

**UNIT-4****UNIVERSITY SYLLABUS**

**Quality Control:** Meaning, process control, SQC control charts, single, double and sequential sampling, Introduction to TQM.

**QUALITY CONTROL**

The quality is defined as the degree to which a product meets the requirements of customers.

The quality of a product consists of the following attributes:

- i. Appearance of product
- ii. Product design
- iii. Performance of the product
- iv. Reliability of the product
- v. Durability of the product
- vi. Serviceability
- vii. Maintainability
- viii. Suitability from customer's point of view
- ix. Degree to which it conforms the product specifications
- x. Marketing and after sales services.

**INSPECTION**

Inspection is a function of quality control. That is, inspection finds out whether the products manufactured are as per specifications. Inspection rejects bad products and accepts good products.

**Objectives of inspection**

The following are the objectives of inspection.

1. To find out and remove faulty material before it is machined. This is to avoid wastage of material.
2. To remove defective products as soon as the defect occurs. This is to prevent further working on the defective products.
3. To discover defects for corrective action before they become serious.
4. To ensure that defective products do not reach the customer.
5. To earn goodwill of the customer.
6. To ensure proper functioning of assembled products.
7. To ensure safe working of the products.
8. To locate defects in design.

**MEANING AND DEFINITION OF QUALITY CONTROL****Meaning**

The term 'Quality Control' consists of two words 'Quality' and 'Control'. Thus 'quality is defined as fitness for purpose'. The quality of an article may include such elements as design, size, materials, chemical composition, mechanical functioning, electrical properties, finish and

appearance. Control is referred to as the comparison of actual results (finished product) with the predetermined standards and specifications. Thus control is a system for measuring and checking



(inspecting) a phenomenon. Control is the correction in the quality of the product, when deviations in the quality are more than expected in the process.

**Definition**

Quality control is the process of control where the management tries to conform the quality of product in accordance with the pre-determined standards and specifications. The quality control is defined as a process of checking the products to ensure that they meet the required quality standards and specifications. The quality control may also be defined as industrial management



technique or group of techniques by means of which products of uniform acceptable quality are manufactured. (Alford and Beatty)

According to J. A. Shobin, quality control means the recognition and removal of the identifiable causes of defects and variations from the pre-sets standards.

### **OBJECTIVES OF QUALITY CONTROL**

Following are the objectives of quality control:

1. To assess the quality of raw materials, semi-finished goods and finished products at various stages of production process.
2. To see whether the product confirms to the predetermined standards and specifications or not.
3. In case the product does not satisfy the standards, then to suggest necessary remedial steps.
4. To suggest suitable improvements in the quality of product without much increase in the cost of production. For this purpose, new techniques in methods and machines may be applied.
5. To develop quality consciousness in various sections of manufacturing unit.
6. To reduce the wastage of raw materials, men and machine during the process of production.

### **BENEFITS /ADVANTAGES OF QUALITY CONTROL**

Following are the benefits of quality control:

1. An efficient quality control system reduces the cost of production of the product due to following factors:
  - (i) Reduction in wastage of raw material
  - (ii) Large-scale production
  - (iii) Minimization of rework cost of substandard goods.
2. By quality control programme, the employees become quality conscious, i.e., the morale of employees is improved.
3. There is maximum utilization of resources, i.e., the necessary control over the machine, equipment, men and materials and all other resources is exercised.
4. Uniformity and reliability of products help in increasing sale.
5. Inspection costs and customers complaints are minimized.
6. Consumers get the quality product of standard specifications, i.e., there is consumers satisfaction.

S. No.	Inspection	Quality Control
1.	It is one of the functions of quality control	It is a system of integrating quality development, quality maintenance and quality improvement
2.	It finds out whether the products manufactured are acceptable or not.	It aims at production of only quality products
3.	It is concerned with detection of defects of products already made.	It is concerned with prevention of defects.

4.	It does not deal with any corrective action.	It finds out the causes of poor quality. It takes suitable corrective action.
5.	It does not control production process.	It controls production process.



## PROCESS CONTROL

Process control is the active changing of the process based on the results of process monitoring. Once the process monitoring detects an out of control situation, the person responsible for the process makes a change to bring the process back into control.

