Govt. Engineering college, Jhalawar
Department of Mechanical Engineering
Modal Question Paper 3rd year 5th Sem
Subject:- Quality Assurance and Reliability

Que.1 Explain meaning of quality with example and Quality of Conformance with factors controlling it.

Que.2 Explain Quality policies and objectives and Cost of Appraisal and Internal And External Failure.

Que.3 What is frequency distribution? Explain binomial distribution with example.

OR

Explain difference between Attribute and Variable data.

Que.4 What do you understand by "Bath Tub Curve"? What is use of this curve?

Que.5 Discuss sampling with help of an imaginary example of any organization. Also write down the basics of subgrouping.

Que.6 Discuss Six-Sigma process and its concept. Also explain why six sigma is used?

OR

Differentiate between probability sampling and non-probability

Solution

Ans.1 a) Quality of design

Quality of design is the quality which the producer or supplier is intending to offer to the customer. When the producer is making the quality of design of the product, he should take into consideration the customer's requirements in order to satisfy them with **fitness for use** of the product.

If the quality of design does not reflect the customer's requirements, the product which the producer offers him would not probably satisfy the customer, even if it does sufficiently conform to the design. Quality of design is usually indicated by completeness and correctness of specifications, drawings, catalogues, etc. and is measured with fitness for use.

Quality of conformance

Quality of conformance is the level of the quality of product actually produced and delivered through the production or service process of the organization as per the specifications or design. When the quality of a product entirely conforms to the specification (design), the quality of conformance is deemed excellent.

Specifications are targets and tolerances determined by the designer of a product. Targets are the ideal values for which production is expected to strive; tolerances are acceptable deviations from these ideal values recognizing that it is difficult to meet the exact targets all the time due to variability in material, machine, men and process.

OR

Ans. 2 Cost of poor quality (COPQ): The costs associated with providing poor quality products or services. There are four categories: internal failure costs (costs associated with defects found before the customer receives the product or service), external failure costs (costs associated with defects found after the customer receives the product or service), appraisal costs (costs incurred to determine the degree of conformance to quality requirements) and prevention costs (costs incurred to keep failure and appraisal costs to a minimum).

Cost of quality is a methodology that allows an organization to determine the extent to which its resources are used for activities that prevent poor quality, that appraise the quality of the organization’s products or services, and that result from internal and external failures. Having such information allows an organization to determine the potential savings to be gained by implementing process improvements.

Quality-related activities that incur costs may be divided into prevention costs, appraisal costs, and internal and external failure costs.

Prevention costs

Prevention costs are incurred to prevent or avoid quality problems. These costs are associated with the design, implementation, and maintenance of the quality management system. They are planned and incurred before actual operation, and they could include:

- Product or service requirements—establishment of specifications for incoming materials, processes, finished products, and services
- Quality planning—creation of plans for quality, reliability, operations, production, and inspection
- Quality assurance—creation and maintenance of the quality system
- Training—development, preparation, and maintenance of programs

Appraisal costs

Appraisal costs are associated with measuring and monitoring activities related to quality. These costs are associated with the suppliers' and customers' evaluation of purchased materials, processes, products, and services to ensure that they conform to specifications. They could include:

- Verification—checking of incoming material, process setup, and products against agreed specifications
- Quality audits—confirmation that the quality system is functioning correctly
- Supplier rating—assessment and approval of suppliers of products and services

Internal failure costs

Internal failure costs are incurred to remedy defects discovered before the product or service is delivered to the customer. These costs occur when the results of work fail to reach design quality standards and are detected before they are transferred to the customer. They could include:

- Waste—performance of unnecessary work or holding of stock as a result of errors, poor organization, or communication
- Scrap—defective product or material that cannot be repaired, used, or sold
- Rework or rectification—correction of defective material or errors
- Failure analysis—activity required to establish the causes of internal product or service failure

External failure costs

External failure costs are incurred to remedy defects discovered by customers. These costs occur when products or services that fail to reach design quality standards are not detected until after transfer to the customer. They could include:

- Repairs and servicing—of both returned products and those in the field

- Warranty claims—failed products that are replaced or services that are re-performed under a guarantee
- Complaints—all work and costs associated with handling and servicing customers' complaints
- Returns—handling and investigation of rejected or recalled products, including transport costs

Cost of quality and organizational objectives

The costs of doing a quality job, conducting quality improvements, and achieving goals must be carefully managed so that the long-term effect of quality on the organization is a desirable one.

