Quality Control

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Dep. Statistics & information

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Quality Control Charts

- The control chart was invented by Walter A. Shewhart while working for Bell Labs in the 1920s. quality control charts represent one of the most important scientific techniques and well known to control the quality of products (medical, industrial, food , etc). The main purpose to produce high quality product and satisfy the required standards, also to detect any significant deviation and then to remove them if any exist.

where μ and σ are constants and σ > 0. $f(X)$ has two parameters μ and σ. The normal distribution with these parameters can be denoted by N (μ, σ 2).

The normal distribution can be completely specified by two parameters:

- Mean
- Standard deviation

Objective of Control Charts

- For quality improvement
- To determine the process capability
- For decisions in regard to product specifications
- For current decisions in regard to the production process
- For current decisions in regard to recently produced items

Quality control charts consist of three straight lines and parallel to the horizontal axis:

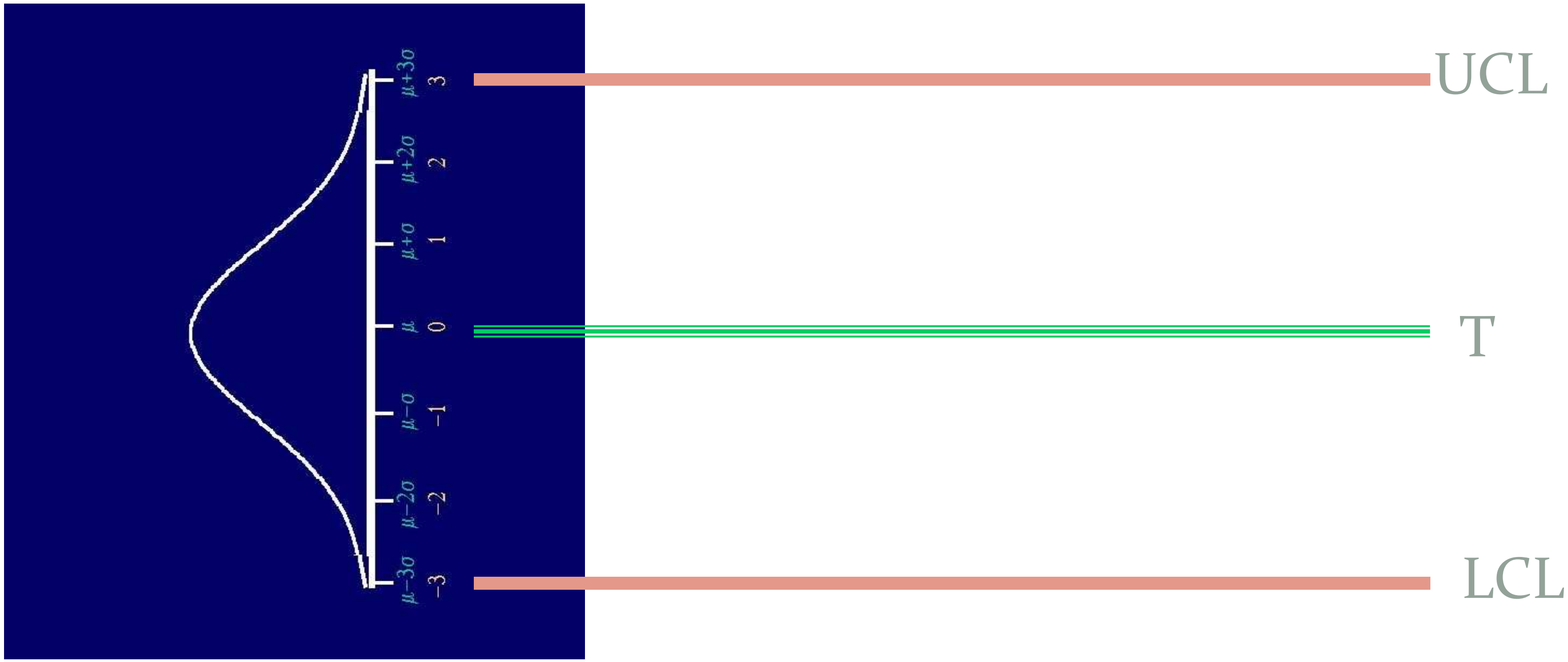


figure – 1

(Genral quality control – chart)

Type of Variable Quality Control Chart

a. **Individual values – Chart.**
b. **Average – Chart.**
c. **Range - Chart .**
d. **Standard Deviation- Chart.**
e. **MR- Chart .**

Individual Values – Chart

(لوحة القيم فردية).

