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# SCI S319 Quality Management For Science And Technology (Free Courseware)

香港公開大學
THE OPEN UNIVERSITY OF HONG KONG

# Contents

# Chapter 1 The concepts and history of quality management

## 1.1 About this module



Welcome to this free courseware module 'The concepts and history of quality management'!

This module is taken from the OUHK course *SCI S319 Quality Management for Science and Technology (http://www.ouhk.edu.hk/wcsprd/Satellite?pagename=OUHK/tcGenericPage2010&c=C_ETPU&cid=191154129600&lang=eng),*a five-credit, higher level course that is part of the BSc/BSc (Hons) in Product Design, Testing and Certification, BSc/BSc (Hons) in Applied Science (Biology and Chemistry) and BSc/BSc (Hons) in Product Design and Technology programmes offered by the School of Science and Technology (http://www.ouhk.edu.hk/wcsprd/Satellite?pagename=OUHK/tcSubWeb&l=C_ST&lid=19113300020 0&lang=eng)of the OUHK. *This course* provides a fundamental, yet comprehensive, coverage of quality management. It covers the principles and practices, and the tools and techniques as well.

SCI S330 is mainly presented in printed format and comprises five study units. Each unit contains study content, activities, self-tests, assigned readings, etc for students' self-learning. This module (The materials for this module, taken from the print-based course SCI S319, have been specially adapted to make them more suitable for studying online, and multimedia elements have been added where appropriate. In addition to this topic on 'The concepts of quality and quality management', which is an extract from Unit 1 of the course, the original Unit 1 also includes the topic of 'Basic probability for quality management') retains most of these elements, so you can have a taste of what an OUHK course is like. Please note that no credits can be earned on completion of this module. If you would like to pursue it further, you are welcome to enrol in *SCI S319 Quality Management for Science and Technology (http://www.ouhk.edu.hk/wcsprd/Satellite?pagename=OUHK/tcGenericPage2010&c=C_ETPU&cid=191154129600&lang=eng)*.

This module will take you about **six hours** to complete, including the time for completing the activities and self-tests (but not including the time for assigned readings). Owing to copyright issues, textbook and assigned readings are not included in the free courseware.

Good luck, and enjoy your study!

## 1.2 Introduction



We will first define and discuss some common definitions and measures of quality that have been put forward by quality philosophers. Next we will provide an overview of the historical development of quality management. In the third major section of this module we describe the eight different dimensions of quality used for analysing quality characteristics. An important measure of the effectiveness of quality management activities is the cost associated with the achievement and non-achievement of product or service quality as a result of these activities. The following section presents the prevention-appraisal-failure (PAF) model of costs of quality which has been widely adopted in different industries. To give a historical perspective to all these quality definitions, we will also discuss how different quality paradigms have emerged over the years due to changes in customer demands, technology and social environments. Let's move on!

## 1.3 Fundamentals of quality management



Quality is an important element in our daily lives as consumers both as individuals and as industrial organizations. It is one of the elements that determines where to procure a product or service. Most of us have a conceptual understanding of quality as relating to one or more desirable characteristics that a product or service should possess. We make our own judgment regarding the quality of purchased goods or services when we are satisfied or dissatisfied with them. If these goods or services satisfy us, we judge them to be something of quality. If we are not satisfied, we judge them to be lacking of quality. In other cases, we judge the quality of a product or service by comparing it explicitly or implicitly to something else in the context of our life experiences. While this conceptual understanding is certainly a useful starting point, we will give a more precise and useful definition of quality later in this unit as understanding and improving quality is essential to compete effectively in today's global market. We begin this section with a brief discussion of the differences between goods and services.

### 1.3.1 Differences between goods and services



Before we move to the definitions of quality, let's first undertake a brief review on the differences between goods and services. The difference is fairly easy to understand. For example, when we go to an appliance shop, we will look for goods such as a television, or a washing machine. On the other hand, when we are not feeling well, we go to see doctor and this is a service. As I'm sure you can imagine, there are some key

differences between goods and services. Table 0.1 summarizes these key differences for you.

| Goods | Services |
|---|---|
| Tangible | Intangible |
| Standardized | Personalized |
| Production seperated from consumption | Simultaneous production and consumption |
| Nonperishable | Perishable |

**Table 0.1 Key differences between goods and services**

Let's go over each of the attributes that allow us to differentiate between goods and services. Goods are something that exists physically, while for services you may not receive a physical item in return for your purchase. As such, services cannot be easily catalogued, displayed or priced — thus, they are considered intangible. If you think about it, when we go to buy goods, we can state the requirements with measurable parameters. Producers can standardize the outputs of goods within tolerance. However, no two services may be identical. The performance in terms of smiling, courtesy, helpfulness and etc. of two waiters from the same restaurant may be quite different. In fact, even the performance of the same waiter may be different at different times if there are more customers in peak hours. Services also tend to be personalized, and depend on human interaction which is difficult to ensure in terms of consistency. Goods, on the other hand, can be produced and used later. That is, we can produce goods, store them and send them to customers when they require the goods. However, services are consumed while they are produced. That is, customers and service providers participate in the process at the same time. In addition, services are perishable in the sense that they cannot be stored, resold, saved or returned. This means that the synchronization of the supply and demand of services can be difficult.

