CHAPTER 1

Introduction to Quality

Learning Objectives

After completing this chapter you should be able to:

1. Define and discuss quality and quality improvement
2. Discuss the different dimensions of quality
3. Discuss the evolution of modern quality improvement methods
4. Discuss the role that variability and statistical methods play in controlling and improving quality
5. Explain the links between quality and productivity and between quality and cost
6. Discuss product liability

Important Terms and Concepts

Acceptance-sampling
Appraisal costs
Critical-to-quality (CTQ)
Dimensions of quality
Fitness for use
Internal and external failure costs
Nonconforming product or service
Prevention costs
Product liability
Quality assurance
Quality characteristics
Quality control and improvement
Quality engineering
Quality of conformance
Quality of design
Quality planning
Specifications
Variability

Exercises

1.1. Why is it difficult to define quality?

Even the American Society for Quality describes "quality" as a subjective term for which each person or sector has its own definition. Given a large set of customers considering purchasing the same product or service, it is likely that each customer evaluates it in terms of a completely different set of desirable characteristics. As a result, it is extremely difficult to come up with a single definition of quality that could meet the expectations of all customers for all products or services. (*For further details refer to page 2*)

1.2. Briefly discuss the eight dimensions of quality. Does this improve our understanding of quality?

Dimensions under discussion: performance, reliability, durability, serviceability, aesthetics, features, perceived quality, conformance to standards, and responsiveness. These components of quality help us evaluate the quality of a product in more specific terms *(For details, refer to page 3-4)*.

1.3. Select a specific product or service and discuss how the eight dimensions of quality impact its overall acceptance by consumers.

Answers will vary.

Consider a TV. Customers will by a certain brand of TV if it meets their requirements. Customers will evaluate the *performance* of the TV – is the picture sharp/clear? Does it have the functions the customer desires? The TV should function without frequent repairs – it should be *reliable*. The TV should be *durable* and last for many years. If the TV needs repair, is it easy for the company to come fix it? The *aesthetics* will be evaluated by the customer: Is the TV pleasing to look at? Is it overly bulky? How much room will it take up? Does the TV have any special features over other brands? Does the TV brand have a good *reputation*? Does the TV have any noticeable defects like scratches or marks?

1.4. Is there a difference between quality for a manufactured product and quality for a service? Give some specific examples.

The service industry has some additional dimensions of quality that can be used to evaluate the quality of a service. These dimensions include professionalism and attentiveness of the service providers. In terms of the aesthetics, for a manufactured product, this would be related to the visual appeal of the product. In the service sector, this is the physical appearance of the facility *(For further details refer to page 4)*.

1.5. Can an understanding of the multidimensional nature of quality lead to improved product design or better service?

Understanding the multidimensional nature of quality can help with improved product design. By focusing on several (or all) dimensions of quality, improvements to a product's design or service can be made. In addition, recognizing that quality is inversely proportional to variability will also lead to improved product designs. Reducing the variability of critical features identified from the dimensions of quality will lead to improved product design or better service.

1.6. What are the internal customers of a business? Why are they important from a quality perspective?

The internal customers of a business are those within the company that require products or services from other departments in the company. Internal customers could include managers or other employees.

1.7. What are the three primary technical tools used for quality control and improvement?

The three primary statistical technical tools include: *statistical process control*, *design of experiments*, and *acceptance-sampling*.

1.8. What is meant by the cost of quality?

Quality costs are the categories of costs that are associated with producing, identifying, avoiding, or repairing products that do not meet requirements. These categories include prevention costs, appraisal costs, internal failure costs, and external failure costs.

1.9. Are internal failure costs more or less important than external failure costs?

External costs can be expensive as a result of defective products being sent to customers. These costs include the costs of returned products/materials, warranty charges, liability costs, and the indirect costs of business reputation or loss of future business. External costs can be eliminated if all units of product conform to requirements, i.e. if the defects are discovered prior to delivery of the product to the customer (internal failure).

