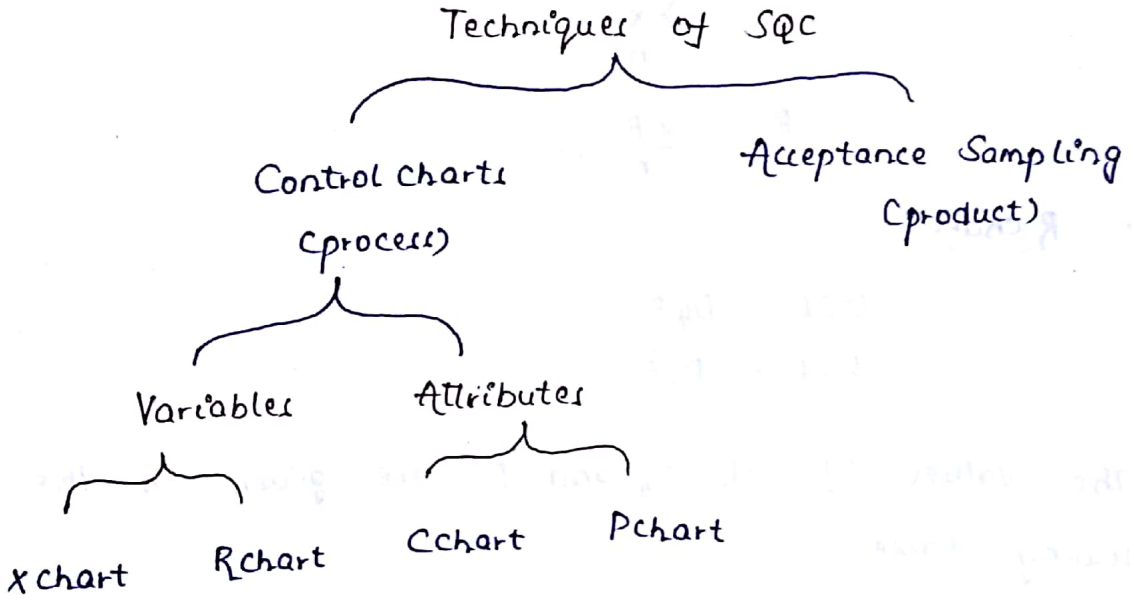
# UNIT - IV

## STATISTICAL QUALITY CONTROL

Statistical Quality Control is an Industrial management technique by means of which the product of uniform acceptable Quality are manufactured. It is mainly Concerned with setting things rather than discovering and rejecting those made wrong.




→ Control charts for Variables:

A Variable is one whose Quality measurement changes from unit to unit. The Quality of these Variables is measured interms of hardness, length, fitness.... The Control charts for Variables are drawn using the principle of normal distribution

There are 2 types of Control charts for Variables

- $\bar{\bar{x}}$ Chart
- R Chart

- $\bar{\bar{x}}$ chart :

For each chart there are

- Upper Control limit (UCL)
- Lower Control limit (LCL)

$$UCL = \bar{\bar{x}} + A_2 \bar{R}$$

$$LCL = \bar{\bar{x}} - A_2 \bar{R}$$

$$\bar{\bar{x}} = \frac{\Sigma \bar{x}}{n}$$

$$\bar{R} = \frac{\Sigma R}{n}$$

- R chart :

$$UCL = D_4 \bar{R}$$

$$LCL = D_3 \bar{R}$$

The Values of $A_2$, $D_4$ and $D_3$ are given in the following table

| n | $A_2$ | $D_3$ | $D_4$ |
|---|---|---|---|
| 2 | 1.880 | 0 | 3.268 |
| 3 | 1.023 | 0 | 2.574 |
| 4 | 0.729 | 0 | 2.282 |
| 5 | 0.577 | 0 | 2.114 |
| 6 | 0.483 | 0 | 2.004 |
| 7 | 0.419 | 0.076 | 1.924 |
| 8 | 0.373 | 0.136 | 1.864 |
| 9 | 0.337 | 0.184 | 1.816 |
| 10 | 0.308 | 0.223 | 1.777 |

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Question 1 :-

Construct $\bar{\bar{x}}$ and R chart from the following information and state whether the process is in control or not. Each of the following $\bar{x}$ has been completed computed from a sample of 5 units drawn at an interval of half an hour from an ongoing manufacturing process

| Sample | $\bar{x}$ | R |
|---|---|---|
| 1 | 20 | 23 |
| 2 | 34 | 39 |
| 3 | 45 | 14 |
| 4 | 39 | 5 |
| 5 | 26 | 20 |
| 6 | 29 | 17 |
| 7 | 30 | 21 |
| 8 | 34 | 11 |
| 9 | 37 | 40 |
| 10 | 23 | 10 |