As a whole, the quality of services is more difficult to measure and control in comparison to goods. However, while there are differences between goods and services, we cannot separate them clearly in our daily life. It is hard to have pure goods or services. For example, when we buy a television from an appliance shop, we are usually not only influenced by the product itself as the service of the shop's staff is one of factors influencing why we choose a particular appliance shop. Or consider a doctor, who will prescribe medicine to patients, so this not purely a service she is providing. In this module, we will use the word product to represent both goods and service.

Let's try 1.3.2 Activity 1.1 (Page 4) and read the 1.3.2.1 Activity 1.1 feedback (Page 4).

## 1.3.2 Activity 1.1



Consider the services you receive or perform in your daily life and try to list a service that corresponds to each of attributes found under 'Services' in Table 0.1. Once you've identified the service, please describe why you think that particular service fits with the corresponding attribute.

### 1.3.2.1 Activity 1.1 feedback



There are many different services you could have chosen that correspond to the attributes in Table 0.1, but we have selected a few that are quite general in the hope that you will be able to relate to them. Consider the following services and the reasons we feel they fit with each corresponding attribute.

1. Intangible — health care consultant: you will probably get advice but nothing physical to bring home.
2. Personalized — reception counter at hotel: smile, response and friendliness might be different for different reception staff.
3. Simultaneous production and consumption — restaurant: you order and the chef cooks the meal, although some of the ingredients can be pre-prepared.
4. Perishable — medical operation: cannot be returned or resold.

## 1.3.3 Definitions of quality



Definitions of quality vary from person to person or organization to organization, but in general, we can say that quality has something to do with the specifications and requirements of the customer being met by the supplier. In addition, quality is related very closely to aspects such as pricing and costs in comparison to the products of competitors. Some people suggest quality as a 'moving target'; in other words, it is something which is difficult to reach an agreement on the meaning and definition. Below are some definitions of quality we usually come across:

- Consistency
- Perfection
- Compliance with policies and procedures
- Doing it right the first time
- Providing a good, usable product
- Delighting or pleasing customers.

In addition, many organizations have their own definitions of quality. Consider the definitions of quality advertised by Fuji Xerox and Hong Kong Petrochemical Co. Ltd.:

1. Fuji Xerox Hong Kong (http://web2.fujixerox.com.hk/company/index.html)

*Quality means providing our external and internal customers with innovative products and services that fully satisfy their requirements.*

2. Hong Kong Petrochemical Co. Ltd. (http://www.hkpetro.com.hk/policy/php)

*Quality means understanding the requirements and expectations of customers and supplying them with products and services to satisfying their expectations and needs.*

In addition, many well-known leading experts in quality have put forward their own definitions of quality. Note that each definition tends to stress a slightly different, but inter-related aspect of quality. We will go through some of the definitions below.

**Dr W Edwards Deming** — *The customer's definition of quality is the only one that matter. So, who is the customer?*

In this definition, Deming notes that quality consists of many different criteria that change continually. To make the picture even more complicated, people place different values on the various criteria. For this reason, it is important to measure consumer preferences and to measure them frequently.

**Dr Joseph M Juran** — *Fitness for purpose.*

In his definition, Juran considers fitness for purpose as being closely linked to:

- product features that meet customer needs, and
- freedom from product deficiencies

**Philip B Crosby** — *Conformance to requirements.*

Crosby believes that as long as requirements are met then this means quality. The important point is that requirements are mutually agreed between customer and supplier.

**Dr Armand V Feigenbaum** — *The total product and service and maintenance through which product or service in use will meet the expectation of the customer.*

Words such as reliability, serviceability and maintainability are frequently used to define quality. According to Feigenbaum, these terms are the individual characteristics that make up the composite of product and service quality. In other words these terms do not reflect the complete picture of the definition of quality. It is important to recognize the key requirements for establishing what is to be the quality of a given product or service. All of the elements need to be balanced if a suitable definition of quality is to be achieved. The key requirements we need to consider must relate to the product's life cycle:

- reliability
- safety
- seviceability
- maintainability

When all the product characteristics are balanced, the right quality becomes that composite which provides the intended functions with the greatest overall economy. It is this property that Feigenbaum calls total customer satisfaction oriented concept of quality.

**ISO 9000** — *Degree to which a set of inherent characteristics fulfils requirements*.

ISO 9000, an international quality management system, defines quality as inherent characteristics that the products or services possess in order to meet the requirements of the customer.

Let's work out 1.3.4 Activity 1.2 (Page 6) and read the feedback.

Before we move on to review the history of quality management, let's briefly discuss the word *grade* here. You may see people mix up the word *grade* with quality, but there is a difference. In quality management, there should be no such thing as low quality or high quality. As long as we have a product meeting our requirements, it is a quality product. Grade is a category or rank given to different quality requirements for products of the same function. For example, high grade cars such as Lexus and Mercedes may have lots of features or benefits compared to a premium grade car such as Hyundai. All are quality products as long as they meet the requirements of the customers. The difference is the grade of the product.

## 1.3.4 Activity 1.2


After considering these different definitions of quality, what are some core concepts of quality that you can extract behind these definitions?

### 1.3.4.1 Activity 1.2 feedback


Although there is no universally accepted definition of quality, the various definitions have enough similarity to extract the following common elements:

- Quality involves meeting or exceeding customer requirements.
- Quality applies to products, services, people, processes and environment.
- Quality is an ever-changing state, that is, what is considered good quality today may not be good enough tomorrow.