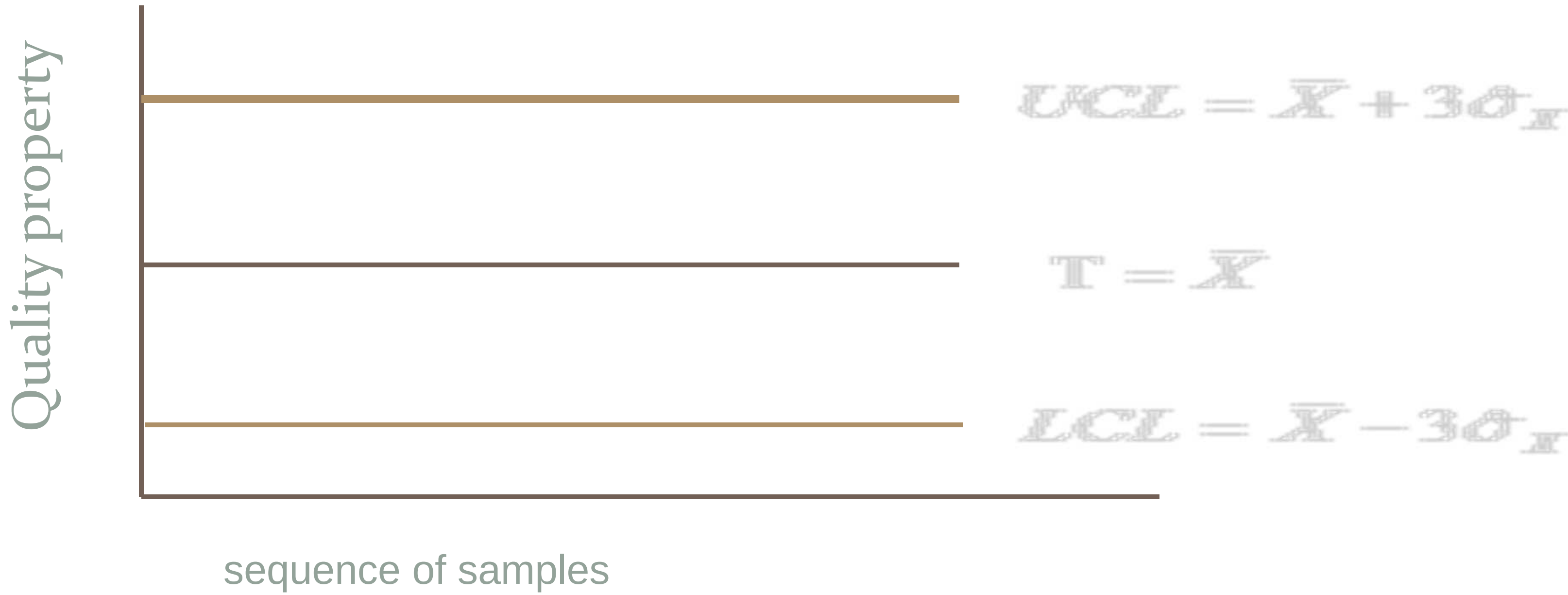
This chart is used to control the quality of the product. The target line for this chart represents the over all average ($T = \bar{x}$) for all observations of the same process . The (upper and lower) control limits are put at (±3σ) from the target line, as shown by the following formulas:

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

where :

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

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



figur-2
(individual values-chart)

Example1:

15 random observation of cigarettes was taken and the percentage of nicotine was :

$$x_i = 18 \ , 16 \ , 20 \ , 19 \ , 18 \ , 19 \ , 18 \ , 18 \ , 17 \ , 17.3 \ , 18.6 \ , 20.3 \ , 21 \ , 19.7 \ , 16.4$$

Draw individual values- chart

X Bar- Chart

This chart is used to control mean of produced product. The central line is (T=$\bar{\bar{x}}$) , the sum of a number of sample mean divided by the number of samples.

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

Where:

$\bar{\bar{x}}$ = Average of the sample mean.

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

m = Number of samples (subgroup)

If $x_1, x_2, \dots, x_n$ is a sample of size n , then the range of the sample is the difference between the largest and smallest observations:

$$R = x_{max} - x_{min}$$

Where:

$R_1, R_2, \dots, R_m$ are the range of the m sample.