* $\bar{x}$ chart :-

$$\bar{\bar{x}} = \frac{\Sigma \bar{x}}{n}$$

$$= \frac{317}{10} = \underline{31.7}$$

$$\bar{R} = \frac{\Sigma R}{n}$$

$$= \frac{200}{10} = \underline{20}$$

$$UCL = \bar{\bar{x}} + A_2 \bar{R}$$

$$= 31.7 + 0.577\ (20) \quad (\because \text{Given at 5 units} = A_2 = 0.577)$$

$$= 43.24$$

$$LCL = \bar{\bar{x}} - A_3 \bar{R}$$

$$= 31.7 - 0.577\ (20)$$

$$= 20.16$$

- **R chart:**

$$UCL = D_4 \bar{R}$$

$$= 2.114 \times 20$$

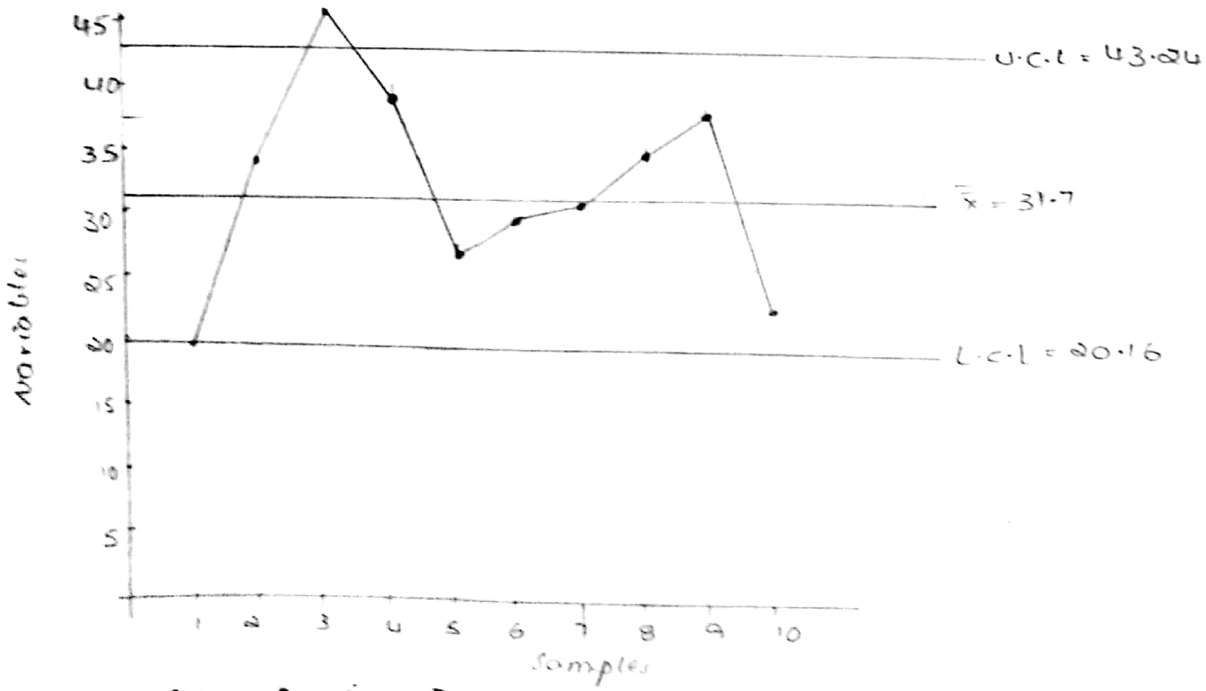
$$= 42.28$$

$$LCL = D_3 \bar{R}$$

$$= 0 \times 20$$

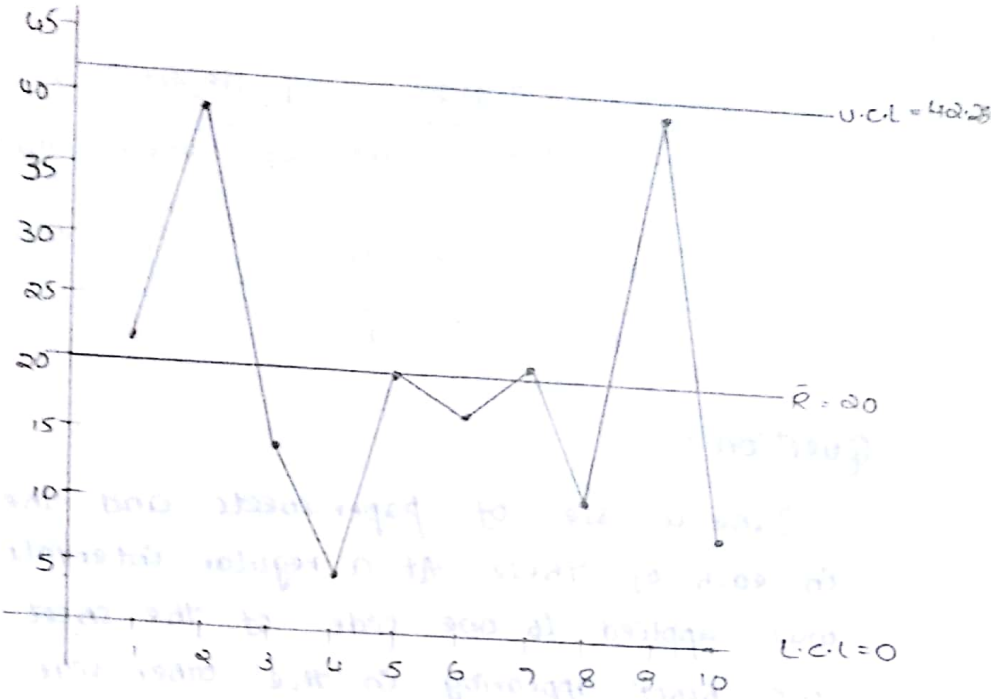
$$= 0$$

* **$\bar{\bar{x}}$ chart :**




At points 3 i.e., $\bar{x} = 45$ the process is not in control it exceeds the UCL

- R chart :




All the points are in between UCL and LCL. So the process is in control.

→ Control Units for Attributes :

The Quality of Attribute can be determined on the basis of Yes or No. In other words in case of a mirror even if there is one scratch on it it is not considered as Quality mirror. Each scratch is a defect. In some cases if no of defects per unit is low it can be sold as second Quality item. The Control charts for Attributes are