# 1.4 Evolution and development of quality management


Quality management has been a part of many different cultures throughout history. It is nothing new and can be traced as far back as 2000 BC in Babylonia. King

Hummurabi of Babylon introduced the concept of product quality and liability into the building industry of the times. In the time of Egyptian pharaohs, the burial of the nobility was documented systematically. The manner of carrying out the necessary rituals and the funerary goods to be buried with the deceased are stated in each Book of the Dead. A systematic document is one of the fundamentals in quality management to ensure consistency. The same steps will be followed by different persons performing the same task. In doing so, the deviation from the requirements can be minimized. The first Emperor of China, Qin Shi Huangdi, decreed that all goods supplied for use in the imperial household should carry a mark so that any maker who produced goods with faults could be traced and punished. During the Middle Ages, merchant guilds were established to guarantee the quality of workmanship and to define the standards to be expected by the buyers. The emergence of mass production in the twentieth century increased the demand of control of product quality. In addition, the demand of consistency in ammunition in war times pushed the need for more stringent product quality. If we look back at this brief history of the development of quality management, it can be seen that we have gone through various phases from quality control to quality assurance and ultimately to total quality management. Let's go over each of these phases of quality management together now.

## 1.4.1 Quality control



Quality control is basically concerned with complying with requirements by inspecting the products and eliminating nonconforming items. It does not address the root causes of nonconforming. This type of control was developed during World War II to ensure the consistency of ammunition being produced.

## 1.4.2 Quality assurance



Similar to quality control, quality assurance originated from the military's need for consistency of military hardware. The success of Japanese manufacturers during the 1960s and 1970s shifted the focus from quality control to quality assurance. In comparison to quality control though, quality assurance focuses on the procedure of compliance and product conformity to specification through activities such as vendor appraisal, line or shop floor trouble shooting, laboratory work, field problems and method development in the production process. However, quality assurance is still basically an inspection process, though it checks more than just the product.

## 1.4.3 Total quality control



Total quality control is an expansion of quality control from manufacturing to other areas of an organization. The concept was introduced by the American scholar Dr Armand Feigenbaum in the late 1950s. The Japanese adopted this concept and renamed it as company-wide quality control (CWQC). It tries to look for long term solutions rather than responding to short term variations. It focuses on pursuit of quality through elimination of waste and non-value-added process. Also, the concept is to expand quality control beyond the production department. Quality control should be covered all the other departments of an organization such as marketing, design, accounting, human resources, logistics and customer services. Quality is not just the responsibility of production.

## 1.4.4 Total quality management



Total quality management (TQM) evolved from the Japanese after World War II with the inspiration from quality experts like Juran and Deming. As it evolved, it changed from process driven by external controls to a customer oriented process. Quality is achieved through prevention rather than inspection. It shifts the main concept from control to management. No matter how stringent the control there is still a chance to have mistakes or defectives. The concept of management is to have a strategic plan starting from identifying customer requirements to after-sales services to producing product meetings or exceeding the customer requirements. TQM will be discussed in more detail in *Unit 5*.

From the evolution of quality management, we can also identify some key attributes of quality. We start by producing product in a consistent manner by meeting the necessary requirements. It is important to trace and isolate defective items preventing further usage. If it is found that a certain batch of products has safety problems after being sold in the market, it is important that it can be identified and recalled. Means are developed to control quality at the initial stage. This is primary achieved through inspection. Later, the scope was shifted to quality assurance. That is, mechanisms are developed to ensure the production process conforms to the requirements of producing good products. The concept of control was extended beyond the production department to include all departments of an organization. To deliver quality product, it requires cooperation and integration of all departments. If the logistics department does not ship the products on time, the customer will not be happy. At the final stage, quality should not rely on control only. Quality is built upon by customer focus, defect prevention and so on. This is total quality management.

We cannot omit the importance of quality standards or systems in the discussion on evolution of quality management. Quality standards or systems with the aim for consistent quality and quality improvement have been developed throughout the

history of quality management. The most well known quality management system, ISO 9000, will be covered in Unit 4.

In the next section, we will further expand on the details and elements of product quality.

## 1.5 Dimensions of quality


David Garvin (1988) has defined eight dimensions that can be used at a strategic level to analyse the quality of characteristics. Some of the dimensions are mutually reinforcing, whereas others are not; improvement in one may be at the expense of another or others. These eight dimensions are especially useful for understanding customers' expectations of product quality. Understanding the trade-offs desired by customers among these dimensions can help build a competitive advantage. The eight dimensions are as follows:

1. 1.5.1 Performance (Page 9)
2. 1.5.2 Features (Page 10)
3. 1.5.3 Reliability (Page 10)
4. 1.5.4 Conformance (Page 11)
5. 1.5.5 Durability (Page 11)
6. 1.5.6 Serviceability (Page 11)
7. 1.5.7 Aesthetics (Page 11)
8. 1.5.8 Perceived quality (Page 12)

In addition to the eight dimensions proposed by Garvin, safety also plays an important role in dimensions of quality and we will consider it in the discussion of these dimensions of quality in the text below.

Let's look at each of these dimensions in more detail now.

### 1.5.1 Performance


Performance refers to a product's primary operating characteristics. Examples of these primary performance characteristics can be seen below:

- **Automobiles**
    1. acceleration
    2. braking distance
    3. steering
- **Television**
    1. sound
    2. picture quality
    3. colour

4. reception

- **Internet service provider**
    1. data transmission rate.

Performance is measurable, so different brands of the same product can be ranked objectively based on individual aspects of performance.