These costs must be a true measure of the quality effort, and they are best determined from an analysis of the costs of quality. Such an analysis provides a method of assessing the effectiveness of the management of quality and a means of determining problem areas, opportunities, savings, and action priorities.

Cost of quality is also an important communication tool. Philip Crosby demonstrated what a powerful tool it could be to raise awareness of the importance of quality. He referred to the measure as the "price of nonconformance" and argued that organizations choose to pay for poor quality.

Many organizations will have true quality-related costs as high as 15 to 20 percent of sales revenue, some going as high as 40 percent of total operations. A general rule of thumb is that costs of poor quality in a thriving company will be about 10 to 15 percent of operations. Effective quality improvement programs can reduce this substantially, thus making a direct contribution to profits.

The quality cost system, once established, should become dynamic and have a positive impact on the achievement of the organization's mission, goals, and objectives.

Ans.3 Binomal Distribution :- A probability distribution is a function or rule that assigns probabilities of occurrence to each possible outcome of a random event. Probability distributions give us a visual representation of all possible outcomes of some event and the likelihood of obtaining one outcome relative to the other possible outcomes.

A binomial distribution is a specific probability distribution. It is used to model the probability of obtaining one of two outcomes, a certain number of times (k), out of fixed number of trials (N) of a discrete random event.

A binomial distribution has only two outcomes: the expected outcome is called a success and any other outcome is a failure. The probability of a successful outcome is p and the probability of a failure is $1 - p$.

A successful outcome doesn't mean that it's a favorable outcome, but just the outcome being counted. Let's say a discrete random event was the number of persons shot by firearms last year. We'd be looking for the probability of obtaining some number of victims out of the pool of

shootings. Being shot is neither a favorable nor a successful outcome for the victim, yet it is the outcome we are counting for this discrete variable.

Given a couple has 5 children, what is the probability that exactly 3 will be boys?
Possible outcomes: boy or girl
Fixed number of repeated independent trials: 5
Out of 5 trials, exactly 3 children are boys = success
Probability of success (0.5) + probability of failure (0.5) = 1

OR

b) Variable Data

Variable data include numerical measurements about a product or item, such as its size, weight or age. The measurements for a 70-inch television, foot-long ruler, or a turkey that weighs 10 pounds are all examples of variable data. You can also get averages from this kind of data, such as an average age for a population in a city or the average temperature on any given day of the year.

Attribute Data

Attribute data consider the quality of a product or item rather than quantifiable numbers. They provide ancillary information about these things, such as the color or finish of a product. Attribute data may also include a count of some sort, such as the number of people who go to the movies, or how many products manufactured by a machine are defective. You cannot use attribute data to calculate other information, such as averages or rankings.

