# CHAPTER FIVE

# TOTAL QUALITY MANAGEMENT

## 5.1. Introduction

Fundamental to any quality program is the determination of quality specification and the cost of achieving and not achieving those specifications.

- Quality can be derived as conformance to specification. “Fitness for use (satisfies customer needs).
- Managing the entire organization so that it excels on all dimensions of products and services that are important to customers.
- Quality management begins before products and services delivered to customers. Raw materials must meet the appropriate specification, strength, size, color, finish, appearance, chemical content and other characteristics. As the materials proceed through production, the quality of partially completed Work In Progress (WIP) products monitored to determine whether the production processes are operating as intended. The finished products and services are inspected to determine their acceptability.

While quality management is cross functional in nature and involves the entire organization, operations have special responsibility to produce a quality product for the customer. This requires the cooperation of the entire organization and careful attention to management and control of quality.

- Quality can be defined in a number of different ways. In an article entitled “what does product quality really mean?” David Garvin, discuss five approaches to define quality:
- He states that a common notion of quality is that it is synonymous with „superiority’ or ‘innate excellence’. From this view point, quality cannot be precisely defined but can only be recognized through experience.
- A second view point is that quality is precise and measurable concept and that differences in quality reflect differences in quantity of some product attributes. For instance, high quality ice cream has high butterfat content. According to this approach, quality can be

ranked based on the amounts of the desired attributes they possess. (It is Product based view)

- The third view is that quality is determined by what a customer wants and is willing to pay. According to this view the goods and services that best satisfy individual consumer‟s unique needs or wants are regarded as having the highest quality. Thus quality can be defined as fitness for intended use, or in other words, how well the product performs its intended functions. (user based view)
- A fourth definition of quality arises from the unique perspective of manufacturing operations. In this setting quality is associated with engineering and manufacturing practices; hence, the perspective of quality is synonymous with conformance to specification. Quality conformance can be defined as, how well manufacturing is able to meet design specification. (manufacturing view)
- Finally, the value based approach to quality defines it in terms of cost and price. In this sense, a quality product is one that provides a predetermined level of performance at an acceptable price or provide conformance to design specification at an acceptable cost. (Value based approach)

In considering all these approaches to quality, it is clear that the meaning of quality depends on one's view point and places in the organization. Thus, different definitions are needed. Moreover it is necessary to shift one's perspective of quality as products move from their design stage to market. All of the viewpoints just presented are necessary in order to result in an overall quality product.

**Differences between Manufacturing and Service Organizations**

Defining quality in manufacturing organizations is often different than it is for service organizations. Manufacturing organizations produce a tangible product that can be seen, touched, and directly measured. Examples include cars, CD players, clothes, computers, and food items. Therefore, quality definitions in manufacturing usually focus on tangible product features.

The most common quality definition in manufacturing is conformance, which is the degree to which a product characteristic meets preset standards. Other common definitions of quality in manufacturing include performance, such as acceleration of a vehicle; reliability, meaning that

the product will function as expected without failure; features, the extras that are included beyond the basic characteristics; durability, the expected operational life of the product; and serviceability, how readily a product can be repaired. The relative importance of these definitions is based on the preferences of each individual customer. It is easy to see how different customers can have different definitions in mind when they speak of high product quality.

| Manufacturing Organizations | Service Organizations |
|---|---|
| Conformance to specifications | Intangible factors |
| Performance | Consistency |
| Reliability | Responsiveness to customer needs |
| Features | Courtesy/friendliness |
| Durability | Timeliness/promptness |
| Serviceability | Atmosphere |

In contrast to manufacturing, service organizations produce a product that is in- tangible. Usually, the complete product cannot be seen or touched. Rather, it is experienced. Examples include delivery of healthcare, the experience of staying at a vacation resort, and learning at a university. The intangible nature of the product makes defining quality difficult. Also, since a service is experienced, perceptions can be highly subjective. In addition to tangible factors, quality of services is often defined by perceptual factors. These include responsiveness to customer needs, courtesy and friendliness of staff, promptness in resolving complaints, and atmosphere. Other definitions of quality in services include time, the amount of time a customer has to wait for the service; and consistency, the degree to which the service is the same each time. For these reasons, **Overview of Total Quality Management (TQM**

TQM: An integrated effort designed to improve quality performance at every level of the organization.