## 1.5.2 Features



Product features are a secondary aspect of performance and are another dimension of perceived quality. They are often the 'bells and whistles' of products which supplement their basic functioning. Features often involve objective and measurable performance attributes reflecting objective individual needs (not prejudices) which can affect the customers in determining quality differences. A flexible approach in developing product features can be used as an advantage to increase customer satisfaction. We'll use the same set of examples we used to show performance aspects to illustrate this secondary aspect of quality.

- **Automobiles**

1. entertainment system
2. antilock brakes
3. reclining seats

- **Television**

1. automatic tuners
2. multi-system capability
3. ease of handling remote control
4. Nicam

- **Internet service provider**

1. free outdoor Wi-Fi services.

## 1.5.3 Reliability



Reliability reflects the probability that a product will malfunction or fail within a specific period of time. The reliability can be measured as the mean time to failure (MTTF), or the mean time between failures (MTBF), or the failure rate per unit of time. Reliability is normally important to customers in that the costs of maintenance and downtime become expensive. These costs can be used to determine the quality differences among products.

## 1.5.4 Conformance



Conformance is the degree by which the design and operating characteristics of a product meet the established standards. When a product is developed, specifications are set for all parts and materials in the design as well as in the manufacturing (or delivery) phases.

## 1.5.5 Durability



Durability is defined as the amount of use one gets from a product before it breaks down, and replacement is preferable to continued repair. This has two implications. First, durability is closely linked with reliability. A product that often fails is most likely to be scrapped earlier than one that is more reliable. Consequently, repair costs will be correspondingly higher and the purchase of a competitor's brand is more likely.

Second, durability figures should be interpreted with care. An increase in product life may not be the result of technical improvements, or the use of longer-life materials; rather, it is a result of the underlying economic environment.

## 1.5.6 Serviceability



Serviceability reflects the speed, courtesy, competence, and ease of repair. Customers are concerned not only about a product breaking down but also about the time before the service is restored, the speed with which the service appointments are kept, the nature of dealings with the service personnel, and the frequency with which the service calls or repairs fail to correct outstanding problems.

Serviceability can usually be measured by the mean time to repair (MTTR), or the number of calls made to correct a particular problem, or the number of calls made during a specified time period. These standards are measured objectively, whereas the measurement of courtesy or standards of professional behavior are more subjective.

## 1.5.7 Aesthetics



Aesthetics reflect how a product looks, feels, tastes or smells. These things are measured based on personal judgments and individual preferences. It is impossible to please everyone on this dimension of quality.

## 1.5.8 Perceived quality



Consumers do not always have the complete information about products. Therefore, a subjective assessment may be their only basis to determine quality differences among different suppliers. This subjective assessment of quality is based on image, advertising or brand name.

A company need not pursue all of these eight dimensions simultaneously. In fact, it is seldom possible unless the company intends to charge unreasonably high prices. Technological limitations may impose further constraints. In some cases, a product can be improved in one dimension of quality only while it becomes worse in another. Trade-offs among all these dimensions may therefore have to be considered.

## 1.5.9 Safety



Another key dimension of quality is the safety of products. Unsafe products are those likely to cause injury or death. In order to avoid these products from being developed, compliance to national or international safety standards (e.g. UL, CSA) are required in some countries. These standards require goods to comply with particular materials, performance and composition, among other characteristics.

In addition to the dimensions of quality discussed above, we must also consider the issue of quality problems. In order understand this issue more clearly, let's look at definitions of potential quality problems in the context of an organization.

## 1.5.10 Quality Problems



Now that we have reviewed the dimensions of quality which serve as elements to satisfy customers, we need to define customer requirements to understand which dimensions customers consider important. Parasuraman, Zeithaml and Berry (1985) developed a five-gap model which helps to define quality according to various aspects and illustrates the gaps between customer perception and expectation. Their approach is illustrated in Figure 0.1.