1. Out of Control Action Plans (OCAPS) detail the action to be taken once an out of control situation is detected.

2. Advance Process Control Loops (APCL) are automated changes to the process that are programmed to correct the size of the out of control measurement.

Variation in the production process leads to quality defects and lack of production consistency. The Intel Corporation, the world's largest and most profitable manufacturer of microprocessors, has implemented a program it calls "copy exactly" at all its manufacturing facilities. The idea is whether the chips are made in Arizona, New Mexico, Ireland, or any of its other plants they are made in exactly the same way. This means using the same equipment, the same exact materials and workers performing the same tasks in the same order. When a water quality was found to be of different at one facility, Intel instituted a purification system to eliminate any differences.

### Sources of Variations

**Common causes of Variation:** Common causes of variations are based on random causes that we cannot identify. An important task in quality control is to find out the range of natural random variation in a process. E.g. if the average bottle of a soft drink produced by ABC Ltd. contains 16 Ounces of liquid we may find out that the amount of natural variation is between 15.8 and 16.2 ounces. This type of difference is completely normal. We would monitor the process to make sure that the amount stays within this range.

**Assignable Cause of Variation:** This type of variation can be precisely identified and eliminated. Eg.

- Poor quality of raw material,
- An employee needs more training,
- A machine in need of repairs.

In each of these cases the problem can be identified and corrected. In the case of soft drinks bottle filled with 15.6 Ounces of liquid would signal a problem and machine needs to be adjusted.

Process control can be divided into two categories as follows:

**1. Discreet Process:** These are motion based such as automotive production, robotic assembly, Packaging application etc. These are characterized as discreet process control.

Discreet manufacturing process is mostly automated. It uses Computer Numeric Control (CNC) Computer Aided Design (CAD) Computer Aided Manufacturing (CAM), Copying machines and robotics etc.

**2. Continuous Process:** These require that specific quantities of raw materials be combined in specific ways for particular durations to produce an intermediate or end product such as chemical, fuels, Plastics and food items beverages and medicines etc. Continuous process control use Programmable Logic Controller (PLC), Distributed Control System (DCS), Supervisory Control and Data acquisition (SCADA) system, etc.

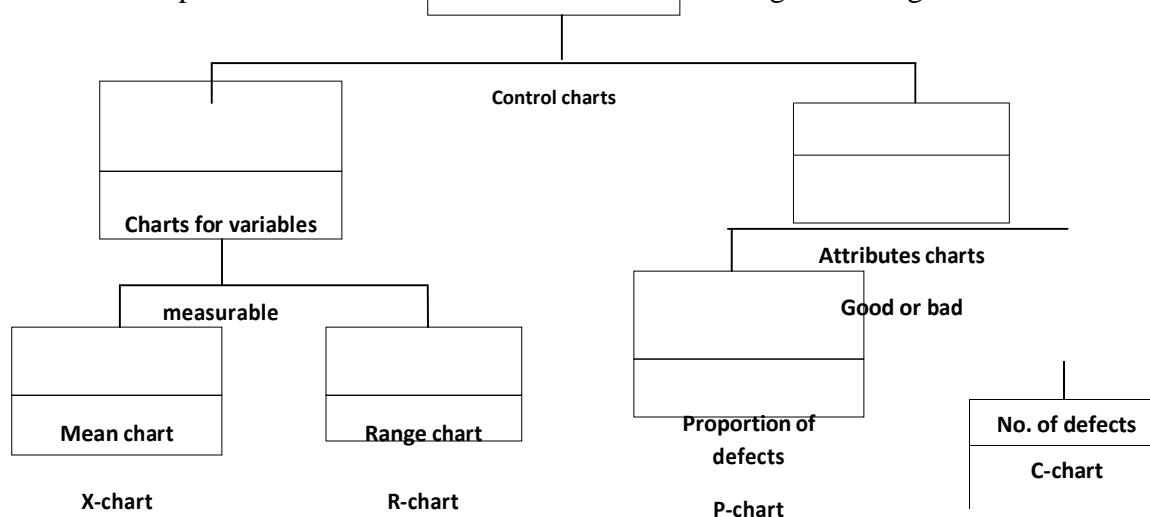
## CONTROL CHARTS

A control chart is a graphical presentation of the collected information. The information pertains to the measured or otherwise judged quality characteristics of the items or the samples.