Now-a-days, customers demand products/services with greater durability and reliability at the most economic price. This forces producers to strictly follow quality procedures right from design till shipment and installation of the products. So that goal of any competitive industry is to provide a product or service at the most economical costs, ensuring full customer satisfaction.

This can be achieved through Total Quality Management (TQM), because, quality is not a technical function, but a systemic process extending throughout all phases of the business, e.g., marketing, design, development, engineering, purchasing, production/operations. Defining quality in services can be especially challenging.

As per Feigenbaum, ―Total Quality Management is an effective system of integrating the quality development, quality maintenance and quality improvement efforts of various groups in an organization so as to enable marketing, engineering, production and service at the most economical levels which allow for full customer satisfaction‖.

**Benefits of TQM**

The benefits of TQM can be classified into the following two categories:

- Customer satisfaction oriented benefits.
- Economic improvements oriented benefits.

1. Customer satisfaction oriented benefits: The benefits under this category are listed below:
   (a) Improvement in product quality.
   (b) Improvement in product design.
   (c) Improvement in production flow.
   (d) Improvement in employee morale and quality consciousness.
   (e) Improvement of product service.
   (f) Improvement in market place acceptance.
2. Economic improvements oriented benefits: The benefits under this category are as follows:
   (a) Reductions in operating costs.
   (b) Reductions in operating losses.
   (c) Reductions in field service costs.
   (d) Reductions in liability exposure.

**Quality Gurus**

To fully understand the TQM movement, we need to look at the philosophies of individuals who have shaped the evolution of TQM. Their philosophies and teachings have contributed to our knowledge and understanding of quality today.

| Quality Guru | Main Contribution |
|---|---|
| Walter A. Shewhart | –Contributed to understanding of process variability.<br>–Developed concept of statistical control charts. |
| W. Edwards Deming | –Stressed management's responsibility for quality.<br>–Developed "14 Points" to guide companies in quality improvement. |
| Joseph M. Juran | –Defined quality as "fitness for use."<br>–Developed concept of cost of quality. |
| Armand V. Feigenbaum | –Introduced concept of total quality control. |
| Philip B. Crosby | –Coined phrase "quality is free."<br>–Introduced concept of zero defects. |
| Kaoru Ishikawa | –Developed cause-and-effect diagrams.<br>–Identified concept of "internal customer." |
| Genichi Taguchi | –Focused on product design quality.<br>–Developed Taguchi loss function. |

**Quality at the source**

Quality at the source is frequently discussed in the context of conformance quality. Quality at the source means that the person who is doing the production takes responsibility for making sure that his/ her output meets specification. Errors or defects should be caught and corrected at the source, not passed along to an internal customer. If this can be accomplished, then in theory, the ultimate goal of zero defects throughout the process is achievable.

**Quality Specification**

**(a) The Malcolm Baldrige National Quality Award (MBNQA)**

The Malcolm Baldrige National Quality Award was established in 1987 when Congress passed the Malcolm Baldrige National Quality Improvement Act. The award is named after the former Secretary of Commerce Malcolm Baldrige, and is intended to reward and stimulate quality initiatives. It is designed to recognize companies that establish and demonstrate high-quality standards and is given to no more than two companies in each of three categories: manufacturing, service, and small business.

### (b) The Deming Prize

The Deming Prize is a Japanese award given to companies to recognize their efforts in quality improvement. The award is named after W. Edwards Deming, who visited Japan after World War II upon the request of Japanese industrial leaders and engi- neers. While there, he gave a series of lectures on quality. The Japanese considered him such an important quality guru that they named the quality award after him.

### (c) ISO 9000 Standards

Increases in international trade during the 1980s led to the development of universal standards of quality. Universal standards were seen as necessary in order for compa- nies to be able to objectively document their quality practices around the world. Then in 1987 the International Organization for Standardization published its first set of standards for quality management, called ISO 9000. The purpose of the International Organization for Standardization (ISO) is to establish agreement on international quality standards. It currently has members from 91 countries, including the United States. It created ISO 9000 to develop and promote international quality standards. ISO 9000 consists of a set of standards and a certification process for companies. ISO 9000 certification demonstrates that companies have met the standards. The standards are applicable to all types of companies and have gained global acceptance. In many industries ISO certification has become a requirement for doing business. Also, ISO 9000 standards have been adopted by the European Community as a standard for companies doing business in Europe.