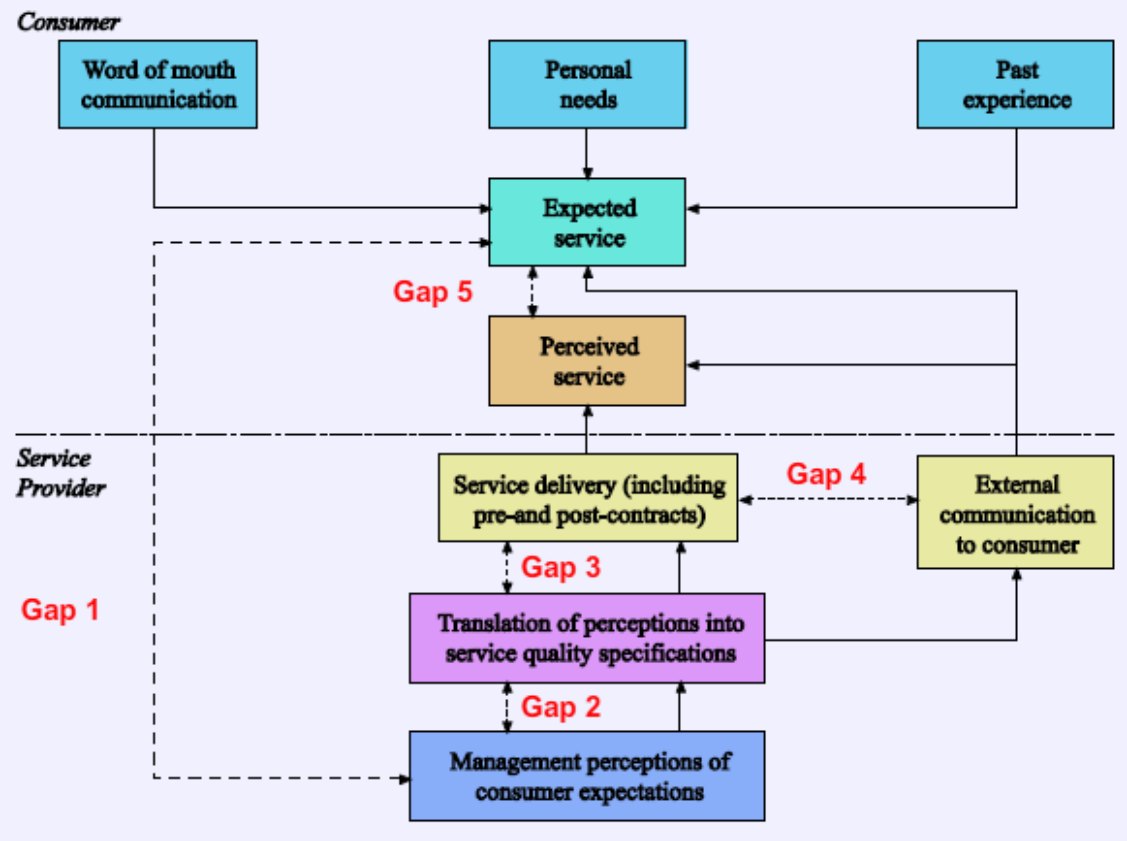


**Figure 0.1 The five gaps between perception and expectation**

### Gap 1: Customer expectation – management perception

In this case, management does not fully understand how customers determine their expectations on the basis of input sources such as advertising, past experience, competitors, personal needs and word of mouth information from friends, colleagues and family. For example, workers in mainland China expect to have low price train tickets returning home during Chinese New Year. However, high speed trains priced about seven times higher than the original trains were introduced and the workers could not afford the new price.

### Gap 2: Quality specifications gap

Management does not always include in the service specifications all the quality attributes it perceives customers wants. This is sometimes due to a lack of sufficient resources or unreasonableness of customer expectations. It also may be characteristic of firms that are not wholly committed to the prospect of service quality. For example, the current design of electric cars cannot run at high speeds and can only be recharged at limited locations.

### Gap 3: Service quality specifications – service delivery gap

Even when appropriate quality guidelines exist, quality services may not be delivered to the customer. The reality, however, is that employees' performance cannot be standardized to ensure consistent quality service. For example, a bank may not have adequate tellers in peak hours and customers have to wait longer for service than the dedicated standards.

### Gap 4: Service delivery – external communication gap

Media advertising and other communications by a firm can affect customer expectations. If expectations are too high, the service as delivered may receive a poor quality rating. In other words, it is unwise to promise something 'absolutely, positively' unless you can do it every time. It is better to under-promise and over-deliver. For example, the arrival and departure times of trains of the railway operator cannot match the timetable announced.

**Gap 5: Expected service – perceived service gap**

The key to ensuring good service quality is meeting or exceeding customer expectations. For example, one customer rated service quality particularly high when a technician not only fixed her broken appliance, but also explained what had gone wrong and how she could fix it herself if a similar problem occurred in the future. Conversely, a bar customer rated service quality particularly low when he could not smoke inside the bar and it was raining heavily outside. The fact that the bar was prevented by law from allowing him to smoke had never been explained to the customer. He perceived the bar to be 'unwilling' rather than 'unable' to allow him to smoke inside the bar.

The above model described by Parasuraman, Zeithaml and Berry not only applies to the service industry but also the manufacturing industry. Now that you have a broader understanding of the definition of quality, the next section will cover the costs of quality.

Let's finish 1.5.11 Activity 1.3 (Page 14) and check out the 1.5.11.1 Activity 1.3 feedback (Page 15).

## 1.5.11 Activity 1.3


We have discussed the five gaps between customer perception and expectation. In your daily life, you probably have come across ways to measure these gaps. Identify some of the ways we can measure these gaps.

Activity 1.3 feedback

Here are three commonly used means to measure gaps between customer perception and expectation:

1. Questionnaires

Surveys alone cannot be conducted to identify customer requirements and customer opinions measuring all the five gaps.

1. Focus groups

Meeting with current customers can identify customer requirements and customer opinions measuring all the five gaps.

1. Mystery customers

Hiring of people to appraise the services can be used to measure gaps (3) and (4).

Can you think of other ways to measure these gaps?

#### 1.5.11.1 Activity 1.3 feedback



Here are three commonly used means to measure gaps between customer perception and expectation:

1. **Questionnaires**

Surveys alone cannot be conducted to identify customer requirements and customer opinions measuring all the five gaps.

2. **Focus groups**

Meeting with current customers can identify customer requirements and customer opinions measuring all the five gaps.

3. **Mystery customers**

Hiring of people to appraise the services can be used to measure gaps (3) and (4).

Can you think of other ways to measure these gaps?

## 1.6 Costs of quality



The application of costs of quality is a good means to identify the quality performance of an organization. A quality costing system is a management tool for identifying and monitoring costs incurred with respect to quality. It enables the application of proper management direction and control over areas where quality cost figures are abnormally high. Some may argue that quality is even better than free. Improving quality need not necessarily increase costs. In fact, the benefits from a properly implemented quality system far outweigh the costs.