Therefore, a control chart is a diagnostic technique. A control chart detects variations in the processing and warns if there is any departure from specified tolerance limits.

Control charts are the most important statistical tools for data analysis in quality control of manufactured products. The classification of control chart is given in Fig.



### Types of control charts.

#### Advantages of Control charts

1. It indicates whether the process is in control or out of control at a particular point of time.
2. It ensures level of quality and builds up the reputation of the enterprise due to customer's satisfaction.
3. It detects unusual variables taking place in a period.
4. It helps in reducing the rejections. It warns in time so that process can be rectified in time.
5. It helps in setting tolerance limits.

### Statistical Factors Based on Normal Distribution

Sample size	2	3	4	5	6	7	8	9	10
A2	1.88	1.023	0.729	0.577	0.483	0.419	0.373	0.337	0.308
D3	0	0	0	0	0	0.076	0.136	0.184	0.219
D4	3.263	2.574	2.2824	2.114	2.004	1.924	1.860	1.814	1.777

#### Control Chart for Variables

##### Calculation procedure

##### 1. Calculate average $\bar{X}$ and range $R$ for each group

- i. A number of samples of items manufactured are collected at regular intervals (say 1 or 2 hours)
- ii. Their quality characteristics (diameter, thickness, weight, length etc. ) are measured.



iii. For sample, mean value and the range is calculated.

For example if sample size is of 5 items and dimensions are  $X_1$ ,  $X_2$ ,  $X_3$ ,  $X_4$ , and  $X_5$



$$\text{The Sample average } \bar{X} = \frac{X_1 + X_2 + X_3 + X_4 + X_5}{5}$$

The range will be  $R = \text{Highest value} - \text{Smallest value}$

**2. Calculate Grand Average  $\bar{X}$  and Average Range  $\bar{R}$ .**

$\bar{X}$  is the average of  $\bar{X}$  value for each group.

$$\bar{X} = \frac{\sum \bar{X}}{N}$$

Where  $\bar{X}$  = Average of Sample mean or average

And  $n$  = Number of observations, or subgroup

Similarly, the average  $\bar{R}$ , is the sum of the ranges of the subgroup or observations divided by the number of sub group

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

**3. Calculate Control Charts for  $\bar{X}$  chart:**

Upper Control Limit  $UCL$  for  $\bar{X} = \bar{X} + A_2 \bar{R}$ ,

Lower Control Limit  $LCL$  for  $\bar{X} = \bar{X} - A_2 \bar{R}$ .

**4. Calculate Control Limits for  $R$  Chart:**

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

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

The value of  $A_2$ ,  $D_3$ ,  $D_4$  are based on normal distribution and can be found out from standard table for a particular sample size.

**5. Plot  $\bar{X}$  and  $R$  chart:**

- Central line on the  $\bar{X}$  chart should be solid horizontal line at  $\bar{X}$ .
- The upper and lower control limits for  $\bar{X}$  should be drawn as dotted horizontal lines at computed values.
- Similarly for  $R$  chart central solid horizontal line will indicate  $\bar{R}$ , and
- The control limits are shown by dotted horizontal line at computed value
- if the size of sample is 6 or less, the lower control limit for  $R$  is zero.

Points outside the control limits are indicated with cross on the  $\bar{X}$  chart, and the points outside the limits on  $R$  chart by a circle

**Control Chart for Attributes**

**1. Control Chart for Fraction Defectives (P- Chart)**

Fraction defective may be defined as the ratio of the number of defective articles in any inspection to the total number of articles actually inspected.

- Take adequate number of samples.
- Find number of defective pieces found
- Calculate fraction defective

$$P = \frac{d}{\text{-----}}$$



iv. Calculate

$$UCL \text{ of } P = P + 3 \frac{P(1-P)}{n}$$

$$CL = P$$

$$LCL \text{ of } P = P - 3 \frac{P(1-P)}{n}$$

## 2. C- Chart (Number of Defects per Unit)

In number of cases it is more convenient to work with number of defects per unit rather than fraction defective. For example number of defects in a bus body, air plane, TV set, etc.

