**STATISTICAL QUALITY CONTROL**

* **Quality:**

**Quality can means different things to different people and can be interpreted in the variety of ways by individuals**

 **Following are some definitions of Quality**

1. **Conformance to specifications. ---from manufactures views**
2. **Fitness for use .---from consumers view**
3. **Total consumers satisfaction.**
* **Statistical Quality Control:**

**Statistical Quality Control ( S.Q.C) was introduced by Dr. Walter A. Shewhart in 1924 .S.Q.C. methods are used to ensure that the process of production is under control and to give a red signal as soon as it goes out of control .**

**Definition: Thus S.Q.C. can be defined as**

 **“The statistical technique or the method which helps to maintain the quality of material and to create goodwill in the market is known as Statistical Quality Control (S.Q.C) “**

 **‘The set of Statistical tools used for maintaining and improving the quality of output throughout the whole process of production ‘**

 **Today the S.Q.C. methods are not only used to control the quality of various industrial products, But are widely applied to many other kinds of repetitive processes viz. Storage, packing, Transportation, consumers complaints etc.**

* **Advantages Of Statistical Quality Control :**
1. **The Technique S.Q.C. is very useful in any repetitive process to maintain minimum production cost.**
2. **S.Q.C. reduces excess use of raw material.**
3. **Due to minimization in production cost you will able to maximize profit function.**
4. **S.Q.C. gives better quality assurance at lower inspection cost.**
5. **It is also use in the field of advertisement, recoveries scrap.**
6. **It is also useful to the increase efficiency of worker which lead to productivity will be maximum.**
7. **The technique of S.Q.C. helps to minimize the variation in the product.**
8. **It helps to maintain the selling price.**
* **Types of variability:**

**a) Chance Causes :**

 **In any manufacturing process and inspection, some stable pattern of variation is inherent. This pattern of variation is due to many minor causes which behave in random manner. The chance cause may be the small fluctuations in voltage of electricity, environmental changes etc. This causes can’t be prevented therefore the corresponding variation also called as allowable variation.**

**b) Assignable Causes:**

 **The second type of variation in any production process is due to non-random or in a systematic way is called assignable causes. The assignable causes include the factor like raw material of the bad quality ,improper settings of machines , wrong handling of machines , machine defects etc. Assignable causes can be identified and eliminated by taking proper care .**

**The S.Q.C. methods can be applied in two different phases of production**

**a) Process Control:**

 **In any manufacturing process the quality of the product is affected by chance and assignable causes. If the items produced by production process indicate the presence of assignable causes, we search assignable (Identifiable) cause of quality variation in the production process and remove them from production process. So that the items produced by the process will be free from the assignable causes and hence of good quality. The technique is known as process control and is achieved through the technique of control charts.**

**b) Product Control or Lot Control:**

**Product control is concerned with the inspection of items already produced. After inspection of items it is decided whether to accept the lot or not. It aims to ensure that , lots of manufactured product do not contain large proportion of defective items . Product control is mainly achieved through the technique of acceptance sampling plans.**

* **Shewhart’s Control Charts:**

**The control charts are graphic devices developed by Shewhart’s for detecting the unnatural pattern of variation in data resulting from respective process.**

 **Shewhart’s control charts provide a powerful tool to detect presence of assignable causes and it enables us to control the process at desired level in industry. We have to face two kinds of problems;**

 **i) Whether the process conforms standards and**

 **ii) To improve the level of standards by reducing variability of quality**

**Both the problem answered by using Shewhart’s control charts.**

* **Construction of Shewhart’s control charts:**

**A control charts is constructed by using following steps:**

1. **We draw samples or subgroups at regular interval of time like hourly, daily etc.**
2. **The values of characteristics of interest like length, diameter etc. are recorded for every item in sample. The summary statistics like mean, range, proportion etc. is computed for each sample or subgroup.**
3. **Along the X-axis we take sample number and on the Y-axis the characteristic under consideration such as mean, sample Range etc. Choose suitable scale.**
4. **A control charts consists of three lines along X-axis viz. Upper Control Limit (UCL), Central Limit (CL), and lower Control Limit (LCL) . These control limits are determine using probability distribution of summary statistics.**
5. **At the end we plot the points corresponding to the statistics computed for each samples or subgroup .These points are called sample points**

**The control Charts looks like the following figures;**

* **Variable Control Charts:**

**A characteristic which can be measured is called variable. e.g. length , kg , cms etc. Following charts for variables**

