\}$$

$$= \min\{ CPU , CPL\}$$

desirable value are $Cpk \geq 1$

Cp	Cpk
Measure of process potential	Measure of actual process performance
Does not change as process mean change	Changes as process mean changes
$Cp \geq 1$ desirable	$Cpk \geq 1$ desirable
$Cp < 1$ Process is not capable	$Cpk < 1$ performance of process is poor

Ppk

Ppk is **an index of process performance which tells how well a system is meeting specifications** . ... If Ppk is 1.0, the system is producing 99.73% of its output within specifications. The larger the Ppk, the less the variation between process output and specifications.

So the key takeaway is that **Cpk is the potential of a process to meet a specification** (short term) while Ppk is how the process actually did (long term). Another way to look at the difference is that Cpk is used for a subgroup of data, while Ppk is used for the whole process.

Process Mean close to USL

If your Process Mean (central tendency) is closer to the USL, use: **Ppk** = [USL – x(bar)] / 3 s, where x(bar) is the Process Mean.

Another way to look at the difference is that **Cpk** is **used** for a subgroup of data, while **Ppk** is **used** for the whole process.

Cpk is typically **used** while processing in the ideal conditions to identify if the process is capable of meeting the specifications.

If we look at the formulas for **Cpk** and **Ppk** for normal (distribution) process capability, we can see they are nearly identical: The only **difference** lies **in the** denominator for the Upper and Lower statistics:

Cpk is calculated using the WITHIN standard deviation,

while **Ppk** uses the OVERALL standard deviation

Cpk is sometimes referred to as the **short-term capability**. With **Ppk**, the calculated standard deviation is used. This includes all the data at one time in the calculation.

Ppk is sometimes called the **long-term capability**.