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# Quality Management



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## LEARNING OBJECTIVES

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**After reading this chapter, you will be able to:**

- Discuss and define the dimensions of quality.
  - Articulate the benefits and costs of good quality, and the costs of poor quality.
  - Understand how quality management systems have evolved and be able to assess the stage of quality evolution a particular company exhibits.
  - Utilize quality tools and the DMAIC methodology in problem solving.
  - Explain the philosophy and magnitude of Six Sigma quality.
  - Recognize quality awards and ISO certifications.
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## Quality and Value in Smartphones

Global sales of smartphones approach 1.3 billion annually. Apple and Samsung are by far the largest players in this market, with the two rivals together holding over 40% of the market, followed by Lenovo, LG, and Huawei, each with approximately a 5% market share. Perceived quality is likely the most prominent purchasing factor among smartphone consumers in this ultra-competitive global market. Smartphone quality can be considered along a number of product dimensions such as performance and reliability, but there are also service dimensions such as the cell-phone service provider and the operating system (OS or Android) that to the consumer reflect on a smartphone's quality. Quality has long been at the core of Apple's corporate culture. Apple has a history of using the highest quality materials, offering innovative design, and providing seamless, easy-to-use software, attributes that other companies have emulated, most prominently and effectively Samsung.

J.D. Power is a global marketing information services company that conducts surveys of customer satisfaction and product quality for a variety of industries and products. Its annual survey of smartphone customer satisfaction is based on four factors (in order of importance): performance, features, physical design, and ease of operation. In their surveys, J.D. Power has found that brands must work extremely well to help differentiate their products from their competitors. When a smartphone performs well, by meeting or exceeding the customer's expectations for features like battery life, camera quality, speaker and screen clarity, touch screen ease of operation, etc., the likelihood of brand loyalty and customer satisfaction increases. Across all cell phone service providers, Apple and Samsung smartphones are consistently rated as the top two and the only smartphone brands that achieve the maximum J.D. Power consumer "Power Circle Score" of 5. In another well-recognized survey of consumer satisfaction with product and service quality, the American Customer Satisfaction Index (ACSI), Apple and Samsung consistently achieve the highest ACSI scores for cell phones, and, in general, the survey shows overall customer satisfaction with product quality for all cell phone companies.

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For companies like Apple and Samsung, as well as for other cell phone competitors, to be successful in the highly competitive global smartphone market requires product quality to be central to their corporate strategy. These companies must focus on well-conceived, pervasive, and all-encompassing quality management programs throughout every part of their supply chains to ensure that they are able to meet their customers' expectations for product quality. In this chapter we will discuss what quality is and how companies develop effective quality management programs using well-defined and established quality management tools and systems.

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## What is Quality?

Asked "What is quality?" one of our students replied, "getting what you pay for." Another student added that to her, quality was "getting *more* than you paid for!" The *Oxford American Dictionary* defines quality as "a degree or level of excellence."

The American Society for Quality (ASQ) defines quality as "a subjective term for which each person has his or her own definition. In technical usage, quality can have two meanings: (1) The characteristics of a product or service that bear on its ability to satisfy stated or implied needs and (2) A product or service free of deficiencies." Obviously, quality can be defined in many ways, depending on who is defining it and the product or service it refers to. In this section we provide a perspective on what quality means to customers and companies.

### Quality from the Customer's Perspective

A business organization produces goods and services to meet its customers' needs. Customers want value and quality has become a major factor in the value of products and service. Customers know that certain companies produce better-quality products than others, and they buy accordingly. That means a firm must consider how the consumer defines quality. The

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customer can be a manufacturer purchasing raw materials or parts, a store owner or retailer purchasing products to sell, or someone who purchases retail products or services over the Internet. W. Edwards Deming, author and consultant on quality, said that “The consumer is the most important part of the production line. Quality should be aimed at the needs of the consumer, present and future.” From this perspective, product and service quality is determined by what the customer wants and is willing to pay for. Since customers have different product needs, they will have different quality expectations. This results in a commonly used definition of quality as a service’s or product’s *fitness for its intended use*, or **fitness for use**: how well does it do what the customer or user thinks it is supposed to do and wants it to do?

**Fitness for use** Is how well the product or service does what it is supposed to.

## Along the Supply Chain

### Defining Quality

In the 1930s, Walter A. Shewhart, a pioneer in quality management known as the “father of modern quality control,” defined quality as satisfying the wants of the customer by converting the customer’s subjective wants and values into measurable objective characteristics that could be achieved with minimal variation. More recently, the American Society for Quality (ASQ) published a report, the *Global State of Quality Research*, which provided survey findings about the practices used by organizations around the world to manage and measure quality. The survey results were gathered from almost 2000 respondents from manufacturing and service organizations from 15 countries around the world. One of the first questions in the survey asked respondents to define quality; following are the ten most common responses:

1. Efficiently providing products and services that meet or exceed customer expectations.
2. Adding value for the customer.
3. Continuously measuring the improvement of processes and service for the customers.
4. Acting as promised and reporting failures.
5. Doing the right thing at the right time in the right way with the right people.
6. Ensuring customers come back and products do not.
7. Providing the best value to customers by improving everyday activities and processes.
8. Beyond delivering what the customer wants, anticipating what the customer

will want when he/she knows the possibilities.

9. Delivering customer value across the company through best-in-class products, services, and support.
10. Meeting and exceeding the expectations of clients, employees, and relevant constituencies in the community.

However, the ASQ also reported that there appears to be no official definition of quality that serves all purposes, and, fifty percent say there is no single definition of quality. What is clear is that how an individual, company, or organization defines quality is determined within their own system context.

Visit the ASQ website at <http://asq.org/> and read about Walter A. Shewhart, and the “ASQ Global State of Quality: Discoveries 2016” research report. What are some of the measures the report cites that organizations commonly use to measure quality?

Source: “The ASQ Global State of Quality Research: Discoveries 2013,” at <http://asq.org/>.

Products and services are designed with intentional differences in quality to meet the different wants and needs of individual consumers. A Mercedes and a Ford truck are equally “fit for use,” in the sense that they both provide automobile transportation for the consumer, and each may meet the quality standards of its individual purchaser. However, the two products have obviously been designed differently for different types of consumers. This is commonly referred to as the **quality of design** —the degree to which quality characteristics are designed into the product. Although designed for the same use, the Mercedes and Ford differ in their performance, features, size, and various other quality characteristics.

**Quality of design** Involves designing quality characteristics into a product or service.

## Dimensions of Quality for Manufactured Products

The *dimensions of quality* for manufactured products that a consumer looks for include the following<sup>1</sup>:

1. **Performance:** The basic operating characteristics of a product; for example, how well a car handles or its gas mileage.
2. **Features:** The “extra” items added to the basic features, such as a stereo CD or a leather interior in a car.
3. **Reliability:** The probability that a product will operate properly within an expected time frame; that is, that a TV will work without repair for about seven years.

4. **Conformance:** The degree to which a product meets preestablished standards.
5. **Durability:** How long the product lasts; its life span before replacement. A pair of L.L. Bean boots, with care, might be expected to last a lifetime.
6. **Serviceability:** The ease of getting repairs, the speed of repairs, and the courtesy and competence of the repair person.
7. **Aesthetics:** How a product looks, feels, sounds, smells, or tastes.
8. **Safety:** Assurance that the customer will not suffer injury or harm from a product; an especially important consideration for automobiles.
9. **Other perceptions:** Subjective perceptions based on brand name, advertising, and the like.

These quality characteristics are weighed by the customer relative to the cost of the product. In general, customers will pay for the level of quality they can afford. If they feel they are getting what they paid for (or more), then they tend to be satisfied with the quality of the product.