 **I) Mean Chart (X bar Charts)**

**II) Range Charts (R Chart)**

* **Mean Chart:**

**The procedure for the construction of mean Chart is given below**

**Step-I:**

**Calculate the mean and ranges of the samples taken denoted by X1, X2, X3…………Xn and R1, R2, R3………….Rn**

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**Step-II:**

** Calculate mean of the mean and mean of the ranges such as**

**Step-III:**

** Calculate Control Limits such as**

**Step-IV:**

 **Observe the calculated value of means and control limits to decide the scale. Take sample number on X-axis and values of mean on Y-axis with suitable scale.**

**Step-V:**

 **Draw Control limits by using value of UCL, CL. And LCL such that UCL and LCL should be in term of dots while CL will be a dark or bold Line. All these Control limits are parallel to X-axis**

**Step-VI:**

 **Plot the points by considering mean values and conclude as follows**

 **a) If all points are in between UCL and LCL then**

 **🡺 The process is in statistical control.**

**b) If any one points beyond these control limits then**

 **🡺 The process is to be out of Control.**

**Step-VII:**

 **If the mean chart shows process is out of control, then there is a presence of assignable causes. Here the producer can be stop the process and they can try to remove assignable causes**

* **Range Chart ( R Chart )**

**The procedure for the construction of Range Chart(R-Chart) is given below**

**Step-I:**

**Take sample of size ‘n’ from time to time from the product and the differences in largest and smallest values among the samples taken denote them R1, R2, R3………….Rn .**

 **Where R = Largest value – Smallest value**

 **= L - S**

**Step-II**

**Obtain mean of their ranges such as**

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**Step-III**

**Calculate Control Limits such as**

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 **Step-IV**

 **Observe the obtained values of ranges to determine the scale .**

 **Take Sample numbers on x-axis and values of R on Y-axis with suitable**

 **Scale.**

**Step-V**

 **Draw Control limits by using value of UCL, CL and LCL such that Use**

 **Dot’s to show UCL and LCL while CL will be a dark or bold Line.**

 **In this charts maximum time LCL becomes zero and hence treat**

 **X-axis as a LCL.**

 **Step-VI**

 **Plot the point of the graph and observe whether all the points are below**

 **UCL or not and comment as follows**

 **a) If all the values of Ranges are below UCL Then**

 **🡺 Variation is in control**

 **b) If any one point is above UCL**

 **🡺 Variation are not in control**

* **Control Charts for Attributes:**

**A characteristic which cannot be measured is called as attribute. e.g. defect such as cracks in a parts etc. at that time the product may be classified as defectives or non-defective. Following are charts for attribute**

 **I) Control charts for number of defectives ( np-chart)**

**II) Control charts for number of defect per unit ( C-chart )**

* **Control charts for number of defectives ( np-chart)**

**The Control chart constructed to check the quality of electronic parts like batteries , transistors to find the number of defectives items is known as control charts for number of defectives . It is also known as ‘np’ chart. It is an application of binomial distribution.**

**The procedure for the construction of np-Chart is given below**

**Step-I**

**Take a sample from a production process and inspect for a number of defectives**

**Step-II**

**Find value of ‘p’ and ‘q’ such as**

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**Step-III**

**Calculate Control Limits such as**

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**Step-IV**

 **Take Sample numbers on x-axis and number of defectives on Y-axis with suitable Scale.**

**Step-VI**

**Draw Control limits by using value of UCL, CL and LCL such that Use Dot’s to show UCL and LCL while dark or bold Line to show CL.**

**Step-VII**

**After Finding Control lines ,plot the points and comments as**

**a) If all the points are below UCL then**

 **🡺 The process is in statistical control**

**b) Any one point is above UCL**

 **🡺 The process is out of control**

* **Control charts for number of Defects per unit ( np-chart)**

**The control chart constructed for Number of defects observed in the products which is denoted as C chart .As we know that there is very small possibilities of getting defects in a finished product which leads to Poisson distribution. ‘C’ Chart is application of Poisson distribution**

**The procedure for the construction of C-Chart is given below**

**Step-I**

**Take sample from time to time and observed the defects , denote them as**

**Step-II**

**Find the mean of number of defects such as**

**Step-III**

**Calculate Control Limits such as**

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**Step-IV**

**Draw X-axis and Y-axis . Take sample no. on X-axis and Value of C on Y-axis with suitable scale**

**Step-V**

**Draw Control limits by using UCL,CL and LCL such that UCL and LCL should be show in dots lines and CL as dark lines . Sometimes LCL may be negative we can take this as zero and Thus X-axis itself will be LCL**

**Step-VI**

**Plot the point of ‘ C’ and comments such as**

**a) If all the points are below UCL then**

 **🡺 The process is in statistical control**

**b) Any one point is above UCL**

 **🡺 The process is out of control**