In December 2000 the first major changes to ISO 9000 were made, introducing the following three new standards:

**ISO 9000:2000,** Quality Management Systems：Fundamentals and Standards: Provides the terminology and definitions used in the standards. It is the starting point for understanding the system of standards.

**ISO 9001:2000,** Quality Management Systems：Requirements: This is the standard for the certification of a firm‘s quality management system. It is used to demonstrate the conformity of quality management systems to meet customer requirements.

**ISO 9004:2000,** Quality Management Systems: Guidelines for Performance: Pro- vides guidelines for establishing a quality management system. It focuses not only on meeting customer requirements but also on improving performance.

**ISO 14000 Standards**

The need for standardization of quality created an impetus for the development of other standards. In 1996, the International Standards Organization introduced standards for evaluating a company's environmental responsibility. These standards, termed ISO 14000, focus on three major areas:

- **Management systems:** standards measure systems development and integration of environmental responsibility into the overall business.
- **Operations:** standards include the measurement of consumption of natural re- sources and energy.
- **Environmental systems:** standards measure emissions, effluents, and other waste systems. With greater interest in green manufacturing and more awareness of environmental concerns, ISO 14000 may become an important set of standards for promoting environmental responsibility.

**Quality circle**

It is another name for problem solving teams –small group supervisors and employees whom meet to identify, analyze and solve production and quality problems. The philosophy behind this approach is that the people who are directly responsible for making the product or providing the service will be best able to consider ways to solve a problem.

**ISO-9000 certification**

The international organization for standardization is a worldwide federation of national standards organizations. ISO establish its uniform quality standards in 1987. The primary benefits of ISO certification is the market access it provide. ISO certification was originally intended as a requirement for doing business in certain industries within the European community (EC) and with the government of EC countries. The idea was that a common standard would prevent company from having to comply with separate standards in every country where it did business.

Even outside the EC, obtaining such certification frequently allows firms to avoid meeting the requirement of various suppliers‟ certification programs promoted by their customers. In fact, many firms now require their supplier to be ISO-certified, and even more prefer ISO –certified suppliers over that that are not certified.

You might have guessed that ISO is the acronym for international organization for standardization, but it is not. ISO, comes from the Greek word isos, meaning “equal”. It has the same meaning as the prefix that is used in the terms isosceles triangle. Certification under the ISO 9000 standards, then, simply mean that a registered third- party examiner has determined that the procedure actually used by the certified organizations are the same as the procedure describe in their own documents. The ISO standard received a stiff

criticism in the 1990s because there is nothing in ISO 9000 about continuous quality improvement, customer satisfaction or employee involvement. As a result of this criticism, the ISO quality standards have recently been revised to focus more on customer satisfaction and continuous improvement. The new standards are currently being referred to as ISO9000:2000

**5.2.1. Dimension of quality**

**The common dimension of quality includes:**

**Performance:** is a measure of product’s primary operating characteristics. Within an automobile, for example, performance characteristics would include how fast it can accelerate from 0 to 60 mph and its fuel efficiency in terms of miles per gallon. For personal computer, performance characteristics would include speed and random accessory memory (RAM).

**Feature:** are the „belts and whistles‟ that are offered with the product. While features are not the primary operating characteristics of a product, nonetheless, be very important to the customer. For example, a moon roof and stereo system may be the designing factors for a new car buyer while a specific type of refrigerator may appeal to a customer because it offers an icemaker and water dispenser.

**Reliability:** The reliability of a product relates to the probability that the product will fail within a specified time. High product reliability is important in such product as airplanes, computers and coping machines. It also refers consistency of performance.

**Durability:** relates to the expected operational life of the product. In some instance, as with a light bulb, the filament eventually burns out and the entire product must be replaced. In other case, such as within an automobile, the consumer must evaluate the tradeoff between replacing the product entirely versus spending money on repair for the existing one. It simply means, „useful life" of the product.