- C Chart
- P Chart

* 'C' chart :

C Chart is used where there are no of defects per unit. this Controls the no of defects per unit. A Control unit Chart reveals the pattern of the quality.

$$\bar{c} = \frac{\text{Total no. of defects in all samples}}{\text{Total no. of samples Inspected}}$$



$$UCL = \bar{c} + 3\sqrt{\bar{c}}$$

$$LCL = \bar{c} - 3\sqrt{\bar{c}}$$

Question :.

Take a case of paper sheets and the no. of defects in each of these, At a regular intervals a coloured ink was applied to one side of the sheet. Each individual ink blocks appearing in the other side of the sheet within 3 minutes is counted as a defect. The particulars of the no. of defects in each sample is given Below

| Sample no. | No. of Defects |
|---|---|
| 1 | 5 |
| 2 | 4 |
| 3 | 9 |
| 4 | 7 |
| 5 | 8 |
| 6 | 9 |
| 7 | 4 |
| 8 | 5 |
| 9 | 2 |
| 10 | 6 |
| 11 | 4 |
| 12 | 6 |
| 13 | 7 |
| 14 | 3 |
| 15 | 5 |
| 16 | 3 |
| 17 | 2 |
| 18 | 1 |
| 19 | 7 |
| 20 | 3 |

$$\bar{c} = \frac{\text{Total no. of defects in all samples}}{\text{Total no. of samples inspected.}}$$