Quality costs comprise four major categories — prevention costs, appraisal costs, internal failure costs and external failure costs. Formal definitions of these categories are described in British Standard BS 6143. Let's take a closer look.

### 1.6.1 Prevention costs



The costs associated with preventing the potential for quality problems. These can consist of training costs, quality improvement programme costs, design costs, preventive maintenance costs, data collection and analysis costs, etc.

## 1.6.2 Appraisal costs



The costs associated with determining the quality of the systems or products. These can consist of inspection equipment costs, testing costs, laboratory costs, inspector costs, costs associated with evaluating the performance of the systems and products, etc.

## 1.6.3 Internal failure costs



The costs incurred as a result of a product failure before it is delivered to the customer. These can consist of rework costs, scrap cost, downtime, etc.

## 1.6.4 External failure costs



The costs incurred when a product fails after it has been delivered to the customer. These can consist of rework costs, warranty costs, liability claims, penalties, etc.

## 1.6.5 Traditional view of quality costs



When prevention and appraisal costs increase, failure costs will fall as the product quality level increases. The total quality cost curve is the numeric sum of the prevention costs, appraisal costs and failure costs. In the traditional quality management mindset, there is an optimum quality level and an optimum cost associated with the lowest point on the total quality cost. In Figure 0.2, you can see the traditional view of quality costs. If we take a look of the curve of the prevention costs, it is believed that it takes a huge amount of money in order to gain a very small reduction of non-conformance rate. Therefore, the perception is that it is not economically advisable to reduce non-conformance to a very low level. Instead, inspection (detection) is used to screen out defectives.

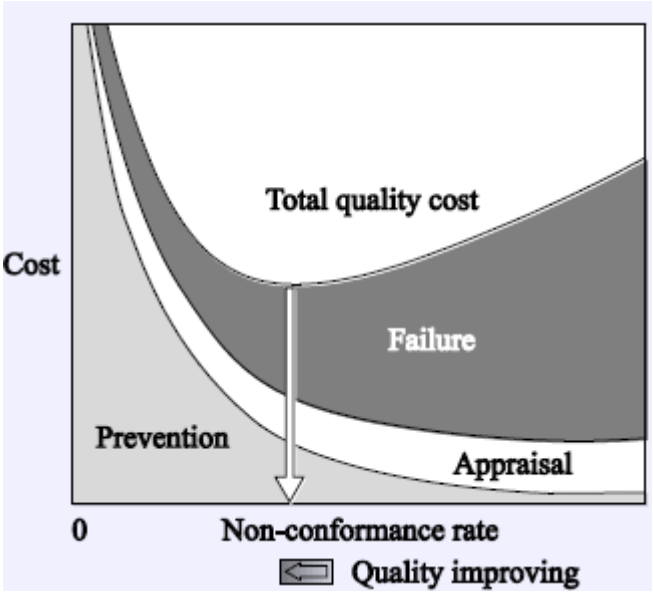


**Figure 0.2 The traditional view of quality costs**

## 1.6.6 Total quality management view of quality costs



In total quality management, people believe that the costs incurred by preventive measures can be more than offset by reductions in the appraisal and failure costs. For example, the failure rate can be greatly reduced if the proper training is conducted for new employees. It is believed that the total quality cost will be lowest when there is no non-conformance. This can be achieved through proper implementation of preventive measures. The total quality management view of quality costs is illustrated in Figure 0.3.

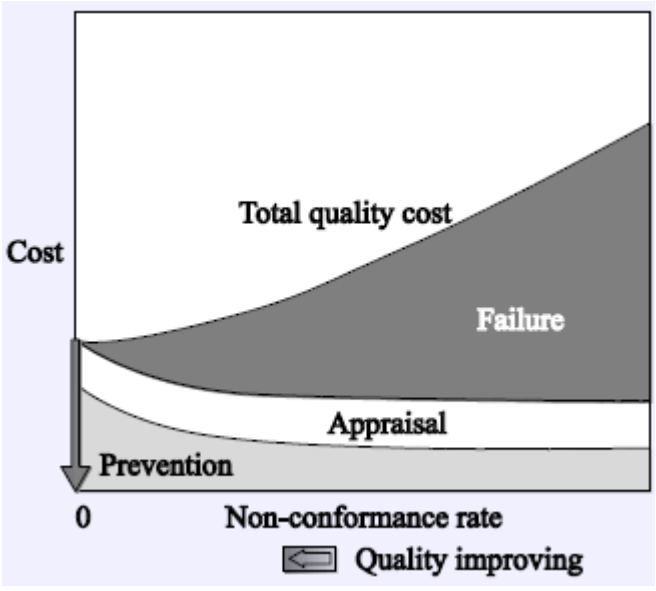


**Figure 0.3 The total quality management view of quality costs**

Now that you have a broader understanding of quality, attempt the next activity based on this section. The next section will cover the historical background of the development of various quality paradigms.

Please take a moment to work through 1.6.7 Activity 1.4 (Page 18) before you move on to the next section of the module and read the feedback.