C- chart deals with the defects in the piece or unit of product manufactured.

- i. Samples are taken at regular intervals
- ii. It may be a length(wire), or an area( piece of cloth)
- iii. Number of defects are counted
- iv. Calculate C.

$$C = \frac{\text{Total number of defects in all samples}}{\text{Total number of samples observed}}$$

$$UCL \text{ of } C = C + 3 \sqrt{C}$$

$$CL = C$$

$$LCL \text{ of } C = C - 3 \sqrt{C}$$

## TOTAL QUALITY MANAGEMENT (TQM)

### DEFINITION OF TQM

Total quality management (TQM) is defined as a philosophy designed to make an organization faster, flexible, focused and friendly. It creates an environment that allows organization wide participation in planning and implementing a continuous improvement process to meet customer needs.

The total quality management is a total approach to put quality in every aspect of management. TQM is basically a business philosophy founded on customer satisfaction. That means low cost, high quality and speed drive all processes.

This is defined as fitness for use or purpose.

TQM is defined as a total organization working as a team to meet the customer needs and

expectation by using systematic approach to continuous improvement.



TQM is a comprehensive and integrated way of managing any organization in order to meet the needs of customer consistently and to achieve continuous improvement in every aspect of the organization activities.

### STAGES IN TQM IMPLEMENTATION

The various stages in an organization during TQM implementation are:

1. Unhealthy situation
2. No relaxing situation
3. Common goal or same vision situation
4. Team work situation

All these situations are shown in fig.

1	
2	
3	
4	

**Stages of development during TQM Implementation**

#### Description of various stages

##### 1 Unhealthy situation

This is the stage in which only few people (four) are constantly working as shown by arrows. The other people (six) shown by dots are doing very minimal work, i.e., relaxing. This is unhealthy situation for an organization.

##### 2. No relaxing situation

Under this situation, there is no dot in the fig., i.e., no person is relaxing. The persons (ten) shown by arrows are focused in different directions. This shows that there is no single focus for the organization. Every people is working in his own way.

##### 3. Common goal or same vision situation

As shown in the figure, all the arrows are pointing towards the same direction, i.e., all people are working in the same direction. Therefore, all have a common goal or vision for the organization. This is a better situation in comparison to two previous situations.

#### **4. Team work situation**

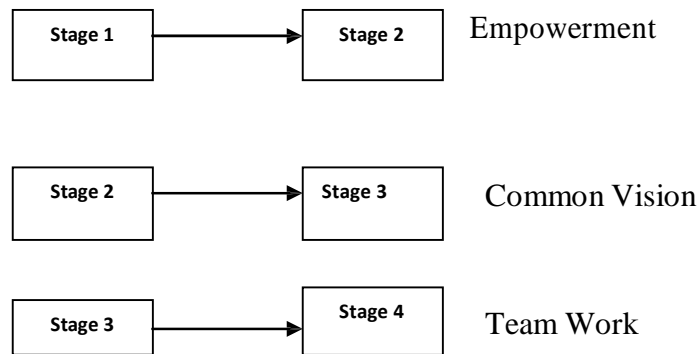
it is obvious from the figure, that the number of arrows in the same direction is increased. This



does not mean that the number of people (10) is increased but the increase is due to the fact that effect of ten people working towards a common goal has increased. This shows a team work. It is important to mention here that the people working as group. The team work situation shows a tremendous increase in productivity. In other words, we can say that with input remaining the same, the output is tremendously increased.

Implementation of TQM strategies will be effective only when the organization is in a stage 4. So, every organization should aim to reach stage 4 at the earliest.

The key factors for stage wise improvement is shown in fig.



Key factors for stage wise Improvement

When the employees are empowered, it can be best assured that stage 2 is reached.

If the organization is in stage 2, then for movement to reach stage 3 requires a common vision. In order to reach stage 4 from stage 3, one has to work towards teaming up the people.

### Goals of TQM

1. The primary goal of TQM is total customer satisfactions so that they become loyal and long term customers.
2. The second goal of TQM is to ensure that the product or service is delivered correctly at the first attempt. This can be achieved by designing quality into the product or service which will prevent defects till it reaches the customer.