## Dimensions of Quality for Services

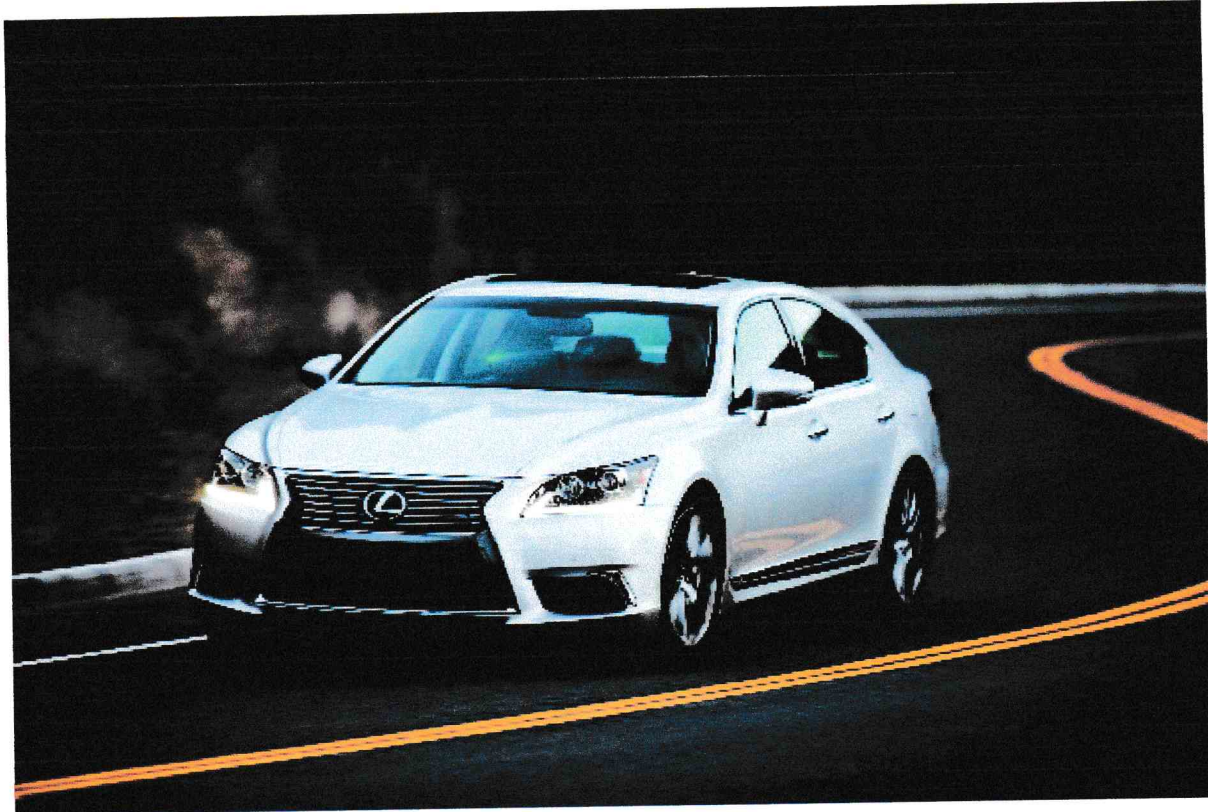
The dimensions of quality for a service differ somewhat from those of a manufactured product. Service quality is more directly related to time and the interaction between employees and the customer. Evans and Lindsay<sup>2</sup> identify the following dimensions of service quality.

1. **Time and timeliness:** How long must a customer wait for service, and is it completed on time? For example, is an overnight package delivered overnight?
2. **Completeness:** Is everything the customer asked for provided? For example, is a mail order from a catalog company complete when delivered?

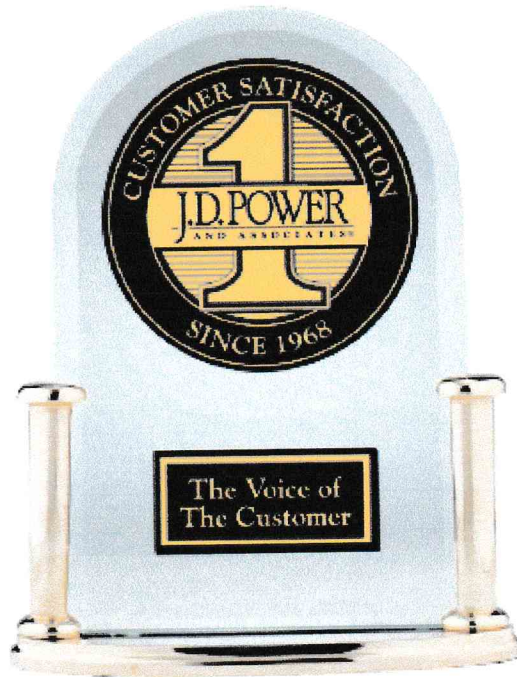


The Ford Motor Company

In the J.D. Power 2015 *Initial Quality Study (IQS)*, the Ford F-Series Super Duty was the highest-ranked model in the Large Heavy Duty Pickup segment. In the 2015 *IQS*, the Lexus LS was not only the highest-ranked model in the Large Premium Car segment, it also achieved the best overall score in the study.



Toyota Motor Corporation



J.D. Power

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**Gourtesy:** How are customers treated by employees? For example, are catalog phone operators at L.L. Bean nice and are their voices pleasant?

4. **Consistency:** Is the same level of service provided to each customer each time? Is your newspaper delivered on time every morning?
5. **Accessibility and convenience:** How easy is it to obtain the service? For example, when you call L.L. Bean does the service representative answer quickly?
6. **Accuracy:** Is the service performed right every time? Is your bank or credit card statement correct every month?
7. **Responsiveness:** How well does the company react to unusual situations, which can happen frequently in a service company? For example, how well is a telephone operator at L.L. Bean able to respond to a customer's questions about a catalog item not fully described in the catalog?

## Quality from the Producer's Perspective

Now we need to look at quality the way a producer or service provider sees it: how value is created. We already know that product development is a function of the quality characteristics (i.e., the product's fitness for use) the customer wants, needs, and can afford. Product or service design results in design specifications that should achieve the desired quality. However, once the product design has been determined, the producer perceives quality to be how effectively the production process is able to conform to the specifications required by the design, referred to as the **quality of conformance**. What this means is quality during production focuses on making sure that the product meets the specifications required by the design.

**Quality of conformance** Is making sure the product or service is produced according to design.

Examples of the quality of conformance: If new tires do not conform to specifications, they wobble. If a hotel room is not clean when a guest checks in, the hotel is not functioning according to the specifications of its design; it is a faulty service. From the producer's

In the 1940s Deming worked at the Census Bureau, where he introduced the use of statistical process control to monitor the mammoth operation of key-punching data from census questionnaires onto millions of punch cards. During World War II, Deming, who is shown in the photo, developed a national program of 8- and 10-day courses to teach statistical quality-control techniques to over 10,000 engineers at companies that were suppliers to the military during the war. By the end of World War II he had an international reputation.

In 1950 Deming began teaching statistical quality control to Japanese companies. As a consultant to Japanese industries and as a teacher, he was able to convince them of the benefits of statistical quality control. He is a major figure in the Japanese quality movement, and in Japan he is frequently referred to as the father of quality control.

Deming's approach to quality management advocated continuous improvement of the production process to achieve conformance to specifications and reduce variability. He identified two primary sources of process improvement: eliminating common causes of quality problems, such as poor product design and insufficient employee training, and eliminating special causes, such as specific equipment or an operator. Deming emphasized the use of statistical quality-control techniques to reduce variability in the production process. He dismissed the then widely used approach of final product inspection as a means of ensuring good quality as coming too late to reduce product defects. Primary responsibility for quality improvement, he said, was employees' and management's. He promoted extensive employee involvement in a quality improvement program, and he recommended training for workers in quality-control techniques and methods.