$$= \frac{100}{20} = 5$$

$$UCL = \bar{c} + 3\sqrt{\bar{c}}$$

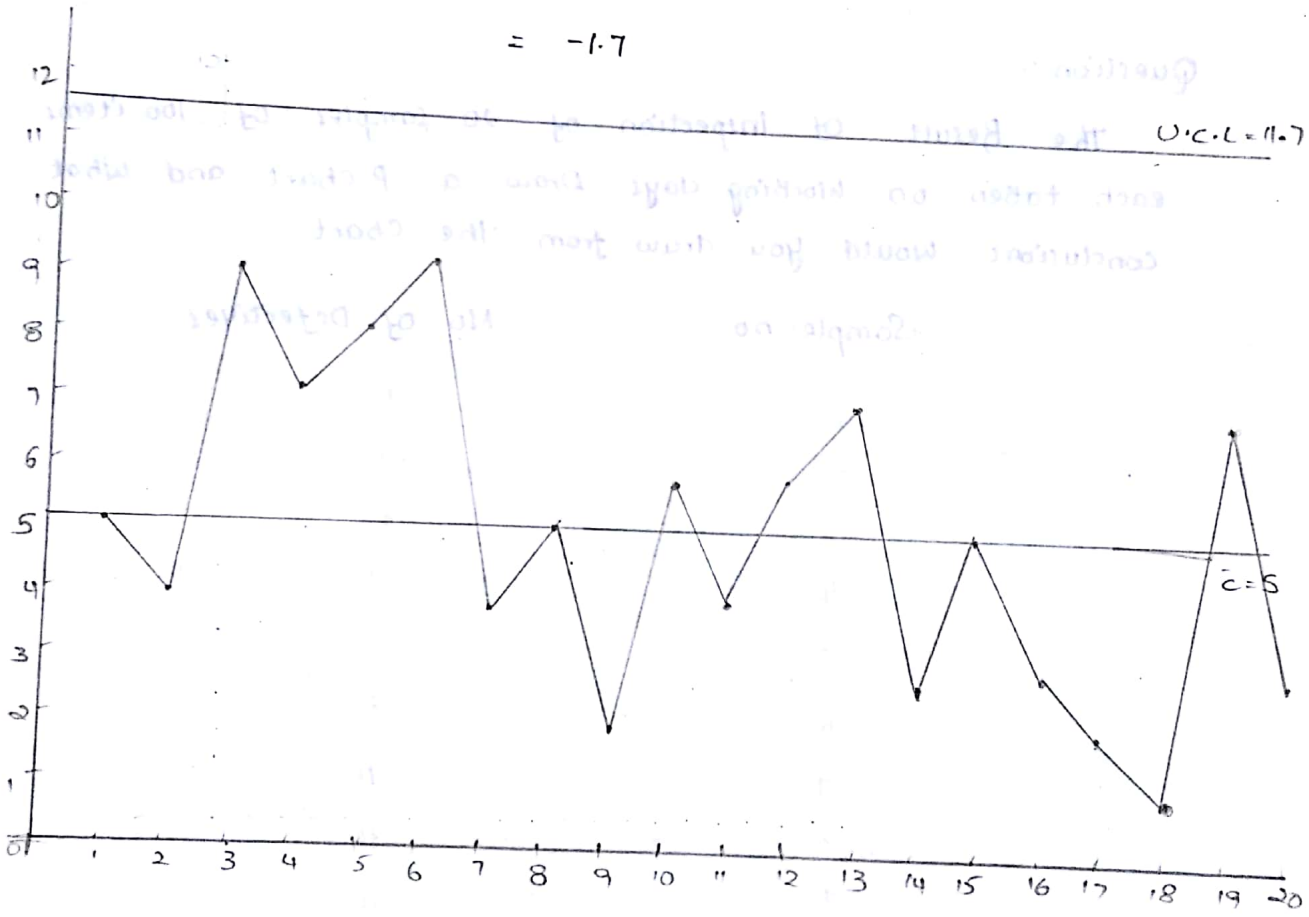
$$= 5 + 3\sqrt{5}$$

$$= 11.7$$

$$LCL = \bar{c} - 3\sqrt{\bar{c}}$$

$$= 5 - 3\sqrt{5}$$

$$= -1.7$$




* **P chart :-**

These charts are constructed by recording atleast 20 sucessive inspections. The percentage of defective items is then calculated. The control limits for P chart are given below.

$$\bar{P} = \frac{\sum p}{nk}$$

$$UCL = \bar{p} + 3\sqrt{\left(\frac{\bar{P}(1-\bar{P})}{n}\right)}$$

$$LCL = \bar{p} - 3\sqrt{\frac{(\bar{P}(1-\bar{P})}{n}}$$

$\bar{P}$ = Central line

$p$ = no of defective items in a sample

$k$ = Total no of samples

$n$ = Sample size

Question :

The Result of Inspection of 20 samples of 100 items each taken on working days. Draw a P chart and what conclusions would you draw from the chart.

| Sample no | No. of Defectives |
|---|---|
| 1 | 9 |
| 2 | 17 |
| 3 | 8 |
| 4 | 7 |
| 5 | 12 |
| 6 | 5 |
| 7 | 11 |
| 8 | 16 |
| 9 | 14 |
| 10 | 15 |
| 11 | 10 |
| 12 | 6 |
| 13 | 7 |
| 14 | 18 |
| 15 | 16 |
| 16 | 10 |

| | |
|---|---|
| 17 | 5 |
| 18 | 14 |
| 19 | 7 |
| 20 | 13 |

Total no. of items Inspected

= no. of samples x Units Inspected in each sample

= 20 x 100

= 2000 units

$$\bar{p} = \frac{\Sigma p}{nk} = \frac{\text{Total no. of defectives}}{\text{Total no. of items inspected}}$$

$$= \frac{220}{2000} = 0.11 \times 1000$$

$$= 11$$

$$C.L = 0.11$$

$$U.C.L = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

$$= 0.11 + 3\sqrt{\frac{0.11(1-0.11)}{100}}$$

$$= 0.20 \times 100$$

$$= 20$$

$$L.C.L = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

$$= 0.016 \times 100$$

$$= \underline{16}$$

→ Acceptance Sampling :

Acceptance sampling is the process of ensuring the quality of the products before they are sent for sale

Acceptance sampling is a technique where a sample is drawn randomly from a whole lot and it is checked for no of defectives before Accepting it