### TQM Process

The TQM involves the following processes:

1. Customer satisfaction.
2. Processes.
3. Continuous Improvement
4. Team work.



## 5. Personal Initiative



The various TQM process can be represented graphically as shown in Fig.

### 1. Customer Satisfaction

Customer is the buyer of goods and services and dictates production or market. The longterm success of any business therefore, depends on customer satisfaction. Losing of a customer can be serious especially for small business.

There are two types of customers for any business:

1. External Customers are the end user of the product or service.
2. Internal Customers are the individuals or departments within an organization who receive products and services from another department for further processing.

The customer requirements can be understood by following the steps listed below:

1. Document the results of the work performed.
2. Identify every customer who receives the output.
3. Pinpoint exactly the characteristics of the want, requirement or expectation of the customer.
4. Verify output requirements, determine importance of requirements and understand present level of satisfaction.

### 2. Processes

Processes are the tasks required to transform input into outputs. These are all tasks performed in an organization.

For example, processes are performed in various departments such as administration, accounting, sales maintenance, recruitment, training, etc. all processes should be properly defined.

The process can be defined by taking the following steps.

1. List team outputs and document the results of the work performed.



2. Group similar outputs and create an outline of the process.
3. Designate the process for easy reference.
4. Define the boundaries of the process as beginning and ending points.
5. List process activities and provide example of tasks involved.
6. Identify inputs and determine the resources required.

### **3. Continuous Improvement in Processes**

The continuous improvement in the performance of processes can be achieved as follows.

*i. Elimination of Waste:* A process can be improved by elimination of waste associated with the process.

*ii. Process Simplification*

Simplification leads to fewer activities and fewer mistakes. It is easier to learn and perform a simpler process continuously.

*iii. Reduction of Cycle Time*

Cycle time is the time required to deliver a product or service to a customer. It includes processing time, checking time and delivery time. Reduction in cycle time helps prompt deliveries to customer and reduction in costs.

### **4. Team Work**

A team is a group of individuals who work together on one or more common processes. The team members may be from same department, several departments, external supplier or customer. Effective team work depends on consensus. It is a general agreement by everyone involved and understands a decision, accept and support it.

### **5. Personal Initiative**

TQM process encourages personal initiative in the functioning of the organization. The employees should be trained in the concepts and techniques of TQM process. The training helps employees to manage the process for which they are responsible for performing. This leads to collective organizational success.

### **Implementation of T.Q.M.**

Implementation of TQM requires a total change in organizational culture, shifting of responsibility to management and continuous participation of all in quality improvement process. W. E. Deming, father of TQM, has suggested Plan –Do- Check-Act cycle for the implementation

of TQM in any organization. The various steps in PDCA cycle are as shown in Fig.



<p style="text-align: center;"><b>PLAN</b></p> <p>1. Policies and objectives 2. Methods to achieve objective</p>	<p style="text-align: center;"><b>DO</b></p> <p>3. Education and training 4. Implementation of change</p>
<p style="text-align: center;"><b>ACT</b></p> <p>7. prevent undesired effects 8. Measures for improvement</p>	<p style="text-align: center;"><b>CHECK</b></p> <p>5. Observe results 6. Analyse results</p>

### Steps in TQM process

#### Benefits of TQM

##### (A) Advantages unique to TQM

1. It makes company a leader not follower.
2. TQM creates goal directed connection between customers, management, and workers. Every one is motivated to contribute. It thus fosters effective team work.
3. It makes the company more sensitive to customer needs.
4. It makes the company adopt more readily to change.

##### (B) Benefits to customers

1. Fewer problems with the product or service.
2. Better customer care.
3. Greater satisfaction.

##### (C) Benefits for the company

1. Better product quality.
2. Staff are more motivated and quality-conscious.
3. Productivity improvement.
4. Reduced quality costs.
5. Enhanced problem solving capacity.
6. Increased market.
7. Increased competitive position of the firm, improved profitability.
8. Good public image of the enterprise by helping it to provide goods and services of higher quality at lower cost to the society.
9. Improvement in human relations and work area morale.

##### (D) Benefits to staff

1. Empowerment.
2. Enhancement of job interest and security.
3. More training and improvement in skills.
4. More recognition.
5. Reduced employee grievances.

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