Deming's overall philosophy for achieving improvement is embodied in his 14 points, summarized in [Table 2.2](#).

**TABLE 2.2 W. E. Deming's 14 Points**

1. Create a constancy of purpose toward product improvement to achieve long-term organizational goals.
2. Adopt a philosophy of preventing poor-quality products instead of acceptable levels of poor quality as necessary to compete internationally.
3. Eliminate the need for inspection to achieve quality by relying instead on statistical quality control to improve product and process design.
4. Select a few suppliers or vendors based on quality commitment rather than competitive prices.
5. Constantly improve the production process by focusing on the two primary sources of quality problems, the system and employees, thus increasing productivity and reducing costs.
6. Institute worker training that focuses on the prevention of quality problems and the use of statistical quality-control techniques.
7. Instill leadership among supervisors to help employees perform better.
8. Encourage employee involvement by eliminating the fear of reprisal for asking questions or identifying quality problems.
9. Eliminate barriers between departments, and promote cooperation and a team approach for working together.
10. Eliminate slogans and numerical targets that urge employees to achieve higher performance levels without first showing them how to do it.
11. Eliminate numerical quotas that employees attempt to meet at any cost without regard for quality.
12. Enhance worker pride, artisanry, and self-esteem by improving supervision and the production process so that employees can perform to their capabilities.
13. Institute vigorous education and training programs in methods of quality improvement throughout the organization, from top management down, so that continuous improvement can occur.
14. Develop a commitment from top management to implement the previous 13

points.

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### Internet Exercises

Deming is also credited with the development of the *Deming Wheel*, although it was originally formulated by Walter Shewart, and later recast and renamed by the Japanese as the *plan-do-check-act (PDCA) cycle*. The PDCA cycle is a four-stage process for continuous

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**Courtesy:** How are customers treated by employees? For example, are catalog phone operators at L.L. Bean nice and are their voices pleasant?

4. **Consistency:** Is the same level of service provided to each customer each time? Is your newspaper delivered on time every morning?
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perspective, good-quality products conform to specifications—they are well made; poor-quality products are not made well—they do not conform to specifications.



Joel Page/©AP/Wide World Photos

L.L. Bean's first product was the Maine Hunting shoe, developed in 1912 by company founder Leon Leonwood Bean, a Maine outdoorsman. He initially sold 100 pairs to fellow sportsmen through the mail, but 90 pairs were sent back when the stitching gave way. However, true to his word, L.L. Bean returned their money and started over with an improved boot. In years to come L.L. Bean operated his business according to the following belief: "Sell good merchandise at a reasonable profit, treat your customers like human beings, and they will always come back for more." L.L. Bean also guarantees their products to "give 100% satisfaction in every way." If they don't, L.L. Bean will replace the item or refund the purchase price "at any time."

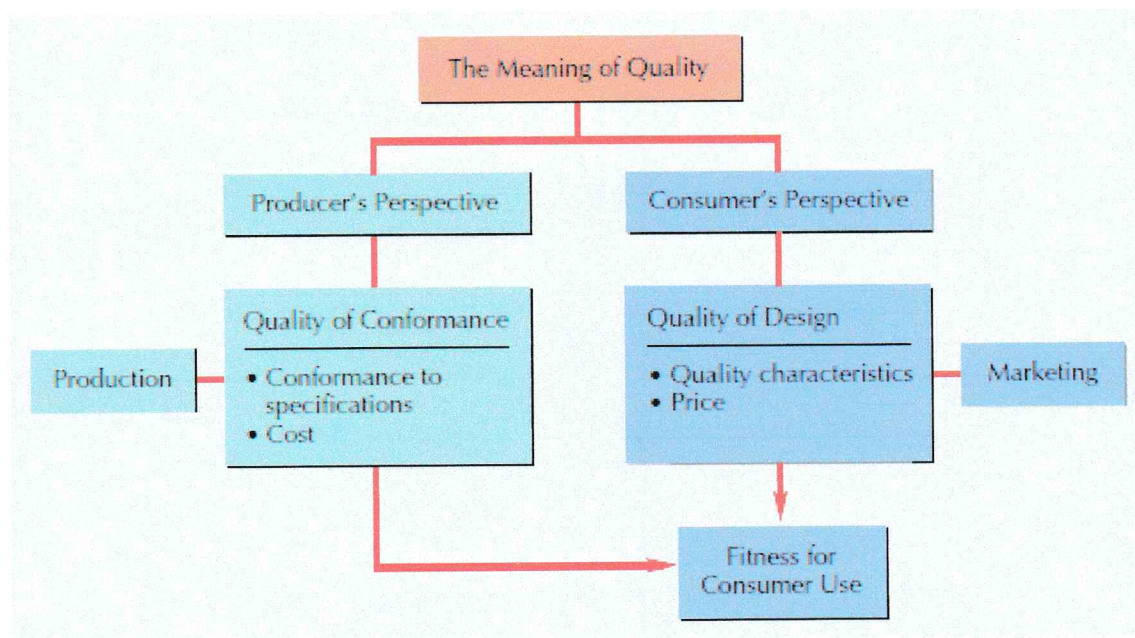
Achieving quality of conformance depends on a number of factors, including the design of the production process (distinct from product design), the performance level of machinery, equipment and technology, the materials used, the training and supervision of employees, and the degree to which statistical quality-control techniques are used. When equipment fails or is maladjusted, when employees make mistakes, when material and parts are defective, and when supervision is lax, design specifications are generally not met. Key personnel in achieving conformance to

specifications include the engineering staff, supervisors and managers, and, most importantly, employees.

An important consideration from the customer's perspective of product quality is product or service price. From the producer's perspective, an important consideration is achieving quality of conformance at an acceptable cost. Product cost is also an important design specification. If products or services cannot be produced at a cost that results in a competitive price, then the final product will not have acceptable value—the price is more than the consumer is willing to pay given the product's quality characteristics. Thus, the quality characteristics included in the product design must be balanced against production costs.

## A Final Perspective on Quality

We approached quality from two perspectives, the customer's and the producer's. These two perspectives are dependent on each other, as shown in [Figure 2.1](#). Although product design is customer-motivated, it cannot be achieved without the coordination and participation of the production process. When a product or service is designed without considering how it will be produced, it may be impossible for the production process to meet design specifications or it may be so costly to do so that the product or service must be priced prohibitively high.