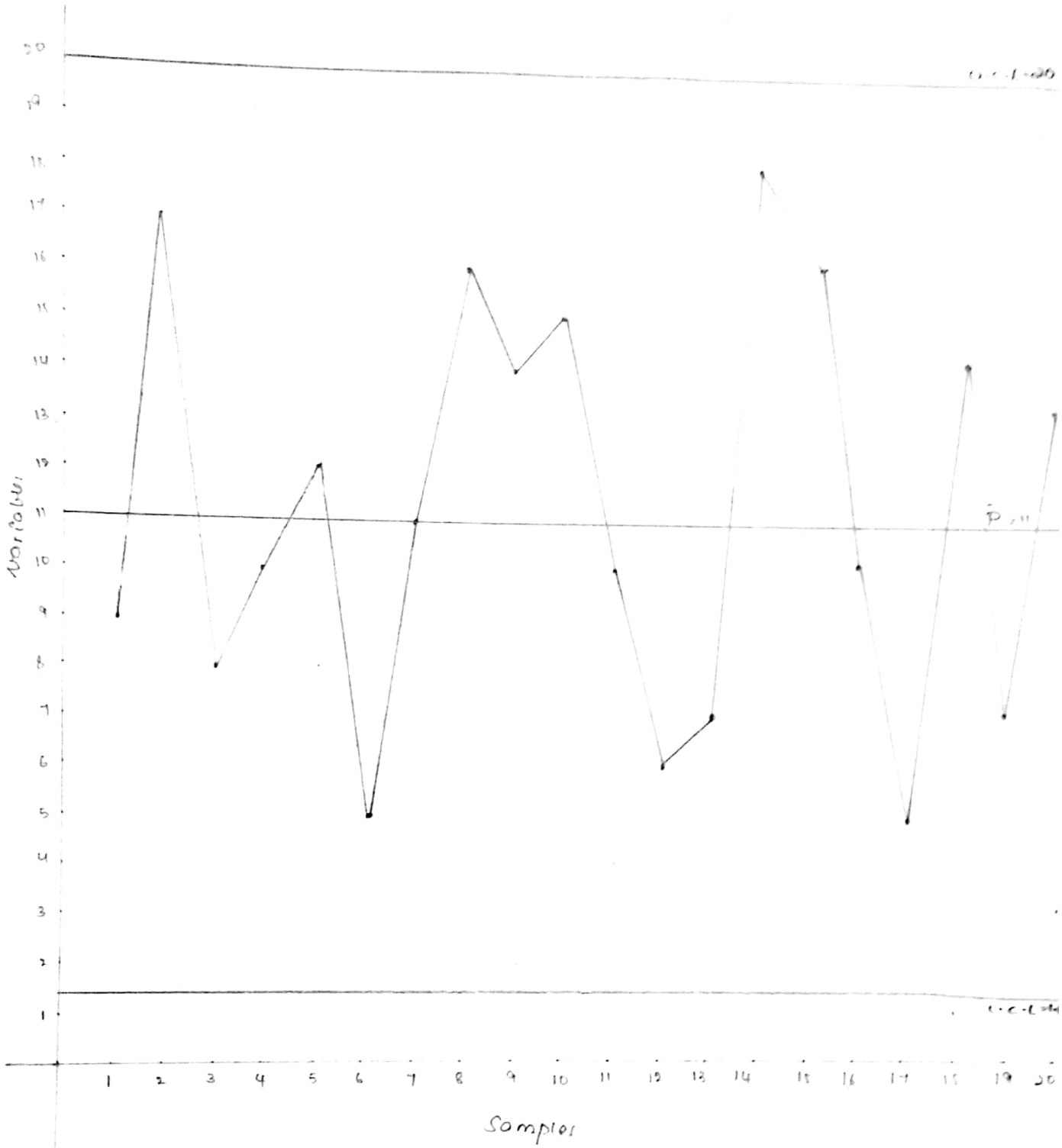
This process is widely applicable in buying food items and other Agricultural products

Advantages

* It is economical to carry out
* Smaller the no of inspection staff it is less Complex, less Costlier
* Inspection errors can be minimised
* There is less damage to the product

Disadvantages

* High sampling risk
* Greater Administrative Cost
* less information about the product is available