1.10. Discuss the statement "Quality is the responsibility of the quality department."

The responsibility for quality spans the entire organization. Quality improvement must be a total, company-wide activity, and that every organizational unit must actively participate. Because quality improvement activities are so broad, successful efforts require, as an initial step, senior management commitment. This commitment involves emphasis on the importance of quality, identification of the

respective quality responsibilities of the various organizational units, and explicit accountability for quality improvement of all managers and employees in the company. Nevertheless, the quality department takes care of the quality planning and analyses in order to make sure all quality efforts are being successfully implemented throughout the organization. (*For further details refer to pages 26-27*)

1.11. Most of the quality management literature state that without top management leadership, quality improvement will not occur. Do you agree or disagree with this statement? Discuss why.

Top management provides the strategic agenda and goals of quality improvement in a company. Management can strategically define the quality improvement projects that will most benefit the company. In addition, they can spread the knowledge and culture of quality throughout the company (*For further details refer to page 26-27*).

1.12. Explain why it is necessary to consider variability around the mean or nominal dimension as a measure of quality.

The primary objective of quality engineering efforts is the systematic reduction of variability in the key quality characteristics of the product. The introduction of statistical process control will help to stabilize processes and reduce their variability. However, it is not satisfactory just to meet requirements – further reduction of variability around the mean or nominal dimension often also leads to better product performance and enhanced competitive position. (*For further details refer to page 17*)

1.13. Suppose you had the opportunity to improve quality in a hospital. Which areas of the hospital would you look to as opportunities for quality improvement? What metrics would you use as measures of quality?

Identifying areas for quality improvement (in any company) should be made with the company's strategic goals in mind. You want to make the improvements that will have the biggest impact on the company (hospital). In a hospital setting, some potential areas of opportunities for quality improvement include clinic wait times, lab processing times, length of stay in the hospital, surgical outcomes, medication delivery, etc.

1.14. Suppose you had to improve service quality in a bank credit card application and approval process. What critical-to-quality characteristics would you identify? How could you go about improving this system?

Some possible CTQs could be the cycle time for the loan to be approved. You might start an improvement to the system by identifying potential causes of long cycle times, determine which causes are the most harmful to the system and then try to eliminate or reduce them.

1.15. How would quality be defined in the following organization?

a) Health-care facility

Some possible dimensions of quality that may be of interest in a health-care facility:
Performance: Is the appropriate treatment provided?
Reliability: Is the treatment effective?
Durability: Is the treatment done correctly the first time?
Aesthetics: Is the facility clean?
Features: Is the facility able to handle different types of health-related issues?
Perceived Quality: Does the facility have a good reputation?
Responsiveness: Does a patient have to wait a long time for treatment? Is the staff prompt?
Professionalism: Are the nurses/doctors/other staff knowledgeable?
Is the facility affordable?

b) Department store

Some possible dimensions of quality that may of interest in a department store:
Performance: Does the store have what you need?
Reliability: Does the store consistently have what you need? Are the products in good condition?

Serviceability: Is it easy and/or possible to make returns or exchanges?
Aesthetics: Is the store clean? Does it have an easy to understand layout?
Features: Does the store have specialized products?
Perceived Quality: Does the store have a good reputation?
Responsiveness: Are the staff quick to help find an item? Is the staff helpful?
Professionalism: Do the staff know where items in the store are?

c) Grocery store

Some possible dimensions of quality that may of interest in a grocery store:
Performance: Does the store have what you need?
Reliability: Does the store consistently have what you need? Are the products in good condition?
Durability: Are there items past the expiration date in the store?
Aesthetics: Is the store clean? Is the layout understandable/logical?
Features: Does the store have specialized products?
Perceived Quality: Does the store have a good reputation?
Responsiveness: Are the staff quick to help find an item? Is the staff helpful?
Professionalism: Do the staff know where items in the store are?

d) University academic department

Some possible dimensions of quality that may of interest in a university academic department:
Performance: Does the department have a high graduation rate? Retention rate? How well do the students perform (possible metrics may include GPA, time to find a job upon graduation, starting salary after graduation)
Reliability: Are classes offered consistently?
Aesthetics: Are the classrooms and department facilities clean? In good shape?
Features: What classes are offered?
Perceived Quality: Does the department have a good reputation (possible metric may include national rankings)? Does the faculty have a good reputation?
Conformance to standards: How does the department compare to similar departments in other universities?
Responsiveness: Are faculty and advisors quick to respond to questions from students?
Professionalism: Are faculty knowledgeable? Are they active in research and/or teaching? Are the faculty/staff/students caring/helpful/knowledgeable?