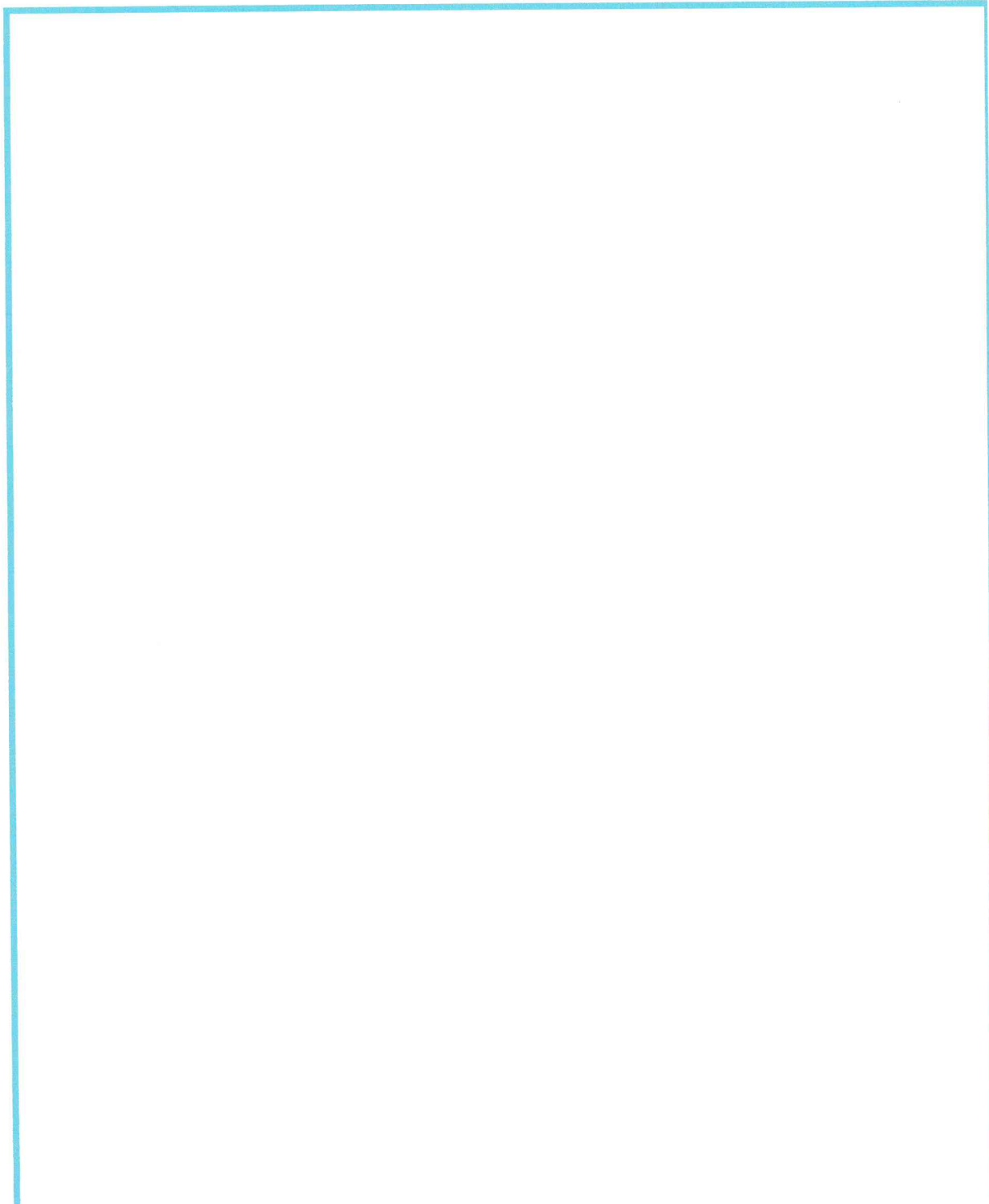


**FIGURE 2.1** The Meaning of Quality

[Figure 2.1](#) depicts the meaning of quality from the producer's and consumer's perspectives. The final determination of quality is fitness for use, which is the customer's view of quality. It is the consumer who makes the final judgment regarding quality, and so it is the customer's view that must dominate.

# Quality Management System

To make sure that products and services have the quality they have been designed for, strategy to achieve quality throughout the organization is required. This approach to the management of quality throughout the entire organization and supply chain has evolved into what is generally referred to as a quality management system (QMS).



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## Along the Supply Chain

### Quality vs. Value in Denim Jeans

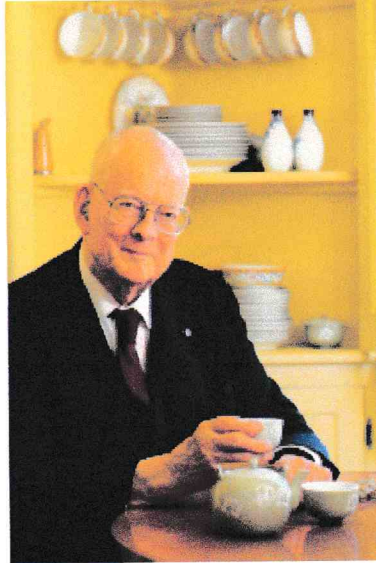
Denim jeans are a global wardrobe staple with about 2 billion pairs of jeans worth nearly \$55 billion sold worldwide each year (70% in the United States, European Union, and China). About 780 million pairs of jeans are sold annually in the United States; virtually all U.S. consumers own at least one pair of denim jeans, and, on average, seven pairs. However, regardless of the price of their jeans, which generally average a little less than \$40, but can approach \$500, American consumers expect them to last longer and be more durable than any other piece of clothing in their closets. U.S. jeans retailers generally acknowledge that while price is the top factor for most consumer clothing decisions, it is less of a factor when buying denim jeans; consumers see the *value* in paying a little more for jeans that have “better” quality, i.e., a better fit and will last longer. Among women jeans buyers, price is the fourth most important factor behind other quality attributes, and among men less than half view price as important when buying jeans. As such, quality is perhaps the most important factor to the various companies up and down the global denim jeans supply chain that grow cotton, manufacture denim cloth, produce denim jeans, and sell jeans to consumers.

How the customer perceives “value” in denim jeans is a key factor that drives the quality management (QM) programs of most major denim jeans companies like Levi Strauss and VF Corporation (Lee and Wrangler Jeans). There are a number of attributes that affect the feel, look, and fit of denim jeans, and thus distinguish their quality. For example, jeans buyers have historically been willing to pay more for jeans with a higher cotton content (resulting in a better “feel”), and apparel consumers, in general, believe better quality clothing is made from natural fibers (like cotton). Different fabric qualities are determined not only by the quality of the cotton used, but by the manufacturing process used to make it; more expensive processes that spin the cotton into fabric unevenly give the fabric more character and depth. How the fabric is cut and sewn; how it is dyed; how it is ultimately washed in the finishing process (which can sometimes exceed all of the other production costs combined); the various trim items such as rivets and buttons, zippers, etc.; and, last but not least, fit, are distinguishing quality attributes. To be successful in the highly competitive global denim jeans market companies must rely on well-conceived and managed quality management programs throughout their supply chains to ensure that they are able to provide the value their customers demand.

What are the quality attributes that affect your purchasing decisions for denim jeans?

## The Evolution of Quality Management

A handful of prominent individuals, summarized in **Table 2.1**, have had a profound impact on the importance of quality in the United States, Japan, and other countries. Of these “quality gurus” W. Edwards Deming has been the most prominent.



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W. E. Deming is the most famous of all “quality gurus.” He introduced statistical quality control to the Japanese, which served as the catalyst for a worldwide quality movement. His “14 points” were the foundation for modern QMS processes.

TABLE 1.1 Quality Gurus

QUALITY GURU	CONTRIBUTION
Walter Shewhart	Working at Bell Laboratories in the 1920s, he developed the technical tools such as control charts that formed the basis of statistical quality control; he and his colleagues at Bell Labs introduced the term <i>quality assurance</i> for their program to improve quality through the use of statistical control methods.
W. Edwards Deming	A disciple of Shewart, he developed courses during World War II to teach statistical quality-control techniques to engineers and executives of companies that were military suppliers; after the war he began teaching statistical quality control to Japanese companies, initiating their quality movement.
Joseph M. Juran	An author and consultant, he followed Deming to Japan in 1954; he focused on strategic quality planning within an annual quality program, setting goals for product quality and designing processes to achieve those goals; quality improvement is achieved by focusing on projects to solve problems and securing breakthrough solutions.
Armand V. Feigenbaum	In his 1951 book, <i>Quality Control: Principles, Practices and Administration</i> , he introduced the concept of total quality control and continuous quality improvement as a companywide strategic commitment requiring the involvement of all functions in the quality process, not just manufacturing; discovered by Japanese in the 1950s at about the same time as Juran's visit; from 1958 to 1968 he was director of manufacturing operations and quality control at GE.
Philip Crosby	In his 1979 book, <i>Quality Is Free</i> , he emphasized that the costs of poor quality (including lost labor and equipment time, scrap, downtime and lost sales) far outweigh the cost of preventing poor quality; in his 1984 book, <i>Quality Without Tears</i> , he defined absolutes of quality management—quality is defined as conformance to requirements, quality results from prevention, the performance standard is “zero defects.”
Kaoru Ishikawa	This Tokyo University professor promoted use of quality circles and developed the “fishbone” (cause and effect) diagram to diagnose quality problems; he emphasized the importance of the internal customer, that is, that a quality organization is first necessary in order to produce quality products or services.

