**Chapter 5**

**Concept of quality**

One of the accepted definitions of quality is **fitness for use**. An equally good definition is conformance to requirements. According to Webster dictionary, quality can be defined as the degree of excellence of a thing. On the other hand, American society for quality defines as the totality of features and characteristics that satisfies needs. Therefore, quality refers to the ability of a product or service to consistently meet or exceed customer satisfaction.

**Consumer perspective**: fitness for use, how well a product or service does what is supposed to do. It also involves designing quality characteristics in to a product or service.

**Producer’s perspectives**: making sure whether it is produced according to design standards or specifications.

**Dimensions of quality for manufactured products**: Although they may vary somewhat from product to product or product to service, the dimensions of quality include:

1. **Performance:** basic operating characteristics of the product, how to works.
2. **Special features:** extra item added to special features.
3. **Conformance:** the degree to which a product meets pre- established standards.
4. **Reliability:** consistency of performance or probability that a product will operate properly within an expected time frame. TV will work for about 7 years without replacement.
5. **Durability;**useful life of the product or service. How long a product lasts before replacement.
6. **Serviceability:** ease of getting repairs, speed of repairs, courtesy and competency of the repair person.
7. **Aesthetics:** how well a product looks, feels, smells, sounds or tests.
8. **Safety:** assurance that customers will not suffer injury or harm a product.

**Determinant of service quality**: The personal component of services is more difficult to measures than the quality of the tangible component. Generally, the user of a service like the user of a good has features in mind that form a basis for comparisons among alternatives. Lack of anyone features may eliminate the services from further consideration. Quality also may be perceived as bundle of attributes to which many lesser characteristics are superior to those of competitor.

* **Reliability**: involves consistency of performance and dependability. It means that the firm performs the service right the first time and that the firm honors its premises.
* **Responsiveness:** concerns the willingness or readiness of employers to provide service. It involves timelines of service.
* **Competence**: means possession of the required skills and knowledge to perform the service.
* **Access:** involves approachability and ease of contact
* **Courtesy**: involves politeness, respect, consideration and friendliness of contact personnel (including receptionists, telephone operator).
* **Communication:** means keeping customers involved in language they can understand and listening to them. It means that the company has adjusted its language for different customers increasing the level of sophistications with a well-educated customer and speaking simply and plainly with a novice.
* **Credibility:** involves trustworthiness, believability and honesty. It involves having the customer’s best interest at heart.
* **Security:** it is freedom from danger, risk or doubt.
* **Understanding/knowing the customer**: involves making the effort to understand the customer’s needs.

**Cost of quality**

The term cost of quality is often a misnomer. Cost of quality is a measure of the cost to the firm for a lack of quality. It is very difficult to measure and often cannot be found in account books. One has to carefully back calculate, as most of the cost elements are hidden. Quality costs are distributed throughout the organization. Most organizations include only the cost of quality control departments whereas the cost of inspection, and measurement carried out in production departments are often ignored.

 More importantly the cost of bad workmanship, wastages, rework, etc. is often not included in quality costs. Careful examination of quality costs should account for Prevention, Assessment, Control Costs and costs due to lack of control. “Quality is free, productivity. But it is not a gift".

This statement sums up the opinion that effective; permanent quality improvement is difficult to achieve, but more than pays for it in increased

1. Costs of achieving good quality: prevention and appraisal costs
2. Costs of poor quality: internal failure and external failure costs.

**Preventions costs**

These are costs related to reducing the potential for quality problems. Preventions costs relate to attempts to prevent defects before occurring. Example, quality improvement program, training personnel, redesigning the product or service, purchasing new equipment and inspection of incoming material before going to the process of production.

**Appraisal costs**

these involves costs of testing and inspecting materials, parts and products at various stages and at the end of the process to conform with quality standards, costs of maintain equipment, costs of labs, inspectors(operator), time spent by operator to get data for testing product quality or make equipment adjustment to maintain quality and to stop work to asses quality.

**Internal failure costs**

These involve the different kinds of costs that result from production of defective productive/services before delivery to customers. This includes the following.