CHAPTER 2

Managing aspects of Quality

Learning Objectives

After completing this chapter you should be able to:

1. Describe the quality management philosophies of W. Edwards Deming, Joseph M. Juran, and Armand V. Feigenbaum
2. Discuss total quality management, six-sigma, the Malcolm Baldrige National Quality Award, and quality systems and standards
3. Understand the importance of selecting good projects for improvement activities
4. Explain the five steps of DMAIC
5. Know when and when not to use DMAIC

Important Terms and Concepts

Analyze step
Control step
Define step
Design for Six-Sigma (DFSS)
DMAIC
Failure modes and effects analysis (FMEA)
Improve step
Key process input variables (KPIV)
Key process output variables (KPOV)
Measure step
Project charter
SIPOC diagram
Six-Sigma
Tollgate

Exercises

2.1. Is Deming's philosophy more or less focused on statistics than Juran?

Deming's philosophy is more focused on statistics than Juran. A significant component of his philosophy is statistical techniques for reducing variability. Juran takes a more strategic approach and believed most quality problems result from ineffective planning for quality. (*For further details refer to pages 32-37*)

2.2. What is the Juran Trilogy?

The Juran Trilogy is the three components of quality management philosophy: planning, control and improvement. The planning process involves identifying external customers, determining their needs, designing products that meet these needs, and planning for quality improvement on a regular basis. Control is used by the operating forces of the business to ensure that the product meets the customers' requirements. Improvement aims to achieve performance and quality levels higher than the current levels.

2.3. What is the Malcolm Baldrige National Quality Award? Who is eligible for the award?

The award is an annual award administered by NIST to recognize U.S. organizations for performance excellence. Awards are given to U.S. organizations in five categories: manufacturing, service, small business, health care, and education.

2.4. What is a six-sigma process?

A six-sigma process is one that operates under six-sigma quality, i.e. the specification limits are at least six standard deviations from the mean. This leads to 3.4 ppm defective units in the process given that we "allow" the mean to shift by as much as 1.5 standard deviations off target.

2.5. Compare and contrast Deming's and Juran's philosophies of quality.

Juran's philosophy of quality focused on a strategic approach to quality management and improvement. One of Deming's key philosophies is to reduce variability. Both emphasize planning in quality improvement: plan, control, and improve are both themes in Deming and Juran's philosophies. (*For further details refer to pages 32-37*)

2.6. What would motivate a company to compete for the MBNQA?

The prestige of winning the award as only three awards are given each year in each of the five categories is one motivating factor. In addition, improving the company's performance leads to improved customer satisfaction, improved product quality, productivity, etc. This will all lead to overall improved business for the company.

2.7. Hundreds of companies have won the MBNQA. Collect information on two of the winners. What success have they had since receiving the awards?

Answers will vary.

2.8. Reconsider the fast-food restaurant out considered in the chapter.

a. What results do you obtain if the probability of good quality on each meal component was 0.999?

$$\text{P(single meal good)} = (.999)^{10} = 0.990045$$

$$\text{P(all meals good)} = (0.990045)^{4} = 0.96077$$

$$\text{P(all visits during the year good)} = (0.96077)^{12} = 0.6186$$

b. What level of quality on each meal component would be required to produce an annual level of quality that was acceptable to you?

Let p be the level of quality on each meal component. Then,

$$\text{P(all visits during the year good)} = ((p^{10})^{4})^{12} = p^{480}$$

Annual Level of Quality	p
0.75	0.999401
0.80	0.999535
0.90	0.999781
0.95	0.999893
0.99	0.999979

2.9. Discuss the similarities between the Shewhart cycle and DMAIC.

Both are cyclic plans/strategies for improvement of a process. There are phases dedicated to planning and defining the current process. Both are team-oriented aimed at testing, implementing, and maintaining improvements (*For further details refer to pages 35, 55-65*).

2.10. Describe a service system that you use. What are the CTQs that are important to you? How do you think that DMAIC could be applied to this process?