The average range is $\bar{R}_j$

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

- The lower control limit is

$$LCL = \overline{R} - 3\hat{\sigma}_R = D_3 \overline{R}$$

- The upper control limit is

$$UCL = \overline{R} + 3\hat{\sigma}_R = D_4 \overline{R}$$

- The point plo

$$\hat{\sigma}_R = \sqrt{\frac{\sum_{j=1}^{m} R_j^2 - m\overline{R}^2}{(m-1)}}$$

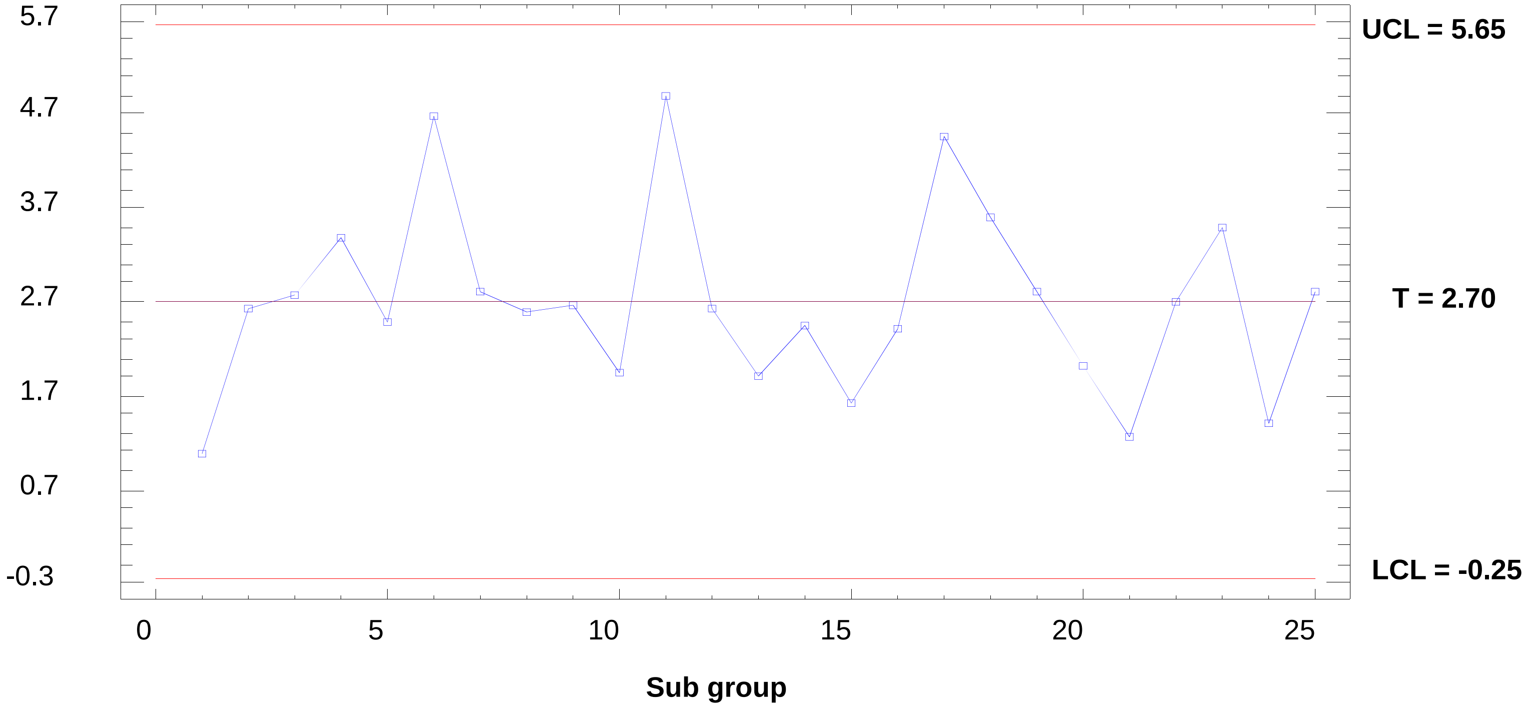
stic (Range of the j-th subgroups) .

$\hat{\sigma} - chart$

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:

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

$\hat{\sigma}$ – *chart*



Decision: The process (in control) because all points are located between (upper and lower) control limits.

P- chart(proportion of non- conforming)

- The p chart is used for data that consist of the proportion of the number of occurrences of an event to the total number of occurrences.
- The central line & control limits as following:

$$P = \frac{\text{number of non-conforming in the sample}}{\text{total number of occurrences}}$$

$$T = \bar{p} = \frac{\sum_{j=1}^{m} p_j}{m}$$

m : sample size
n: No. of items in the any sample