**Scarp costs**: costs of poor quality products that must be discarded, including labor, material and other costs.

**Rework costs**: costs of fixing defective products to conform to quality specifications.

**Process failure costs**: costs of determining why production process is producing poor quality products.

**Process downtime costs**: costs of shutting down production process to fix a problem.

**Price-down grading costs**: costs of discounting poor quality products.

Internal failure costs occur because of several reasons. These are, receiving defective materials from vendors, incorrect machine setting, usage of faulty equipment, carelessness, improper materials handling procedures and lack of well-trained employees.

**External failures costs**

These are that occur after delivery of products or services to the customer. Example

* Warranty claim costs
* Customer compliant costs (costs of investigating and satisfactory responding to a customer complaints resulting from poor products).
* Loos of customers(loos of good will)
* Product return costs (costs of handling and replacing poor quality products returned by a customer).

**Total Quality management (TQM)**

TQM refers to an organizations- wide effort to achieve quality. It is a philosophy about quality intended to involve everyone in the organizations in controlling quality. It extends to suppliers as well as customers. Customer is the focal point in TQM and customer satisfaction is the driving force and total involvement is important.

TQM is an interlocking arrangement of procedures and practices that ensures all employees in every department are adequately trained and directed to continuously implement aligned improvements in quality, service and total costs such that customer satisfaction are meet or exceeded.

Fundamentals principles of TQM

1. Understand and answer the voice of the customer
2. All people must be involved in quality management
3. Continuously strive for zero defects/continuous improvements
4. Design and build quality in to the product
5. Focus on the process
6. Quality function deployment
7. Quality improvement tools
8. Suppliers are partners in quality

**Understanding voice of the customer**

We should find out customer want by means of customer survey, focus group discussion or interview to integrate customer’s voice in decision making process. This is because designing a product or service that meet or exceed customers want makes it easy to use and produce.

**Employee involvement in quality management**

This refers to involving employees in every stage of the production process. This includes

* Giving workers the responsibility for improvements
* Put decision making in to the hands of those who are closest to the job
* Everyone must be totally committed.

**Continuous improvements**

TQM requires never ending process of continuous improvements on people, equipment’s, suppliers, materials and procedures. The basis of the philosophy is that every aspect of an organization can be improved.

The end goal is perfection, which is never achieved but always sought. Ceasing improvement lead to loss of competitive advantage a decreased level of customer satisfaction.

The Japanese work Kaisen refers to ongoing process of unending improvement as well as the in U.S terms in TQM zero defects six sigma are also used to describe continuous improvement efforts.

**Design and build in to the product:** this contains

* Design a quality product in the beginning
* Design to prevent quality problems
* Design for reliability and serviceability
* Specify methods of measurement
* Design must satisfy customers

**Focus on the process**

Process is a repetitive set of interacting activities that uses resources to transform inputs in to outputs. So, focusing on the process involves

* Looking at variations i.e. special and common cause variations
* Variations due to chance(common cause) i.e. inherent variations, nothing can be 100%
* Variations due to special causes: example, warm parts, incorrect machines setting etc.

**Quality function deployment**

Customers should be involved in the design stage of new/redesigned products. The idea is to try to much customer requirements with the engineering characteristics of a product.

**Knowledge of TQM tools**

To empower employees and implement TQM as a continuing effort, everyone in the organizations is trained in the use of quality control and improvement tools. The term quality at the sources refers to making each worker responsible for the quality of his/her work. When the work is passed on to the next operation in the process (the internal customers who receive his output) or if that step is the last step in the production process, the worker is certifying that it meet quality standards.

**Suppliers**: are regarded as partners in the process. They are also expected to provide quality at the source, thereby reducing or eliminating the need to inspect delivers from suppliers.

The basic quality controls tools

There are a number of tools that can be used to collect, present and analyze data about any kind of process, including service processes. Within the quality literature, seven basic tools have been identified that can assist managers in improving the quality of their process. Theses seven basic quality control (QC) tools are:

1. **Process flowchart(diagrams)**

Processes flow diagrams or flow charts each of the steps that are required to produce either a good or a service. The primary purpose for using flow chart analysis is to properly sequence the various tasks that are required to produce a given product or services and to identify any bottlenecks in the process that limits its overall capacity. The purpose of flowcharting, from a quality improvement perspective is to identify those steps in the process that could be potential source of error.

1. **Checksheet**

Most of us have collected data about some process by noting how frequently an event occurs and making atick mark for a particular category in a checksheet.