In the 1940s Deming worked at the Census Bureau, where he introduced the use of statistical process control to monitor the mammoth operation of key-punching data from census questionnaires onto millions of punch cards. During World War II, Deming, who is shown in the photo, developed a national program of 8- and 10-day courses to teach statistical quality-control techniques to over 10,000 engineers at companies that were suppliers to the military during the war. By the end of World War II he had an international reputation.

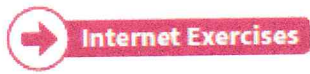
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**TABLE 2.2 W. E. Deming's 14 Points**

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13. Institute vigorous education and training programs in methods of quality improvement throughout the organization, from top management down, so that continuous improvement can occur.
14. Develop a commitment from top management to implement the previous 13 points.

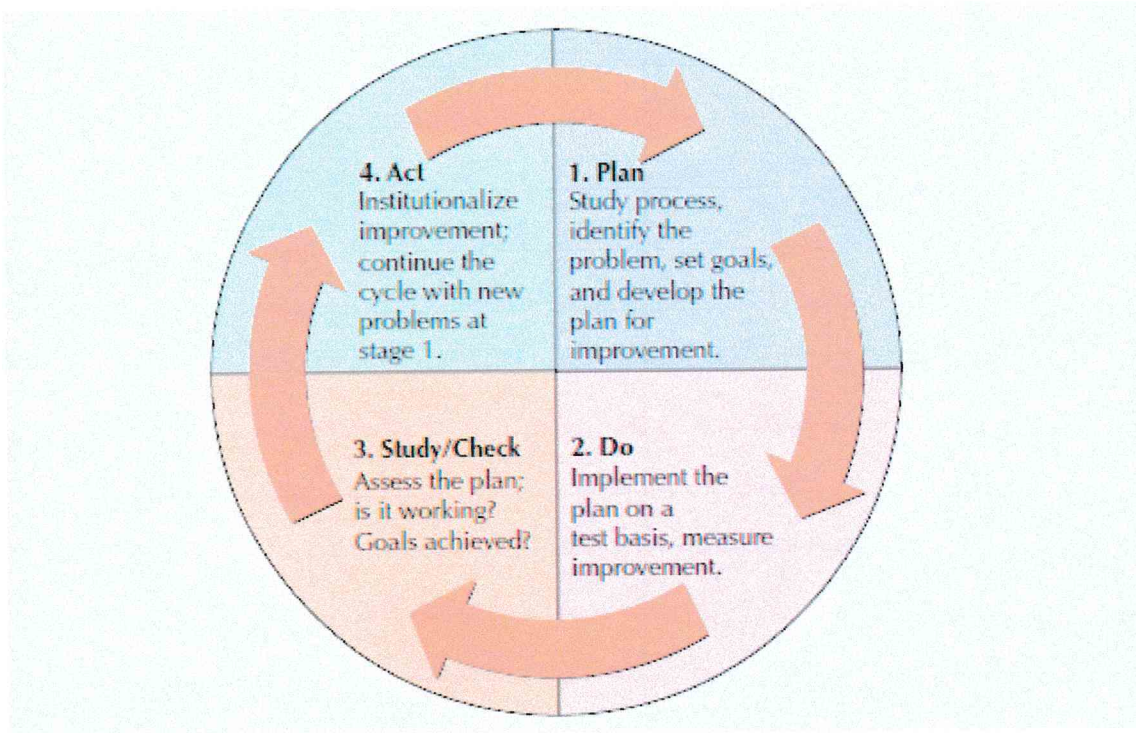


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quality improvement that complements Deming's 14 points, as shown in [Figure 2.2](#). Years later, Deming once again modified the original Shewart cycle as a circle flow diagram for learning and improvement of a product and process that he called the *plan-do-study-act (PDSA) cycle* (also shown in [Figure 2.2](#)). The PDCA cycle later formed the basis for the Six Sigma five-step DMAIC breakthrough strategy (we'll talk about this in the "Six Sigma" section later in this chapter).



**FIGURE 2.2 The Deming Wheel (PDCA Cycle)**

Deming's approach to quality embodied in his 14 points and PDCA cycle are the foundation for today's quality management systems employed by many successful companies.

## TQM and QMS

**Total quality management (TQM)** has been the most prominent and visible approach to quality to evolve from the work of Deming and the early quality gurus. TQM originated in the 1980s as a Japanese-style management approach to quality improvement, and became very popular during the 1990s, being adopted by thousands of companies. Although it has taken on many meanings, it was (and still is) a philosophy for managing an organization centered on quality and customer

satisfaction as “the” strategy for achieving long-term success. It requires the active involvement, participation, and cooperation of everyone in the organization, and encompasses

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virtually all of its activities and processes. To achieve and sustain this pervasive focus on quality requires a significant long-term commitment on the part of the organization's leadership. Deming's 14 points and the philosophies and teachings of the early quality gurus are clearly embodied in the basic principles of TQM:

**Total quality management (TQM)** Customer-oriented, leadership, strategic planning, employee responsibility, continuous improvement, cooperation, statistical methods, and training and education.

1. Quality can and must be *managed*.
2. The *customer* defines quality, and customer satisfaction is the top goal; it is a requirement and is not negotiable.
3. Management must be involved and provide *leadership*.
4. Continuous quality improvement is "the" *strategic* goal, which requires planning and organization.
5. Quality improvement is the responsibility of every *employee*; all employees must be trained and educated to achieve quality improvement.
6. Quality problems are found in *processes*, and problems must be prevented, not solved.
7. The quality *standard* is "no defects."
8. Quality must be *measured*; improvement requires the use of *quality tools*, and especially statistical process control.

TQM has been supplanted to a large extent by what is most commonly referred to as a **quality management system (QMS)**. This approach (or term) has evolved out of the ISO:9001 certification process that many companies around the world have gone through; essentially ISO certifies a company's "quality management system," and much of the ISO's written materials refer directly to "quality management systems." (ISO certification is discussed in greater detail in a separate section later in this chapter.) A QMS is not as much of a philosophy as TQM; rather, it is a system that complements a company's other systems and functions. It is a systematic approach to achieving quality and hence customer satisfaction, and while it suggests no less commitment to that goal than TQM, it maintains less of a core strategic focus than TQM. Further, since a QMS is not a "philosophy," it more naturally is designed to meet the individual needs and circumstances of a particular company. It outlines the policies and procedures necessary to improve and control specific (but not all) processes that will lead to improved business performance. A QMS tends to focus more on individual projects that have a quantifiable impact (i.e., increased profitability). Some companies have adopted the Malcolm Baldrige National Quality Award criteria as its QMS; another well-known QMS is Six Sigma (discussed in detail in a later section).

**Quality management system (QMS)** A system to achieve customer satisfaction that complements other company systems.

Regardless of the term a company uses to identify its approach to achieving quality improvement, and the possible differences between TQM and a QMS or other approaches, there are certain common characteristics of companywide approaches to quality improvement, such as customer satisfaction and employee involvement, topics we will talk about later in the chapter.