Benefits of Variable Data

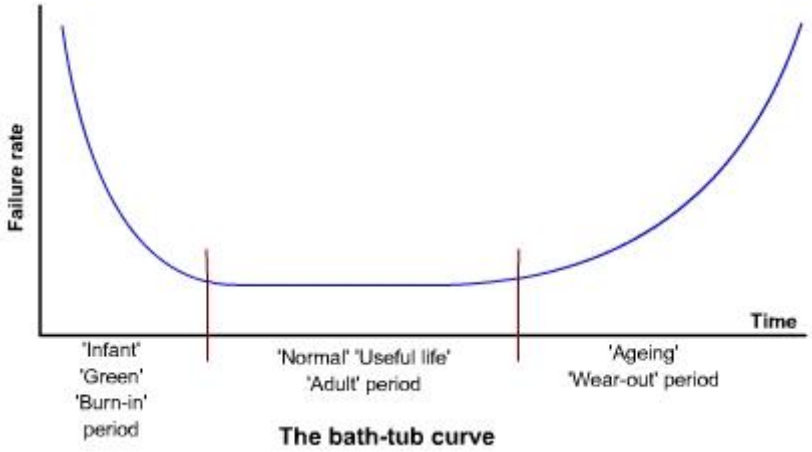
Variable data provide detailed and concrete information about a product. In contrast, attribute data may be obscure or unhelpful. For example, if nails need to be made to a one-inch specification, with a leeway of 0.1-inches either way, variable data about each nail would provide the exact length. Attribute data would only state whether each nail fit the specification or not. It wouldn't state whether the nail was too long or too short.

Benefits of Attribute Data

Attribute data are often more helpful when qualitative information is needed. Examples include the state of an object, non-numerical characteristics and customer feedback. For example, the attribute data might count the number of people who shop at a specific store, or the size of a product, such as a small or large serving of food. Attribute data are useful for analysis as you can use attribute data to create ratios, percentages or charts, whereas variable data don't lend itself as freely to this.

Ans.4 **BATH TUB CURVE**

Most products go through three distinct phases from product inception to wear out. Figure below shows a typical life cycle curve for which the faiure rate is plotted as function of time.



The bath-tub curve

Infancy / Green / Debugging / Burn-in-period: Many components fail very soon after they are put into service. Failures within this period are caused by defects and poor design that cause an item to be legitimately bad. These are called infant mortality failures and the failure rate in this period is relatively high. Good system vendors will perform an operation called "burn in" where they put together and test a system for several days to try to weed out these types of problems so the customer doesn't see them.

Chance failure / Normal Operating Life: If a component does not fail within its infancy, it will generally tend to remain trouble-free over its operating lifetime. The failure rate during this period is typically quite low. This phase, in which the failure rate is constant, typically represents the useful life of the product.

Wear out / Ageing: After a component reaches a certain age, it enters the period where it begins to wear out, and failures start to increase. The period where failures start to increase is called the wear out phase of component life.

Reliability Determination

In the adult or mature phase the failure rate of a component or system is constant. Under such conditions the time to failure follows an exponential law, and the probability density function of exponential distribution is as given below:

$f(t) = \lambda e^{-\lambda t}$

Where ? denotes the failure rate. The Mean time to failure MTTF for the exponential distribution is

MTTF = 1 / ?

If the failure rate is constant, the MTTF is the reciprocal of the failure rate. For repairable system it is also equal to MTBF.

The reliability at time t, R(t), is the probability of the product lasting up to at least time t. It is given by

$R(t) = 1 - F(t) = 1 - \int_0^t e^{-\lambda t} dt = e^{-\lambda t}$

Ans.5 In statistics, quality assurance, and survey methodology, **sampling** is the selection of a subset (a statistical sample) of individuals from within a statistical population to estimate characteristics of the whole population. Two advantages of sampling are that the cost is lower and data collection is faster than measuring the entire population.

Each observation measures one or more properties (such as weight, location, colour) of observable bodies distinguished as independent objects or individuals. In survey sampling, weights can be applied to the data to adjust for the sample design, particularly stratified sampling. Results from probability theory and statistical theory are employed to guide the practice. In business and medical research, sampling is widely used for gathering information about a population. Acceptance samplingis used to determine if a production lot of material meets the governing specifications.