1. **Bar charts and histograms**

Bar charts and histograms visually display data variations. A bar chart is used to graph nominal data (also called categorical or attribute data), which are data can be categorized and counted, rather than measured.

1. **Pareto charts**

Pareto charts (sometimes referred to as Pareto analysis) are specialized bar charts.in this charts the frequency of occurrence of errors is sorted in descending order and a cumulative percent line is typically added to make it easier to determine how the errors add up.

Pareto charts can help to establish priorities for action, focusing attention on those errors that occurs most frequently.

1. **Scatterplots (diagrams)**

Scatterplots show the relationship between two measured (no counted) variables. For example in upscale restaurant, you may want to understand the relationship between how long customer waits to have their orders taken and how satisfied they are with their service.

1. **Run (trend) charts**: Run charts show the behavior of some variable over time.
2. **Cause**-and-effect(fishbone ) diagrams

Cause-and-effect diagrams (also known as fishbone diagrams or Ishikawa diagrams, after their inventor) are used to identify the cause that lead to a particular outcomes or effect.

**Statistical quality controls**

One of the cornerstones of quality control is the use of statistical methods to determine how much inspection to use. In many case a great deal can be saved by taking a sample rather than making 100 percent inspection. In other cases there is no alternative but to take a sample .e.g. destructive testing. Two distinct types of statistical methods are available: acceptance sampling and process control. Consider each in the following discussion.

**Acceptance sampling**

Applies to lot inspection where a decision to accept or reject a lot of materials is made on the basis of random sample drawn from the lot. This type of inspection is frequently used for incoming raw materials or for finished goods prior to shipment.

Generally it can be defined as taking one or more samples at random from a lot of items, inspecting each of the items in the sample (s) and deciding – on the basis of inspection result- whether to accept or reject the entire lot. This type of inspection can be used by the customers to ensure that quality standards are met prior to shipments. Acceptance sampling is used in preference to 100% inspection where ever the cost of inspection is high in relation to the cost of passing defective items to the customer.

In a single acceptance sampling, one sample is taken from a lot and the decision whether to accept or reject the lot is made after the sample is inspected and compared with standards.

Formally, we let:

 n= sample size

 c= acceptance number

 x= number of defective units found in the sample.

For single sampling, the decision rule whether to accept or reject the lot after inspecting the sample is as follows:

 If x ≤ c, accept the lot

 If x>c, reject the lot

For example, suppose we have a lot of 10,000 items and we decided to take a random sample of 100 items (n=100). We inspect the 100 items and find 3 defectives(x=3). Assume the acceptance number in this case is 2(c=2). Since the number of defective units in the sample exceeds the acceptance number, the lot of 10,000 units will be rejected. Note that very good lots or very bad lots will usually require only one sample and lots of medium quality may require two or more samples to reach a decision.

**Process quality control system**

No two products or services are exactly alike because the processes used to produce them contain many sources of variation, even if the processes are working as intended. For example, the time required to process a credit card application varies because of the load on the credit department, the financial background of the applicant, and the skill & attitude of the employees. Nothing can be done to eliminate variation in process output completely, but management can investigate the cause of variation. Generally, the source of variation can be:

1. Common causes of variation: which are purely random, unidentifiable sources of variation that are unavoidable with the current process. No matter how perfectly the process is designed, there will be some variability in quality characteristics from one unit to the next. For example, a machine filling cereal boxes will not deposit exactly the same weight in each boxes; the amount filled will vary around some average figure. The aim of process control is to find the range of *natural variation* of the process and to then ensure that production stays within this range. Natural variation is usually under the state of control.
2. Assignable causes: The second category of variation is assignable sources of variation also called special cases includes any abnormal variations which are not usually found in a state of control. Assignable causes of variation are any variation causing factor that can be identified and eliminated. Assignable causes that results abnormal variation may include: lax (careless) procedures, untrained operators, improper machine maintenance. The first job of process control manager is to seek out these sources of unnecessary variation and bring the process under statistical control, where the remaining variation is due to random causes.

A process can be brought to a state of control and can be maintained in this state through the use of quality control charts –also called process chart or control chart.

In the control chart shown below the Y axis represents the quality characteristics which is being controlled while the X axis represent time or particular sample taken from the process. The center line of the chart is the average quality characteristic being measured. The upper control limit represents the maximum acceptable random variations and the lower control limit indicates the minimum acceptable random variation when a state of control exists. Generally speaking, the upper and lower control limits are set at +- three standard deviations from the mean. If normal probability distribution is assumed, these control limits will include 99.7 % of the random variations observed.