## 1.6.7 Activity 1.4



Imagine that you are working for a food manufacturer producing packaged dumplings. Think of at least four examples of quality related cost under each of the following categories:

1. Prevention cost
2. Appraisal cost
3. Internal failure cost
4. External failure cost.

### 1.6.7.1 Activity 1.4 feedback



1. Prevention costs
    1. training and education of personnel
    2. running of quality improvement programme
    3. preventive maintenance of machines
    4. review and verification of new products
2. Appraisal costs
    1. incoming inspection of purchased materials
    2. in-process inspection and testing of semi-finished food
    3. audit of suppliers
    4. dumplings consumed during testing
3. Internal failure costs
    1. non-conforming material scrap in production line
    2. repacking labour cost for broken wrapping
    3. production down time
    4. failure analysis and subsequent remedial action
4. External failure costs
    1. handling and follow-up of customers' complaints
    2. warranty claims of contaminated dumplings
    3. dumplings rejected and returned by customers for broken package
    4. liability claims should the dumplings cause illness.

# 1.7 Evolution of quality paradigms and scope of quality assurance



There are generally five distinct quality paradigms (ways of thinking about quality and doing quality activities), namely: custom-craft, mass production and sorting, statistical quality control, total quality management (TQM), and techno-craft. These five different quality paradigms are depicted in Figure 1.4 (Kolarik and Pan 1999, 38, Figure 3.1.) These paradigms have emerged over the years due to changes in the diverse factors of market demands, technology, and social systems, among others.

Let's now look at each of these paradigms more closely.

## 1.7.1 Custom-craft paradigm



The custom-craft paradigm focuses on the product specification relative to customer demands. In this case the craftsperson and customer communicate directly so the product is customized to exactly what the customer wants. Figure 1.4(a) illustrates the custom-craft quality paradigm. A service industry can be depicted in the same manner, with the box on the bench being a service product, rather than a hard-good product. Examples of this system include the custom building and housing industry, custom clothing, bank loans, hair styling, etc. Customer requirements are clear about product performance, but products are relatively expensive and may require relatively long delivery time.

## 1.7.2 Mass production and sorting paradigm



The focus in the mass production and sorting paradigm is on productivity. Customers are often contacted through mass advertising sales promotion. The product is defined with the customer in mind but without direct customer involvement. Figure 1.4(b) illustrates this quality paradigm. Cost is usually relatively low and delivery time is typically short since sales are from stock on hand. Examples include office buildings, hand tools, electronic components, bank counter services, clothes cleaning services and agricultural production. This paradigm emerged with mass production technology (mechanization or automation), mass markets and automated inspection and testing technology, etc. Service organizations in this paradigm still tend to be rather labour-intensive, whereas manufacturing and agricultural production in this paradigm tend to be very mechanized.

## 1.7.3 Statistical quality control paradigm



The statistical quality control paradigm is similar to the mass production and sorting paradigm with the difference that more attention is given to production processes. Statistical process control and lot-by-lot sampling inspection are used. The result is far less scrap and rework than in the mass production and sorting paradigm. Product performance and timeliness are similar to that obtained with the mass production and sorting paradigm. Using upstream sampling and statistical process control to limit losses due to poor quality will usually reduce production costs. Since process knowledge is gained, process improvements usually result. The statistical quality control paradigm is depicted in Figure 1.4(c).

## 1.7.4 Total quality management paradigm



The total quality management (TQM) paradigm involves customers and suppliers in addition to mass production and statistical methods. It is illustrated in Figure 1.4(d). The production process is similar to that in mass production and sorting paradigm. Nevertheless, the TQM paradigm recognizes the importance of customer focuses on continuous quality improvement in day-to-day processes, aiming at higher product performance, lower cost, and faster delivery than in either the mass production and sorting or the statistical quality control paradigms.

## 1.7.5 Techo-craft paradigm



The techno-craft paradigm is the socio-technical counterpart to the custom-craft paradigm. It is illustrated in Figure 1.4(e). The techno-craft paradigm is a new frontier in quality that seeks to emulate the custom-craft paradigm in performance, but reduce the cost and the delivery time. The techo-craft paradigm is possible through the proper integration of people, machines and automation. We have seen techo-craft paradigm in industries such as apparel and software development. In the future most of the customer products, such as shoes, clothing, etc., which must 'fit' the users in order to function at their best, will emerge at competitive prices. In the techno-craft paradigm, customers get exactly what they want. A high level of flexibility in product design and process flexibility is necessary to make this paradigm feasible. Computer aided design and computer aided manufacturing technology, along with automated and integrated measuring machines, make the techno-craft paradigm a reality.

## 1.7.6 Scope of quality assurance



Quality assurance means assuring quality in the product so that a customer can buy it with confidence and use it with confidence and satisfaction. To be able to buy with confidence, a customer must have a sense of trust in a particular product from a particular company that has a record of having reliable products for a long time. To build up this kind of trust, it is necessary to ensure quality of design and to make certain that the product is fully functional in the way that the customer expects. Quality assurance is almost like a contract entered into by the producer and its customer. In order to provide true quality assurance, top executives must establish firm policies that will encompass all of the following divisions: research, planning, design, production, marketing, after sales service and customer service.

Quality assurance is a set of activities intended to establish confidence that quality requirements will be met. It is one part of quality management. The quality assurance function should be a cross functional activity in which all functional departments play a specific role in planning for and analysing quality.

Quality control is considered part of the quality functions. It is a regulatory process through which each department measures the actual quality performance, compares it with the standard, and acts on the difference.

Inspection is an appraisal activity that compares products to applicable standards. In a modern quality management approach, everyone in the organization is an inspector and is responsible for inspecting the work they perform. The best inspection is conducted at the source, at the time the output is made, and by the individual who makes it.