Successful statistical practice is based on focused problem definition. In sampling, this includes defining the population from which our sample is drawn. A population can be defined as including all people or items with the characteristic one wishes to understand. Because there is very rarely enough time or money to gather information from everyone or everything in a population, the goal becomes finding a representative sample (or subset) of that population. In the most straightforward case, such as the sampling of a batch of material from production (acceptance sampling by lots), it would be most desirable to identify and measure every single item in the population and to include any one of them in our sample. However, in the more general case this is not usually possible or practical. There is no way to identify all rats in the set of all rats. Where voting is not compulsory, there is no way to identify which people will actually vote at a forthcoming election (in advance of the election). These imprecise populations are not amenable to sampling in any of the ways below and to which we could apply statistical theory.

Sampling methods

Within any of the types of frames identified above, a variety of sampling methods can be employed, individually or in combination. Factors commonly influencing the choice between these designs include:

- Nature and quality of the frame
- Availability of auxiliary information about units on the frame
- Accuracy requirements, and the need to measure accuracy
- Whether detailed analysis of the sample is expected
- Cost/operational concerns

Ans.6 **Six Sigma** (**6σ**) is a set of techniques and tools for process improvement. It was introduced by engineer Bill Smith while working at Motorola in 1986. Jack Welch made it central to his business strategy at General Electric in 1995.

It seeks to improve the quality of the output of a process by identifying and removing the causes of defects and minimizing variability in manufacturing and business processes. It uses a set of quality management methods, mainly empirical, statistical methods, and creates a special infrastructure of people within the organization who are experts in these methods. Each Six Sigma project carried out within an organization follows a defined sequence of steps and has specific value targets, for example: reduce process cycle time, reduce pollution, reduce costs, increase customer satisfaction, and increase profits.

The term *Six Sigma* (capitalized because it was written that way when registered as a Motorola trademark on December 28, 1993) originated from terminology associated with statistical modeling of manufacturing processes. The maturity of a manufacturing process can be described by a *sigma* rating indicating its yield or the percentage of defect-free products it creates. A six

sigma process is one in which 99.99966% of all opportunities to produce some feature of a part are statistically expected to be free of defects (3.4 defective features per million opportunities). Motorola set a goal of "six sigma" for all of its manufacturing operations, and this goal became a by-word for the management and engineering practices used to achieve it.

Six Sigma doctrine asserts:

- Continuous efforts to achieve stable and predictable process results (e.g. by reducing process variation) are of vital importance to business success.
- Manufacturing and business processes have characteristics that can be defined, measured, analyzed, improved, and controlled.
- Achieving sustained quality improvement requires commitment from the entire organization, particularly from top-level management.

Features that set Six Sigma apart from previous quality-improvement initiatives include:

- A clear focus on achieving measurable and quantifiable financial returns from any Six Sigma project.
- An increased emphasis on strong and passionate management leadership and support.
- A clear commitment to making decisions on the basis of verifiable data and statistical methods, rather than assumptions and guesswork.

OR

b) Sampling means selecting a particular group or sample to represent the entire population. Sampling methods are majorly divided into two categories probability sampling and non-probability sampling. In the first case, each member has a fixed, known opportunity to belong to the sample, whereas in the second case, there is no specific probability of an individual to be a part of the sample. For a layman, these two concepts are same, but in reality, they are different in the sense that in **probability sampling** every member of the population gets a fair chance of selection which is not in the case with **non-probability sampling**. Other important differences between probability and non-probability sampling are compiled in the article below.

BASIS FOR COMPARISON	PROBABILITY SAMPLING	NON-PROBABILITY SAMPLING
Meaning	Probability sampling is a sampling technique, in which the subjects of the population get an equal opportunity to be selected as a representative sample.	Nonprobability sampling is a method of sampling wherein, it is not known that which individual from the population will be selected as a sample.
Alternately	Random sampling	Non-random sampling

BASIS FOR COMPARISON	PROBABILITY SAMPLING	NON-PROBABILITY SAMPLING
known as		
Basis of selection	Randomly	Arbitrarily
Opportunity of selection	Fixed and known	Not specified and unknown
Research	Conclusive	Exploratory
Result	Unbiased	Biased
Method	Objective	Subjective
Inferences	Statistical	Analytical
Hypothesis	Tested	Generated