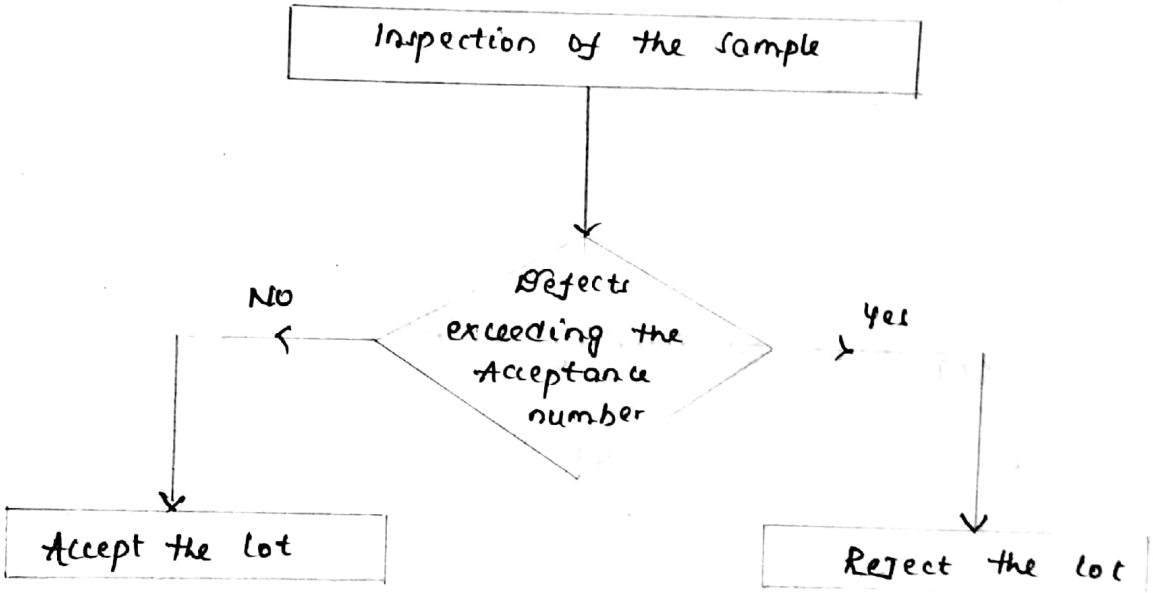


- Methods of Acceptance Sampling :

  - Single Sampling
  - Double Sampling
  - Multiple Sampling
  - Sequential Sampling

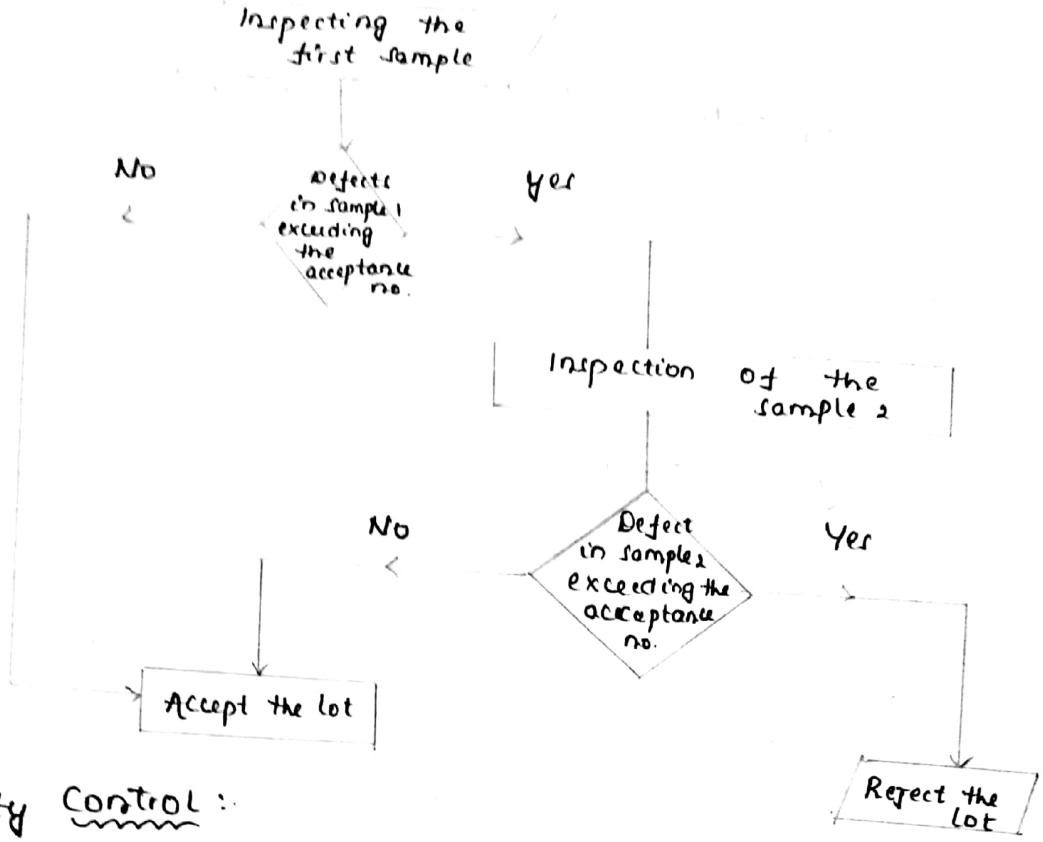
- Single Sampling :

In this method the Quality of the whole lot is decided depending on the Quality result of only one Sample. If the no. of defectives in the randomly Selected Samples is less than acceptance number, the entire lot is accepted




- Double Sampling :

In this method the Quality of a lot is ensured on the basis of the Quality results of two randomly but Sucessively drawn sample at the first stage the first sample is inspected for no of defectives If the no. of defectives in sample 1 exceeds the acceptance number sample 2 is Inspected for defectives and if the defects are less than acceptance number the entire lot is accepted otherwise it is rejected




→ Quality Control :

According to Alford Quality Control may be defined as that industrial management techniques or group of techniques by means of which products of uniform acceptable quality are manufactured.