We need to consider the three different aspects of quality assurance:

1. inspection-oriented quality assurance
2. process control-oriented quality assurance
3. quality assurance with emphasis on new product development.

#### Inspection-oriented quality assurance

Quality assurance started with doing inspection well. This approach is still being practised in a lot of countries as many people still consider that inspection equals quality assurance. This may stem from the basic assumption that the work and workers must be supervised very strictly. To accomplish this, the inspection department is made independent and its authority is enhanced. In short, the basic emphasis is on strengthening inspection in order to bring about quality assurance. Therefore, the ratio of inspectors to line workers is very high. This approach, however, raises several other points, or some might say problems in managing quality.

- Problem 1

The first problem is that inspectors are unnecessary personnel who reduce the overall productivity of a company. They are not making anything. Inspection is necessary because defects and defectives exist. If defects and defectives disappear, inspectors become unnecessary.

- **Problem 2**

The second problem is that responsibility for quality assurance rests with the producers. Needless to say, this concept is for the benefits of consumers, but it has been further applied within a company. The producer, the production department, assumes responsibility for quality assurance, and the inspection department does not. The latter's function is to check the products from the point of view of consumers or of company managers. The production department, being duly educated and trained, will control its process itself and self-inspect its own products before sending them off to the next process. It thus assures quality.

- **Problem 3**

The third problem deals with the issue of information feedback from the inspection department to the production department. This process takes time. If the line worker who is responsible for a particular product is given the task of self-inspection, feedback is instantaneous and action can be taken immediately. The latter approach ensures a sharp reduction in the number of defectives.

- **Problem 4**

The fourth problem deals with the question of production speed. When the speed accelerates, workers cannot inspect. Thus automated inspection must be considered.

- **Problem 5**

The fifth problem concerns the application of the statistical sampling method. The method may designate an acceptable quality level (AQL; the lowest quality acceptable, details will be discussed in Unit 3) at 1% or at 0.5%. This is unsatisfactory for companies that seek higher quality levels, such as those seeking a defect rate of 0.01% or those seeking ppm (parts per million) control (at a defect rate of one one-millionth).

- **Problem 6**

The sixth problem deals with those many items whose quality cannot be assured through inspection alone. The quality of many complicated assembled commodities and materials cannot be known until used. For example, components embedded in a sub-assembly. When a company seeks control based on a destructibility test, a rigorous performance test, or reliability test, inspection is often uneconomical and cannot necessarily assure quality by itself.

Lastly, it must be noted that defects can indeed be uncovered through inspection, without the end result measuring up to true quality assurance. When defects are found, the only action the manufacturer can take is that of making adjustments, reworking the product, or consigning it to scrap.

**Process control-oriented quality assurance**

This approach, so called 'quality must be built into each process,' emphasizes process control. The process capabilities are studied and it is made certain that each product should meet quality standards through control of the production process. It relies on the control of the process rather than the inspection of products by the inspection department to perform the task of quality assurance. Everyone in the process has to be involved. The process control concept can be further extended to cover suppliers and subcontractors.

However, quality assurance can not be achieved by means of process control alone. Problems can occur in the designing or development process, which obviously can not be solved by the production or inspection department. And no matter how hard a department engages in process control, if the selection of materials are wrong, nothing can be accomplished. Therefore, while process control remains an important concern and must continue to be practised, it has been discovered that it is indispensable to have quality assurance, which begins at the stage where new products are developed.

**Quality assurance with emphasis on new product development.**

This approach emphasizes that at each step of the way from planning for new products to after-sales service, evaluation must be tightly conducted and quality assured. These steps include new product planning, design, prototype making, testing, subcontracting, purchasing, process design, trial production, production, marketing, distribution and after-sales service. Prior to entering the stage of production, quality analysis has to be adequately performed, including testing for reliability under various conditions. Quality assurance is thus built into the entire product and processes as well. Since quality assurance is conducted for new product development, full participation of all departments in the company in realizing quality control and quality assurance is essential.

These departments include research, planning, design, testing, purchasing, subcontracting, production engineering, production, inspection, marketing and after-sales service. Starting with those people who engage in market research and planning and ending with those employees who engage in sales and after-sales service, everyone and every department in the company must participate.

Based on the above discussion, quality assurance does not completely negate the importance of inspection. It must be clear, however, that no matter how closely a company may inspect its products, there will always be some inspection misses and some defectives will still be shipped. It is uneconomical to rely on inspection. This is the reason for shifting emphasis to process control. However, good process control without proper new product development is meaningless. We need to have sound new product development then we can have good quality with proper process control.

## 1.8 References



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## 1.9 Conclusion



In this module, you learned about the basic concepts of quality management. Different definitions of quality were discussed. Customer satisfaction and continuous improvement were the two core concepts behind these definitions. Quality management is not something new and we have gone through the history of quality management briefly. In order to compete and win we need to understand the dimensions of quality. Costs of quality were analysed to have a better understanding the performance of an organization in quality management. You have learned the evolution of different quality paradigms developed over the years.

If you would like to learn more on this subject, you are welcome to enrol in SCI S319 Quality Management for Science and Technology (http://www.ouhk.edu.hk/wcsprd/Satellite?pagename=OUHK/tcGenericPage2010&c=C_ETPU&cid=191154129600&lang=eng) offered by the School of Science and Technology (http://www.ouhk.edu.hk/wcsprd/Satellite?pagename=OUHK/tcSubWeb&l=C_ST&lid=191133000200&lang=eng) of the OUHK.