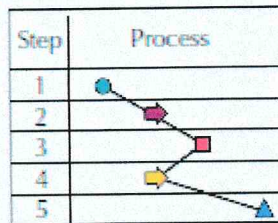
## Quality Tools

A major cornerstone of the commitment to quality improvement prescribed by Deming and the other early quality gurus is the need to identify and prevent the causes of quality problems, or defects. These individuals prescribed a number of “tools” to identify the causes of quality problems that are still widely used today, including Pareto charts, process flowcharts, checksheets, histograms, scatter diagrams, statistical process control charts, and cause-and-effect diagrams. In fact, as noted previously, Deming traveled to Japan primarily to teach statistical process control techniques. These popular tools became the basis for the quality management programs developed by many companies. In this section we will briefly describe some of these tools, which are summarized in [Figure 2.3](#).



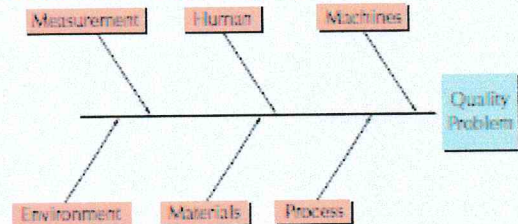
**Internet Exercises**

### Process Flowchart



A diagram of the steps in a process; helps focus on where in a process a quality problem might exist.

### Cause-and-Effect Diagram



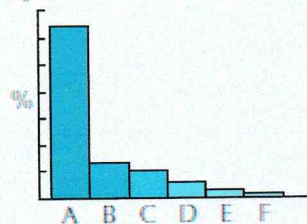
Also called a "fishbone" diagram; a graph of the causes of a quality problem divided into categories.

### Check Sheet

Items	1	2	3	4
Dirt	✓✓			✓✓
Old		✓		✓
Temp.	✓	✓✓	✓✓	
Fault	✓✓✓		✓✓	

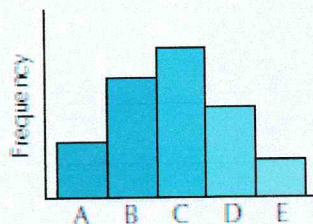
A fact-finding tool for tallying the number of defects for a list of previously identified problem causes.

### Pareto Analysis



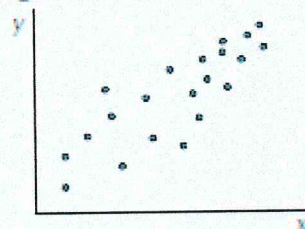
A diagram for tallying the percentage of defects resulting from different causes to identify major quality problems.

### Histogram



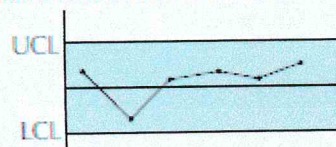
A diagram showing the frequency of data related to a quality problem.

### Scatter Diagram



A graph showing the relationship between two variables in a process; identifies a pattern that may cause a quality problem.

### Statistical Process Control Chart



A chart with statistical upper and lower limits; if the process stays between these limits over time, it is in control and a problem does not exist.



**FIGURE 2.3 Quality Tools**

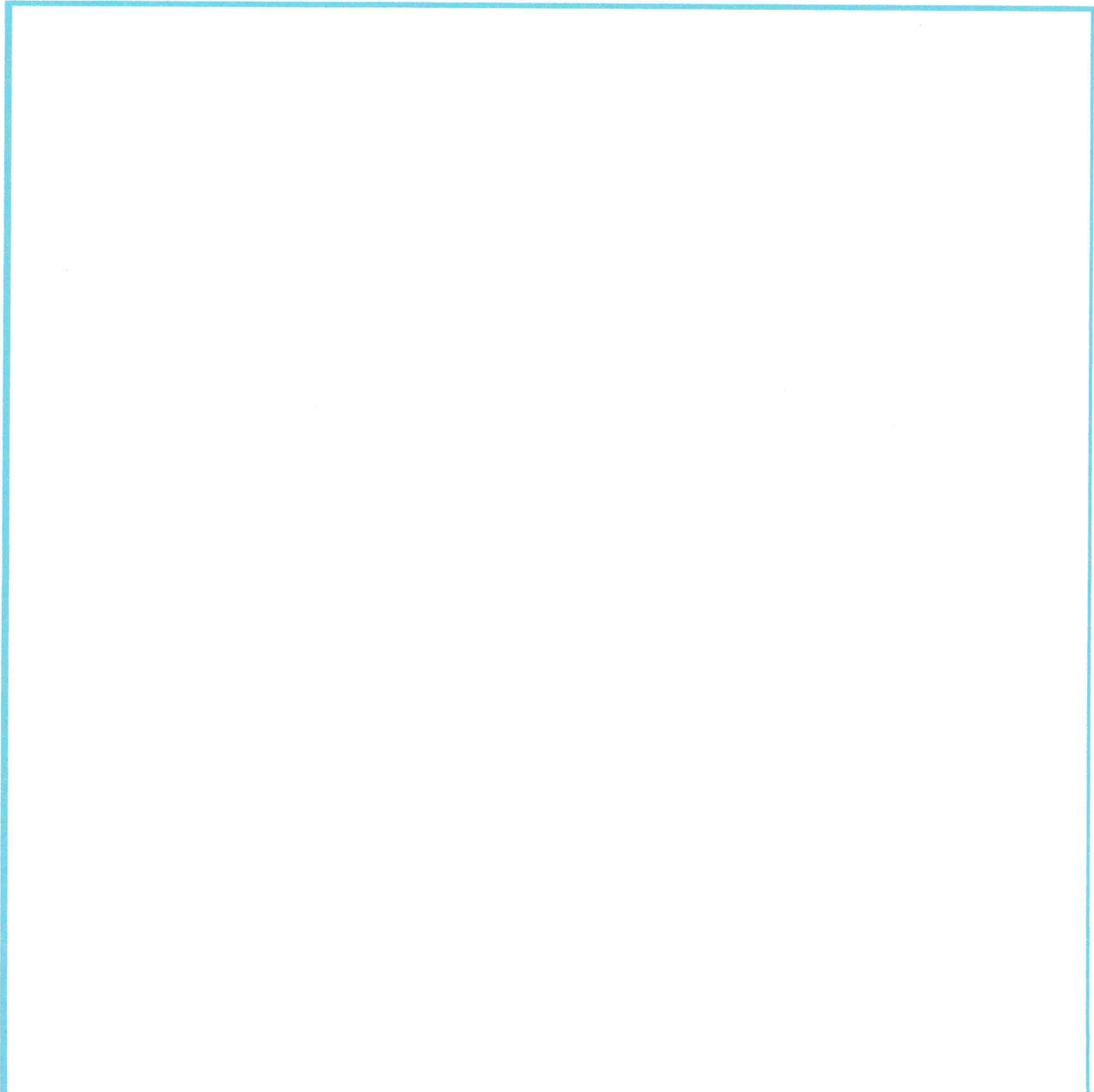
## Process Flowcharts

A **process flowchart** is a diagram of the steps in a job, operation, or process. It enables everyone involved in identifying and solving quality problems to have a clear picture of how a

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specific operation works and a common frame of reference. It also enables a process improvement team to understand the interrelationship of the departments and functions that constitute a process. This helps focus on where problems might occur and if the process itself needs fixing. Development of the flowchart can help identify quality problems by helping the problem solvers better understand the process. Flowcharts are described in greater detail in [Chapter 6](#) (“Processes and Technology”) and [Chapter 8](#) (“Human Resources”).

**Process flowchart** A diagram of the steps in a job, operation, or process.



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## Along the Supply Chain

### Applying Deming's PDCA Cycle in Education

The Pewaukee School District (PSD), located in Waukesha County, Wisconsin (just west of Milwaukee), with 2760 K–12 students and 296 employees in four schools (two elementary, one middle, and one high school) was a 2013 Baldrige National Quality Award Winner. Despite having one of the state's most rigorous graduation requirements (28 credits), it has had a higher graduation rate and percentage of graduates attending college than other county, state, and nearby high-performing districts. Its AP exam pass rate (76%) was higher than the county and state and its ACT composite score (23.4) was better than both state and national averages. Parent surveys showed satisfaction with communication was 20% higher than the national average, and satisfaction with education quality was over 93%. PSD also significantly outperformed county and state districts in dropout and truancy rates and in student volunteering. PSD has been named one of "Wisconsin's Top 100 Workplaces" by the *Milwaukee Journal Sentinel* and staff satisfaction ratings for salaries, benefits, and engagement/involvement greatly exceed national averages.