Objectives of Quality Control :

* To Improve the Quality of finished products at various stages of production process.
* To see whether the product confirms to the pre-determined standards and specifications.
* To Develop Quality Consciousness in the various sections of the manufacturing units
* To Acess various techniques of Quality control and Suggest Improvements in it.
* To reduce wastage of raw materials men and machine during the process of production

→ Importance of Quality Control:-

The program of Quality control is Advantageous to both the producer and consumer. A Quality product which statisfy consumer needs on the other hand the demand of the product will increase resulting in large scale production.

The Importance of Quality Control lies in the following facts.

* Reduction in cost
* Improve in the morale of employees
* Max utilication of resources
* Increase in sales
* Customer statisfaction
* Study of Variations

→ INSPECTION :-

Inspection is an important and essential tool of quality control that ascertains and controls the Quality of the product. The main purpose of Quality Inspection is to safeguard Quality by Comparing materials, workmenship and products with the set of standards

- Definition :-

According to Kinball "Inspection is the art of Comparing materials, products or performances with the established standards."

- Objectives :-

- Maintainence of Quality
- Improving the product Quality
- Reduction in cost

- Maintainence of Quality :

The fundamental purpose of inspection is to maintain the Quality of the product items which confirm to the specifications or within the Acceptable limits are Accepted

- Improving the product Quality :

By comparing the Quality of the product against the set standards, the defective items are located and probably the reason for defects are established

- Reduction in Cost :

The rawmaterials are inspected to see whether they are as per standards or not. the defective raw materials are thus not allowed to use in production.

→ Inspection Methods (or) Types (or) Tools :

* Tool Inspection
* First piece Inspection
* Working Inspection
* Sample Inspection
* Operation Inspection
* final Inspection

→ Six SIGMA :

Six Sigma stands for six standard deviations from mean six sigma methodology provides the tools and techniques to improve the capability of reducing the defects in any process

→ Definition :-

According to James Harrington "Six sigma is a TQM Process that use process capability analysis as a way of measuring process."

→ History of Six Sigma :-

The Concept of Six Sigma Quality evolved in the motorola corporation in U.S.A Bill Smith an engineer of Company who is now called as father of six sigma. Conducted a statical corelation between life of the product and the defects detected during the manufacturing of the product

→ Objectives of Six Sigma :-

- To Decrease Deviations :-

The Main objective of six sigma is to Acheive zero variations both in the product and process

- To Bring down Defects/rework :-

Six Sigma reduces defects as it is a process Control technique

- To Enhance productivity level :-

Six sigma Aims at Improving the productivity of organization for proper utilisation of resources and reducing the wastage of different levels

- To Improve Customer Satisfaction :-

The principle objective of six sigma is to Acheive Customer Satisfaction by providing good Quality products and services to the Customers

⇒ Methods of Six Sigma:

- DMAIC
- DMADV

→ DMAIC (Define, Measure, Analyse, Improve, Control)

Six Sigma Methodology Improves any existing business process by constantly reviewing and returing the process. To Acheive This Six Sigma has user methodology as DMAIC

→ DMADV (Define, Measure, Analyse, Design, Verify)

DMADV is used by Organization where there is either no existing process in place (or) the process currently is being utilised in unworkable.

→ Total Quality Management: (TQM)

Total Quality Management was developed by william deeming, a management Consultant where work had Great impact in Japanese manufacturing. Total Quality management is a Comprehensive and Structured Approach to Organizational management that worm to Improve the Quality of product Services through on going refrigerants in response to Continous feedback.

* Definition:

According of Oakland "TQM is an Approach to Improving the effectiveness and flexibility of business as a Whole. It is essentially a way of Organizing and Evoluing the Whole organization, every department, activity every single at every level."

According to Bilcreech "A Total approach to put Quality in every Aspect of management."

→ Objectives of Total Quality Management:

The Two Basic Objectives of Total Quality Management are * Customer Statisfaction
* Performance

* Customer Statisfaction:

Customers are Considered as Important objective part in every business Organication. The Sucess of Organication is only About the Statisfied Customer

* Performance:

Performance is the Important objective of firms TQM Where the firm mainly focus About the Superiority in the Areas

- Speed
- Quality
- Cost
- flexibility

→ The Other Objectives of TQM are:

- Making an Availability According to the Customer focus.
- Continous Improvement as a Cultural of Organisation according to the way of life.
- To change the Organisation from function focus to Customer focus
- To Create the Organisation where people (employees) and Customers are Core of every Activity and encourage the work into teams

→ Quality Circle :

It is a Small Group of employees in the same work area or doing a similar type of work who voluntarily meet regularly for About an hour every week to identify, analyse and resolve work related problems, leading to Improvement in there total performance and enrichment of the Work life.

"Quality Circles are a formal Institutionalized mechanism for productive and participative problem slowing Interaction Among Employees."