*Process control chart*

 Stop the process.

 Look for assignable cause

 Average +3 upper control limits (UCL)

 SD

 Quality central line (CL)

 Measurement

 Average

 Average -3 SD lower control limits (LCL) stop the process.

 Look for assignable

After a process has been brought to steady –state operation, periodic samples are taken and plotted on the control chart. When the measurement falls within the control limits, the process is continued. If the measurement falls outside the control limits, the process is stopped and a search is made for an assignable causes. Through this procedure, the process is maintained in a constant state of statistical control and there is only natural variation in the processes output.

***Quality measures***: to detect abnormal variation, inspectors must be able to measure quality characteristics. Quality can be evaluated in two ways. One way is to measure variables i.e. product or service characteristics such as weight, length, volume or time that can be measured. Another way to evaluate quality is to measure attributes- i.e. product or service characteristics that can be quickly counted for acceptable quality.

Generally as discussed below, quality can be measured for control charts by attributes or by variables.

1. **Process control with attribute measures: using P charts**

The P chart is commonly used control chart for attributes. The quality characteristic is counted rather than measured and the entire item or service can be declared good or defective. For example in the bank industry, the attributed counted might be the number of non endorsed deposits or the number of incorrect financial statements sent. The method involves selecting a random sample, inspecting each item in it, and calculating the sample proportion defective (-p) *which is the number of defective units (p)* divided by the sample size (n). Sampling for P- charts involves yes- no decisions: the item or service either ‘is’ or “is not’ defective. The underling statistical distribution is based on the binomial distribution. However, for large sample size the normal distribution provides a good approximation to it

To get the center line and control limits of the ‘P’ control chart, we take a large number of samples of ‘n’ units each. The P value is computed for each sample and then averaged over all samples to yield a value –p. This value of –p is used as the centre line, since it represents the best available estimate of the true average percent defective. We also use the value of –p to compute upper and lower control limits.

To construct the P chart, calculate:

In this case the, the process’s standard deviation is the quantity under the square root sign. We are adding and subtracting three standard deviations from the mean to get the control limits. After the p control charts is constructed with this center line and lower control limits, samples of the process being controlled are taken and plotted on the chart i.e. the observed values of ‘p’ are plotted on the chart, one for each sample. If the sample percentage falls within the control limits, no action is taken. If the sample percentage falls outside the control limits, the process is stopped and a search for an assignable cause (material, operator, or machine) is made. After the assignable cause is found and corrected – or, in a very rare case, no assignable cause is found-the process is restored to operating condition and production is resumed.

Example: suppose samples of 200 cards are taken from a key punch operation at 2 hours interval to control the keypunch process. The percentage of cards in error for the past 10 samples is found to be 0.7, 1.2, 1.6, 2.0, 1.0, 0.8, 1.8, 1.5, 0.9, and 1.2 percent is the process out of control?

 The average of these sample percentages yields a –p=1.27 percent or 0.0127 (sum of all samples divided by sample number i.e.10) which is the centre line of the control chart. The upper and lower control limits are:

When the LCL is negative, it is rounded up to 0 because a negative percentage is impossible. Thus we have the following charts.

 3.64 UCL

 \*

 \*

 \* \* CL

 1.27 \* \*

 \* \* \*

 0 \* LCL

Since all sample points are found to be in the control, these 10 samples can be used to establish the centre line and control limits.

Example:-The operations manager of the booking services department ABC bank is concerned about the number of wrong customer account numbers recorded by the ABC bank’s personnel. Each week a random sample of 2500 deposit is taken, and the number of incorrect account numbers is recorded. The results for the past 12 weeks are shown in the following table. Is the process out of control?

|  |  |  |  |
| --- | --- | --- | --- |
| Sample No, | Wrong account Number | Sample Number | Wrong account Number |
| 1 | 15 | 7 | 24 |
| 2 | 12 | 8 | 7 |
| 3 | 19 | 9 | 10 |
| 4 | 2 | 10 | 17 |
| 5 | 19 | 11 | 15 |
| 6 | 4 | 12 | 3 |
| Total | 147 |