PSD's strategic planning process is based on Deming's PDCA cycle. In the "plan" stage of the cycle a large stakeholder group assembled in the spring clarifies purpose and direction by assessing performance and reviewing progress on goals and action plans, and validates missions and strategies. In the "do" stage, administrative, school, and department teams align action by updating plan goal measures, creating short-term action plans during the summer, and creating school improvement plans for five strategy areas. The strategic plan is approved in the summer, resources are allocated, and action plans are deployed in the fall. In the "study" stage senior leaders and the board of education measure plan goals and analyze the results of action plans quarterly during the school year. In the final "act" stage of the cycle, senior leaders and the board of education evaluate action plan results and goal attainment, identify successes and opportunities for improvement, make recommendations for continuous improvement, and evaluate the strategic planning process before beginning the cycle again. Some of the innovations resulting from this strategic planning process include personalized learning, a 1:1 laptop initiative for grades 5 and higher, a community volunteer program, an elementary world language study, and innovative student schedules that maximize learning time.

In this examples the PDCA cycle is used in education; can you think of specific processes in a service organization you are familiar with that the PDCA cycle might be applied to, perhaps even your own university?

Sources: Based on M. Schmidt, "The Ripple Effect, Education and Healthcare Makes Waves in Performance Excellence Circles," *Quality Progress* 47, (8): August

2014), pp. 32–41; and National Quality Program at the National Institute of Standards and Technology website

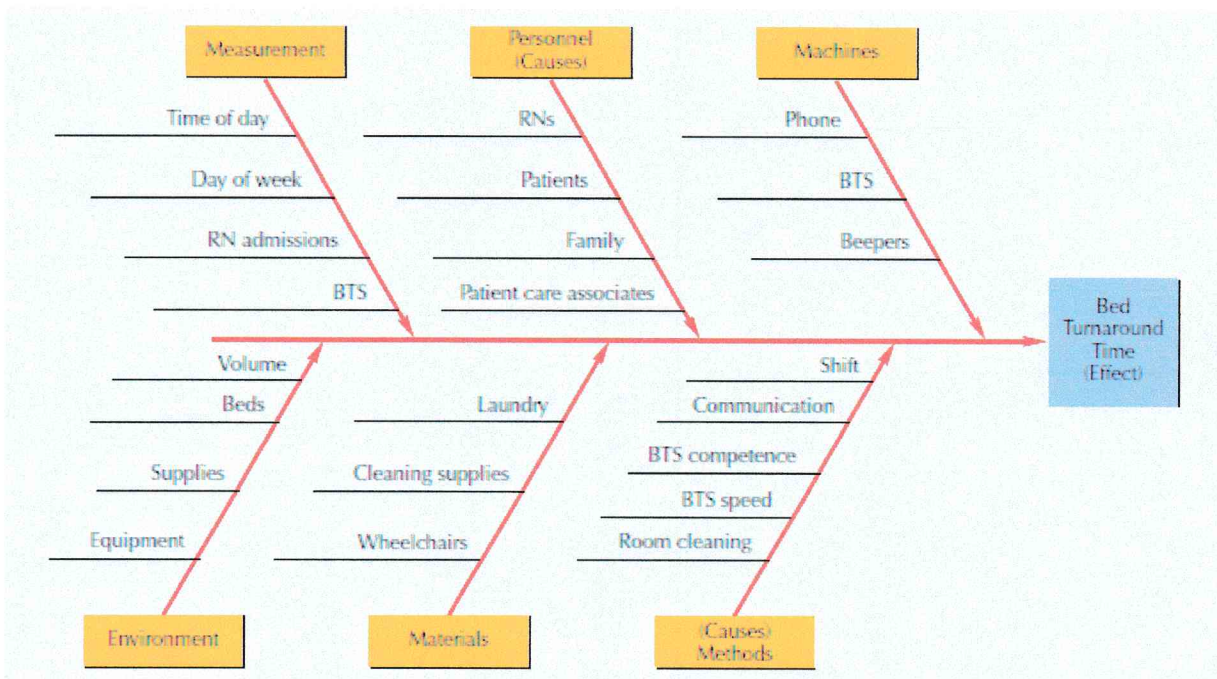
[http://www.nist.gov/baldrige/about/baldrige\\_faqs.cfm](http://www.nist.gov/baldrige/about/baldrige_faqs.cfm).

## Cause-and-Effect Diagrams

A **cause-and-effect diagram**, also called a **fishbone** or Ishikawa diagram, is a graphical description of the elements of a specific quality problem and the relationship among those elements. It is used to identify the causes of a quality problem so it can be corrected. Cause-and-effect diagrams are usually developed as part of *brainstorming* to help a quality team of employees and managers identify causes of quality problems.

**Cause-and-effect diagram or fishbone diagram** A chart showing the different categories of problem causes.

**Figure 2.4** is a cause-and-effect diagram for a Six Sigma project at a hospital to reduce delays in patient bed turnaround time, which creates a patient flow problem throughout the hospital. The primary cause of the problem is suspected to be related to the “bed tracking system” (BTS), an electronic system that indicates the status of each bed to the registered nurse (RN) who admits patients and assigns them to a room. (See the “Along the Supply Chain” box for the North Shore University Hospital.)



**FIGURE 2.4 A Cause-and-Effect Diagram**

The “effect” box at the end of the diagram is the quality problem that needs correction. A center line connects the effect box to the major categories of possible problem causes, displayed as branches off of the center line. The box at the end of each branch (or fishbone) describes the cause category. The diagram starts out in this form with only the major categories at the end of each branch. Individual causes associated with each category are attached as separate lines along the length of the branch during the brainstorming process. Sometimes the causes are rank-ordered along the branches in order to identify those that are most likely to affect the problem. The cause-and-effect diagram is a means for thinking through a problem and recording the possible causes in an organized and easily interpretable manner.

A complementary tool related to the fishbone diagram is the **cause-and-effect matrix**, which is used to prioritize the potential causes of quality problems in a process that might first be identified using a cause-and-effect diagram. The output (or *Y*) variables are listed along the top of the matrix. These are also referred to as CTQs or CTQCs, (i.e., “critical-to-quality characteristics”) and they are measurable characteristics that express the key requirements

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defined by a customer. CTQCs are what the customer expects from a product, and accordingly they have a significant impact on customer satisfaction. The input (or *X*) variables that might affect the outcome of process (i.e., the potential causes of an outcome) are listed along the left side of the matrix (or grid). The CTQCs are ranked or weighted in terms of importance to the customer; then, the relationship between causes and effects (CTQs) are weighted or ranked; and finally, an overall score is calculated for the causes (or *X* variables). The causes with the highest score should be addressed first in improvement efforts because they will have the largest impact on customer satisfaction. **Figure 2.5** shows a cause-and-effect matrix for the hospital bed turnaround time example. Note that staff communication has the highest score, and thus, the greatest impact on how satisfied the customers are with the overall process.