**Serviceability:** concerned with how readily the product can be repaired and the response (i.e. speed, competence, and courtesy) associated with that repair. It simply refers „easy of repair"

**Aesthetic:** is also a dimension of quality for wish there is a high degree of individual judgment and that is also highly subjective. In fact, in terms of aesthetics, good quality to one group of customers might even be perceived as poor quality to another group. Companies, there for, have an opportunity with this quality dimension to seek out a very specific market niche. It refers to sensory characteristics (sound, feel, look etc.).

**Perceived quality:** is directly related to the reputation of the firm that manufactures the product. Often total information about the various quality aspects of a product is not available, especially when the product is new. Consequently, customers relay heavily on the past performance and reputation of the firm making the product.

**Cost of quality**

A new idea in the quality area is to calculate and control the cost of quality. The cost of quality may be divided in to two components: control cost and failure cost. The control costs are related to activities which remove defects in the production stream. This can be done in two ways: by prevention and by appraisal.

**1. The prevention cost**

Prevention costs are costs associated with preventing defects before they happen. Such costs include:

- Cost of providing quality engineering, and quality planning services for: ensuring correct specifications of materials, use of right methods and process, preparing company standards, preparing sampling procedures, preparing test schedules arranging training of personnel, planning process control etc. cost of inspection so as to keep the production

going ( not to sort out good from bad items) such as inspection of patterns, , tools, gauges, dies, jigs and fixtures, ;inspection of production equipment's etc.

- Cost involved with training and retraining of operators, supervisors and other staffs.
- Cost of research and development efforts, so as to maintain high quality products.
- The cost of redesigning the process to remove the cause of poor quality.
- Cost incurred in the organization of quality circles and other techniques with the objectives of creating interests and involvements of workers and staffs in their work motivate them and high quality of work life. These activities occur prior to production and are aimed at preventing defects before they occur.

**2. The appraisal (inspection)**

Appraisal costs are costs incurred in assessing the level of quality attended by the operating system. Appraisal helps management identify quality problem. Such costs include:

- Cost of testing or inspecting incoming raw materials, including the cost of their movement for the purpose of inspection testing at regular interval
- Cost of providing and maintaining laboratory services for the purpose of inspection
- Cost of process control test or stage inspection.
- Cost of product inspection, such as mechanical testing, non destructive testing cost of carrying out field trials etc.
- Cost of maintenance and calibration of test and inspection equipment and apparatus at regular interval.
- Expenditure incurred in vendor rating when any of the materials required for the product are procured from outside sources.

The failure costs are incurred either during the production process (internal) or after the production is shipped (external).

**A. The internal failure cost**

Internal failure costs result from defects that are discovered during the production of a product or services. Such costs include:

- Cost of scrap or rejections produced which cannot be passed on to, or which will be not be accepted by the customer and which becomes a total cost. It will include the cost of power and various in process materials spent in producing the rejection.
- cost of rework or corrective operations, in case of such items which have not been passed during inspection but which can be made acceptable after certain rework or repair such as welding, brazing, pressing, filling, re-heat treatment rough machining etc.
- Cost involved in fault investigation, trouble –shootings, defect analysis. It may also entail cost of re-examination, and testing, test methods, change of material specification or method of production etc. Loss in capacity of production because of the rejection produced.

**B. The external failure cost**

External failure costs arise when a defect is discovered after the customer has received defective products or services. Such costs include product:

- Loss of future orders to the company owing to loss in its prestige caused by high rejection or poor performance in services. The customer may even withhold payments and the relation may be impaired which may be difficult to improve again. The customers may permanently with draw placing order.
- Cost involved in attending to customers complaints and providing customer services, including warranty charges (the cost of refund, repair, or replace), returned merchandises (cost related to returning goods to sellers including transportation), losses of taxes and duties, allowance (cost of concession), complaints (the cost of setting customer complaints) and the like.
- Litigation costs which include not only legal fees but also the time and effort of employees who must appear for the company in court.

