SQC: STATISTICAL QUALITY CONTROL

Statistics: Statistics means data, a good amount of data to obtain reliable results. The science of statistics handles this data in order to draw certain conclusions.

- **S.Q.C:** This is a quality control system employing the statistical techniques to control quality by performing inspection, testing and analysis to conclude whether the quality of the product is as per the laid quality standards.

- Using statistical techniques, S.Q.C. collects and analyses data in assessing and controlling product quality.
- The technique of S.Q.C. was though developed in 1924 by Dr. Walter A.
- Shewartan American scientist; it got recognition in industry only second world war. The technique permits a more fundamental control.

- The fundamental basis of S.Q.C. is the theory of probability.
- According to the theories of probability, the dimensions of the components made on the same machine and in one batch (if measured accurately) vary from component to component.
- This may be due to inherent machine characteristics or the environmental conditions.
- The chance or condition that a sample will represent the entire batch or population is developed from the theory of probability.

- Relying itself on the probability theory, S.Q.C. evaluates batch quality and controls the quality of processes and products. S.Q.C. uses three scientific techniques, namely;

- **Sampling inspection**
- **Analysis of the data, and**
- **Control charting**

- **ADVANTAGES OF S.Q.C :** S.Q.C is one of the tool for scientific management, and has following main advantages over 100 percent inspection:

- **Reduction in cost**: Since only a fractional output is inspected, hence cost of inspection is greatly reduced.
- **Greater efficiency:** It requires lesser time and boredom as compared to the 100 percent inspection and hence the efficiency increases.
- **Easy to apply:** Once the S.Q.C plan is established, it is easy to apply even by man who does not have extensive specialized training.
- **Accurate prediction:** Specifications can easily be predicted for the future, which is not possible even with 100 percent inspection.

- Can be used where inspection is needs destruction of items: In cases where destruction of product is necessary for inspecting it, 100 percent inspection is not possible (which will spoil all the products), sampling inspection is resorted to.
- **Early detection of faults:** The moment a sample point falls outside the control limits, it is taken as a danger signal and necessary corrective measures are taken.
- Whereas in 100 percent inspection, unwanted variations in quality may be detected after large number of defective items have already been produced.
- Thus by using the control charts, we can know from graphic picture that how the production is proceeding and where corrective action is required and where it is not required.

PROCESS CONTROL

- Under this the quality of the products is controlled while the products are in the process of production.
- The process control is secured with the technique of control charts. Control charts are also used in the field of advertising, packing etc. They ensure that whether the products confirm to the specified quality standard or not.

- Process Control consists of the systems and tools used to ensure that processes are well defined, performed correctly, and maintained so that the completed product conforms to established requirements.

- Process Control is an essential element of managing risk to ensure the safety and reliability of the Space Shuttle Program.

- It is recognized that strict process control practices will aid in the prevention of process escapes that may result in or contribute to in-flight anomalies, mishaps, incidents and non-conformances.

The five elements of a process are:

- People – skilled individuals who understand the importance of process and change control
- Methods/Instructions – documented techniques used to define and perform a process
- Equipment – tools, fixtures, facilities required to make products that meet requirements
- Material – both product and process materials used to manufacture and test products
- Environment – environmental conditions required to properly manufacture and test products

- **PROCESS CONTROL SYSTEMS FORMS**
- Process control systems can be characterized as one or more of the following forms:

- **Discrete –** Found in many manufacturing, motion and packaging applications.
- Robotic assembly, such as that found in automotive production, can be characterized as discrete process control.
- Most discrete manufacturing involves the production of discrete pieces of product, such as metal stamping.

- **Batch –** Some applications require that specific quantities of raw materials be combined in specific ways for particular durations to produce an intermediate or end result.
- One example is the production of adhesives and glues, which normally require the mixing of raw materials in a heated vessel for a period of time to form a quantity of end product.
- Other important examples are the production of food, beverages and medicine.
- Batch processes are generally used to produce a relatively low to intermediate quantity of product per year (a few pounds to millions of pounds).

- **Continuous** – Often, a physical system is represented through variables that are smooth and uninterrupted in time.
- The control of the water temperature in a heating jacket, for example, is an example of continuous process control.
- Some important continuous processes are the production of fuels, chemicals and plastics.
- Continuous processes in manufacturing are used to produce very large quantities of product per year.

STATISTICAL PROCESS CONTROL (SPC)

- SPC is an effective method of monitoring a process through the use of control charts.
- Much of its power lies in the ability to monitor both process center and its variation about that center.
- By collecting data from samples at various points within the process, variations in the process that may affect the quality of the end product or service can be detected and corrected, thus reducing waste as well as the likelihood that problems will be passed on to the customer.
- It has an emphasis on early detection and prevention of problems.

CONTROL CHARTS

- Since variations in manufacturing process are unavoidable, the control chart tells when to leave a process alone and thus prevent unnecessary frequent adjustments. Control charts are graphical representation and are based on statistical sampling theory, according to which an adequate sized random sample is drawn from each lot. Control charts detect variations in the processing and warn if there is any departure from the specified tolerance limits. These control charts immediately tell the undesired variations and help in detecting the cause and its removal.