* Features Of Quality Circles :

- Quality Circle is a Small Group of employees
- Quality Circle is Organised in same work area or doing similar type of work.
- Quality Circles are Voluntary
- Quality Circles meet regularly for about an hour every week
- Quality Circle Identifies, Analyses and resolves work related problems
- Quality Circle leads to total performance
- Quality Circle enrich work life

# CHAPTER 3

# THE CONCEPT OF QUALITY CIRCLE

## Introduction

The previous chapter presented the overview of literature on the research study. The aim of this chapter is to understand the concept of quality circles. It covers the meaning of quality circle, definition of quality circle, the essential elements and structure of quality circles.

## 3.1 Definition

There have been different interpretations of the concept of quality circles in various organizations in India and abroad. However, the most commonly accepted definitions in keeping with the essence of the philosophy as it originated in Japan are:

"Quality Circle is a small group of employees in the same work-area or doing a similar type of work who voluntarily meet regularly for about an hour every week to identify, analyse and resolve work-related problems, leading to improvement in their total performance, and enrichment of their work life" (Udupa 1986).

"Quality circles are a formal, institutionalized mechanism for productive and participative problem-solving interaction among employees"(Lozano & Thompson 1980).

"Quality control circle is not just a little room adjacent to the factory floor, whose occupants make a nuisance of themselves to everyone else. It is a state of mind and a matter of leadership with everyone from the president to production trainee involved"(Rehder 1981).

"Quality circle is a small group to perform capital quality control activities within the same workshop. This small group carries on continuously as a part of company wide quality control activities self development and mutual development and improvement within the workshop, utilizing quality control techniques with all member participating"(Dr.Ishikawa).

### 3.2 Meaning of Quality Circle

In Japan, quality circles are organized within a department or work area for the purpose of studying and eliminating production related problems. They are problem solving teams which use simple statistical methods to research and decide on solutions to workshop problems.

Quality circles in North America are similar to Japanese circles in spite in spite of the fact that each may emphasize a particular function such as problem solving, team building or quality control.

Underlying the quality circle concept is the assumption that the causes of quality or productivity problems are unknown to workers and to management. It is also assumed that shop floor workers have hands on knowledge, are creative and can be trained to use this natural creativity in job problem solving. Quality circles, however, are a people building, rather than a people using, approach.

### 3.3 Features of Quality Circles

The main features of quality circle are:

#### (a) Quality circle is a small group of employees

Quality circle is a small group of employee of 8 to 10. A circle with less than 5 members would lose its vitality due to high rate of absenteeism. This may cause a circle to become inactive. On the other hand, more than 15 members in a circle could result in denial of opportunity for active participation by every one. As

such, 8 to 10 are recommended as the minimum and maximum strength of quality circles respectively. The reason for such numbers is that number of interaction among members would be manageable.

**(b) Quality circle is organized in the same work area or doing similar type of work**

A quality circle is a homogeneous group and not an inter-departmental or inter-disciplinary one. Members participating in circle activities must be on the same wave-length. Discussions taking place at the meetings should be intelligible to each one of the members. This is possible only if the composition of the circle includes employees working in the same work area or engaged in a similar type of work. Designations of members need not necessarily be equal but the work in which they all are engaged should be common. For example, in any assembly area, turner, drillers, electricians, and unskilled workers, etc., could decide to form a circle. Similarly, circles could be composed of stenographers in an office, operators on a group of milling machines, nurses in hospitals, draughts men in an engineering section, clerks in a bank's. etc.

**(c) Quality circles are voluntary**

Employees decide to join quality circles on their own willingness. No compulsion, coercion or pressure can be brought on any employee to join or not to join quality circles. This is based on voluntarism principle.

**(d) Quality circles meet regularly for about an hour every week**

Normally, a quality circle meets for about an hour every week. It is therefore possible for the circle to meet atleast three or four times a month. The regularity of such meetings is very significant and it must be adhered to. These meetings could be conducted during or after working hours. This decision is left to quality circle members themselves. For example the Bharath Heavy Electric Ltd., Bangalore, have been conducting the meetings for an hour after the shift hours on every Saturdays (QCFI Convention Report 2008).

**(e) Quality circles identifies, analyses and resolves work-related problems**

The employees who work continuously in a work area knows best what problems are hindering achievement

**(f) Quality circle leads to total performance**

As quality circles resolve work related problems relating to quality, productivity, cost reduction, safety etc. the total performance of the work area naturally improves. This results in both tangible and intangible gains to the whole organization. Empirical data provided in chapter 5 would substantiate this feature of quality circle.

**(g) Quality circle enrich work life**

The spin off benefits of quality circles of the organization includes enrichment of the work life of their employees apart from attitudinal changes, cohesive team culture, etc. Improved working environment, happier relations with co-employees, greater job satisfaction etc. are responsible for this enrichment of their work life.

## 3.4 Assumptions of Quality Circles

The concept and philosophy of quality circles are derived from the following basic assumptions (Mathew George 1991):