Quality Control & Reliability

Slides prepared

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Definitions

- Quality: Quality can be defined as a property or characteristic of the produced material.
- Control:is a set of procedures leading to obtain more information regarding the work or something specific to a target.
- Quality Control: is a set of activities intended to ensure that quality requirements are actually being met.

Control Charts:

Control Chart : A graphical record of the variation in quality of a particular characteristics during a specified time period.

- Why Use a Control Chart?

  To monitor, control, and improve process performance over time by studying variation and its source.

Quality Characteristics

Quality characteristics divided into two parts :

:

- **Measurable Characteristics**

The characteristics that can be quantified (measurable) also called structural characteristics such as (length, weight, temperature, size, etc).

- **Immeasurable Characteristics**

The characteristics that can not be measured in units of measurement also called sensory characteristics such as (color, taste, smell, etc).

Variable Control Charts

I. **Variable quality Control Charts**

These charts are used in the process of controlling and monitoring the quality of products. If the characteristics of the produced product is measurable.

Individual Values - Chart

This chart is used to control the quality of the product. The target line for this chart represents the over all average ($T = \bar{x}$) for all observations of the same process . The (upper and lower) control limits are put at (±3σ) from the target line, as shown by the following formulas:

$$UCL = \bar{x} + 3\hat{\sigma}_x$$
$$LCL = \bar{x} - 3\hat{\sigma}_x$$

where

$(\hat{\sigma}_x)$ represents the standard division for all observations and calculated by the following formula:

$$\hat{\sigma}_x = \sqrt{\frac{\sum_{i=1}^{n} x_i^2 - n\bar{x}^2}{(n-1) or (n)}}$$

XBar- Chart

This chart is used to control mean of produced product. The central line is $\overline{\overline{X}}$, the sum of a number of sample mean divided by the number of samples.

$$\overline{\overline{X}} = \frac{\sum_{j=1}^{m} \overline{x}_j}{m}$$

Where:

$\overline{\overline{X}}$ = Average of the sample mean.

$\overline{x}_j$ = Average of the subgroup.

m = Number of samples (subgroup)

control limits for xbar charts is

$$UCL = \bar{\bar{x}} + 3\hat{\sigma}_{\bar{x}} = \bar{\bar{x}} + A_2\bar{R}$$

$$LCL = \bar{\bar{x}} - 3\hat{\sigma}_{\bar{x}} = \bar{\bar{x}} - A_2\bar{R}$$

$$\hat{\sigma}_{\bar{x}} = \sqrt{\frac{\sum_{i=1}^{m} \bar{x}_i^2 - m\bar{\bar{x}}^2}{(m-1)}}$$

Where:

The constant A_2 is tabulated value and dependent on sample size.

R- Chart

This chart controls the process variability since the sample range is related to the process standard deviation. When the sample size is relatively small (less than 10), the center line of the R chart is the average range.

The central line is the average range $\bar{R}$ the sum of a number of sample range collected while the process was considered to be “in control” divided by the number of samples. Calculated as:

$$\bar{R} = \frac{\sum_{j=1}^{m} \overline{R_i}}{m}$$

$\sigma - chart$

This chart used to monitor the spread of the quality characteristic. When the sample size is relatively big (say equal to or greater than 10) .The target line & control limits are:

$$T = \overline{\hat{\sigma}} = \frac{\sum_{i=1}^{n} \hat{\sigma}_i}{m}$$

- The lower control limit is

$$LCL = \overline{\hat{\sigma}} - 3\hat{\sigma}_{\hat{\sigma}}$$

- The upper control limit is

$$UCL = \overline{\hat{\sigma}} + 3\hat{\sigma}_{\hat{\sigma}}$$

$$\hat{\sigma}_{\hat{\sigma}} = \sqrt{\frac{\sum_{i=1}^{n} \hat{\sigma}_i^2 - n\overline{\hat{\sigma}}^2}{(n-1) or (n)}}$$

The point plotting values are the standard devotion of the subgroup.

Control Charts for Attributes

- For variables that are categorical

  Good/bad, yes/no, acceptable/unacceptable
- Measurement is typically counting defectives
- Charts may measure:
  1. Percent defective (p-chart)
  2. Number of defects (c-chart)

Reliability

- Qualitative Reliability
- Quantitative Reliability
- Probability
- P = number of successes / total number

$$R(t) = p(T > t)$$

$$R(t) = \int_t^{\infty} f(s)\,ds$$

R(t) = 1- F(t)

R(t) + Q(t) = 1

Q(t) unreliability function

Probability of Failure f(t)

Hazard Function z(t)

Empirical Reliability

Examples :

Mean Time to Failure (MTTF)

Mean Time Between Failure (MTBF)

Examples :

Reliability of System

- Connection in series
- Two – unity cases
- Example
- Generalization
- Examples

Connection in parallel

Two – unity cases

Example

Generalization

Example

Mixed connection

Series parallel

Examples

Parallel series

Examples