- In control charts, where both upper and lower values are specified for a quality characteristic, as soon as some products show variation outside the tolerances, a review of situation is taken and corrective step is immediately taken.

- If analysis of the control chart indicates that the process is currently under control (i.e. is stable, with variation only coming from sources common to the process) then data from the process can be used to predict the future performance of the process.
- If the chart indicates that the process being monitored is not in control, analysis of the chart can help determine the sources of variation, which can then be eliminated to bring the process back into control.
- A control chart is a specific kind of run chart that allows significant change to be differentiated from the natural variability of the process.

- The control chart can be seen as part of an objective and disciplined approach that enables correct decisions regarding control of the process, including whether or not to change process control parameters.

- Process parameters should never be adjusted for a process that is in control, as this will result in degraded process performance.

- **Control chart is:**

- A device which specifies the state of statistical control,

- A device for attaining statistical control,

- A device to judge whether statistical control has been attained or not.

PURPOSE AND ADVANTAGES

1. A control charts indicates whether the process is in control or out of control.
2. It determines process variability and detects unusual variations taking place in a process.
3. It ensures product quality level.
4. It warns in time, and if the process is rectified at that time, scrap or percentage rejection can be reduced.
5. It provides information about the selection of process and setting of tolerance limits.
6. Control charts build up the reputation of the organization through customer's satisfaction.

A control chart consists of:

- Points representing a statistic (e.g., a mean, range, proportion) of measurements of a quality characteristic in samples taken from the process at different times.
- The mean of this statistic using all the samples is calculated (e.g., the mean of the means, mean of the ranges, mean of the proportions)

- A center line is drawn at the value of the mean of the statistic
- The standard error (e.g., standard deviation/sqrt (n) for the mean) of the statistic is also calculated using all the samples
- Upper and lower control limits (sometimes called "natural process limits") that indicate the threshold at which the process output is considered statistically 'unlikely' are drawn typically at 3 standard errors from the center line

- Control charts can be used to measure any characteristic of a product, such as the weight of a cereal box, the number of chocolates in a box, or the volume of bottled water.

- The different characteristics that can be measured by control charts can be divided into two groups: **variables and attributes.**

- A control chart for variables is used to monitor characteristics that can be measured and have a continuum of values, such as height, weight, or volume.
- A soft drink bottling operation is an example of a variable measure, since the amount of liquid in the bottles is measu
- red and can take on a number of different values. Other examples are the weight of a bag of sugar, the temperature of a baking oven, or the diameter of plastic tubing.

- A control chart for attributes, on the other hand, is used to monitor characteristics that have discrete values and can be counted.
- Often they can be evaluated with a simple yes or no decision. Examples include colour, taste, or smell.
- The monitoring of attributes usually takes less time than that of variables because a variable needs to be measured.
- An attribute requires only a single decision, such as yes or no, good or bad, acceptable or unacceptable (e.g., the apple is good or rotten, the meat is good or stale, the shoes have a defect or do not have a defect, the light-bulb works or it does not work) or counting the number of defects (e.g., the number of broken cookies in the box, the number of dents in the car, the number of barnacles on the bottom of a boat).

ADVANTAGES OF ATTRIBUTE CONTROL CHARTS

- Attribute control charts have the advantage of allowing for quick summaries of various aspects of the quality of a product, that is, the engineer may simply classify products as acceptable or unacceptable, based on various quality criteria.

- Thus, attribute charts sometimes bypass the need for expensive, precise devices and time-consuming measurement procedures.

- Also, this type of chart tends to be more easily understood by managers unfamiliar with quality control procedures; therefore, it may provide more persuasive (to management) evidence of quality problems.

ADVANTAGES OF VARIABLE CONTROL CHARTS

- Variable control charts are more sensitive than attribute control charts.
- Therefore, variable control charts may alert us to quality problems before any actual "unacceptables" (as detected by the attribute chart) will occur.
- Montgomery (1985) calls the variable control charts leading indicators of trouble that will sound an alarm before the number of rejects (scrap) increases in the production process.

COMMONLY USED CHARTS

- 1. (X-Bar) and R charts, for process control.
- 2. P chart, for analysis of fraction defectives
- 3. C chart, for control of number of defects per unit.

ACCEPTANCE SAMPLING PLANS

- A sampling plan is a plan for acceptance sampling that precisely specifies the parameters of the sampling process and the acceptance/rejection criteria.
- The variables to be specified include the size of the lot (N), the size of the sample inspected from the lot (n), the number of defects above which a lot is rejected (c), and the number of samples that will be taken.

- There are different types of sampling plans.

- Single Sampling (Inference made on the basis of only one sample)

- Double Sampling (Inference made on the basis of one or two samples)

- Sequential Sampling (Additional samples are drawn until an inference can be made) etc.