The total cost of quality can thus be expressed as the sum of the following cost:

$$Total\ cost\ =\ control\ cost\ +\ failure\ cost, \text{ that is}$$

$$(Prevention\ cost\ +\ appraisal\ cost)\ +\ (internal\ failure\ cost\ +\ external\ failure\ cost)$$

## STATISTICAL PROCESS CONTROL

**Statistica1 quality control (SQC):** is the term used to describe the set of statistical tools used by quality professionals. Statistical quality control can be divided into three broad categories:

1. **Descriptive statistics:** are used to describe quality characteristics and relation- ships. Included are statistics such as the mean, the standard deviation, the range, and a measure of the distribution of data.
2. **Statistical process control (SPC):** involves inspecting a random sample of the output from a process and deciding whether the process is producing products with characteristics that fall within a predetermined range. SPC answers the question of whether or not the process is functioning properly.
3. **Acceptance sampling:** is the process of randomly inspecting a sample of goods and deciding whether to accept the entire lot based on the results. Acceptance sampling determines whether a batch of goods should be accepted or rejected. The tools in each of these categories provide different types of information for use in analyzing quality.

Descriptive statistics are used to describe certain quality characteristics, such as the central tendency and variability of observed data. Although descriptions of certain characteristics are helpful, they are not enough to help us evaluate whether there is a problem with quality.

Acceptance sampling can help us do this. It helps us decide whether desirable quality has been achieved for a batch of products and whether to accept or reject the items produced. Although this information is helpful in making the quality acceptance decision after the product has been produced, it does not help us identify and catch a quality problem during the production process. For this we need tools in the statistical process control (SPC) category.

All three of these statistical quality control categories are helpful in measuring and evaluating the quality of products or services. However, statistical process control (SPC) tools are used most frequently because they identify quality problems during the production process. For this reason, we will devote most of the chapter to this category of tools. The quality control tools we will be learning about do not only mea- sure the value of a quality characteristic; they also help us identify a change or variation in some quality characteristic of the product or process. We will

first see what types of variation we can observe when measuring quality. Then we will be able to identify the specific tools to use for measuring this variation.

**Sources of Variation: Common and Assignable Causes**

If you look at bottles of a soft drink in a grocery store, you will notice that no two bottles are filled to exactly the same level. Some are filled slightly higher and some slightly lower. Similarly, if you look at blueberry muffins in a bakery, you will notice that some are slightly larger than others and some have more blueberries than others. These types of differences are completely normal. No two products are exactly alike because of slight differences in materials, workers, machines, tools, and other factors. These are called common, or random, causes of variation. Common causes of variation are based on random causes that we cannot identify.

These types of variation are unavoidable and are due to slight differences in processing. The second type of variation that can be observed involves those where the causes can be precisely identified and eliminated. These are called assignable causes of variation. Examples of this type of variation are poor quality in raw materials, an employee who needs more training, or a machine in need of repair. In each of these examples, the problem can be identified and corrected. If the variation is allowed to persist, it will continue to create a problem in the quality of the product.

**Descriptive Statistics**

**The Mean**

The arithmetic average, or the mean, is a statistic that measures the central tendency of a set of data. Knowing the central point of a set of data is highly important. Just think how important that number is when you receive test scores!

To compute the mean, we simply sum all the observations and divide by the total number of observations. The equation for computing the mean is

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

where $\bar{x}$ = the mean
$x_i$ = observation $i$, $i = 1, \ldots, n$
$n$ = number of observations

**The Range and Standard Deviation**

It tells us how spreads out the data are around the mean. There are two measures that can be used to determine the amount of variation in the data. The first measure is the range, which is the difference between the largest and smallest observations. Another measure of variation is the standard deviation. The equation for computing the standard deviation is

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n - 1}}$$

where $\sigma$ = standard deviation of a sample
$\bar{x}$ = the mean
$x_i$ = observation $i$, $i = 1, \ldots, n$
$n$ = the number of observations in the sample

Small values of the range and standard deviation mean that the observations are closely clustered around the mean. Large values of the range and standard deviation mean that the observations are spread out around the mean.

**Distribution of Data**

A third descriptive statistic used to measure quality characteristics is the shape of the distribution of the observed data. When a distribution is symmetric, there is the same number of observations below and above the mean. This is what we commonly find when only normal variation is present in the data. When a disproportionate number of observations are either above or below the mean, we say that the data have a skewed distribution.