**Cause-and-effect matrix** A grid used to prioritize causes of quality problems.

		Key Output (Y) Variables (CTQC's)						Score	Rank of X Variables/Importance to Customer
		1	2	3	4	5	6		
		Turnaround time	Patient flow	Physician time	Emergency dept	Patient time	Operating room		
Key Input (X) Variables	Customer rank	1	3	2	5	6	4	Score	
	Weight	10	9	9	7	7	8		
1	BTS	9	8	10	8		5	348	3
2	Beepers	7	5	8		5		222	7
3	Volume	7	10	6	7	5	5	338	4
4	Beds	4		9				121	10
5	Time of day	3	4	5	4	10		209	8
6	Day of week	9	10	6			6	282	5
7	Communication	9	8	10	8	7	9	429	1
8	BTS competence	10	9	7		7	7	349	2
9	Room cleaning	7	5	3		8	4	230	6
10	Supplies	8	9					161	9

$$(8)(10) + (9)(9) = 161$$

**FIGURE 2.5 A Cause-and-Effect Matrix**

## Checksheets and Histograms

Checksheets are frequently used in conjunction with histograms, as well as with Pareto diagrams. A *checksheet* is a fact-finding tool used to collect data about quality problems. A typical check sheet for quality defects tallies the number of defects for a variety of previously identified problem causes. When the check sheet is completed, the total tally of defects for each cause can be used to create a *histogram* or a Pareto chart, as shown in **Figure 2.6**.

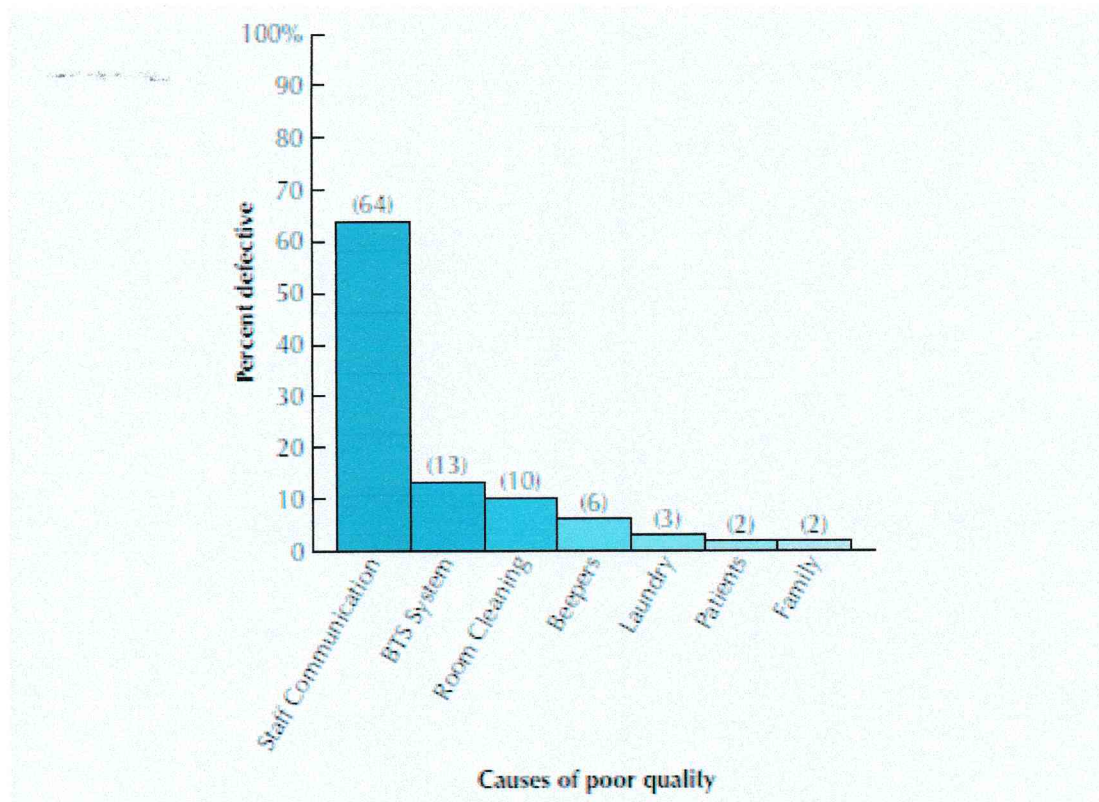



FIGURE 2.6 Pareto Chart

## Pareto Analysis

**Pareto analysis** is a method of identifying the causes of poor quality. It was devised in the early 1950s by the quality expert Joseph Juran. He named this method after a nineteenth-century Italian economist, Vilfredo Pareto, who determined that a small percentage of the people accounted for most of the wealth. Pareto analysis is based on Juran's finding that most quality problems and costs result from only a few causes. For example, he discovered in a textile mill that almost 75% of all defective cloth was caused by only a few weavers, and in a paper mill he studied, more than 60% of the cost of poor quality was attributable to a single category of defects. Correcting the few major causes of most of the quality problems will result in the greatest cost impact.

**Pareto analysis** Most quality problems result from a few causes.

Pareto analysis can be applied by tallying the number of defects for each of the different possible causes of poor quality in a product or service and then developing a frequency distribution from the data. This frequency distribution, referred to as a *Pareto diagram*, is a useful visual aid for focusing on major quality problems.

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The quality problem for hospital bed turnaround time is described in the previous section on cause-and-effect diagrams ([Figure 2.4](#)). In this case, a defect is anytime the turnaround time exceeds 150 minutes for a patient out of a sample of 195 patients. Some of the causes of this problem are as follows.

CAUSE	NUMBER OF DEFECTS	PERCENTAGE
Staff communication	83	64%
BTS system	17	13
Room cleaning	13	10
Beepers	7	6
Laundry	4	3
Patients	3	2
Family	3	2
	130	100%

For each cause of poor quality, the number of defects attributed to that cause has been tallied. This information is then converted into the Pareto chart shown in [Figure 2.6](#).

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This Pareto chart identifies the major cause of poor quality to be poor staff communication. Correcting the problem will result in the greatest quality improvement. However, the other problems should not be ignored. Continual quality improvement is the long-term goal. The Pareto diagram simply identifies the quality problems that will result in the greatest immediate impact on quality improvement.

## Scatter Diagrams

*Scatter diagrams* graphically show the relationship between two variables, such as the brittleness of a piece of material and the temperature at which it is processed. One temperature reading should result in a specific degree of brittleness representing one point on the diagram. Many such points on the diagram visually show a pattern between the two variables and a relationship or lack of one. This diagram could be used to identify a particular quality problem associated with the baking process.

## Process Control Charts and Statistical Quality Control

We discuss control charts and other statistical quality-control methods in [Chapter 3](#), “Statistical Process Control.” For now, it is sufficient to say that a control chart is a means for measuring if a process is doing what it is supposed to do, like a thermostat monitoring room temperature. It is constructed with a horizontal line through the middle of a chart representing the process average or norm. It also has a line below this center line representing a lower control limit and a line above it for the upper control limit. Samples from the process are taken over time and measured according to some attribute. In its simplest form, if the measurement is within the upper and lower control limits, the process is said to be in control and there is no quality problem, but if the measurement is outside the limits, then a problem probably exists and should be investigated and corrected.

Statistical quality-control methods such as the process control chart are important tools for quality improvement. Employees who are provided with extensive training in statistical quality-control methods are able to identify quality problems and their causes and to make suggestions for improvement. (See the “Along the Supply Chain” box to see how a control chart is used to monitor hospital bed turnaround times.)

# Customers and Employees in Quality Management

The main focus of Deming's 14 points, TQM, and all QMSs is to achieve customer satisfaction, and most of Deming's 14 points refer to employees. The reasons are simple. Customers who are very happy and delighted are less likely to switch to a competitor, which translates to profits. Employees have the most direct influence on quality.

A high level of satisfaction creates an emotional bond instead of simply a rational preference. Research by companies has shown that there is a direct link between customer satisfaction and attrition rates, indicating that delighted customers are less likely to defect than dissatisfied customers. **Figure 2.7** highlights some of the "facts" that are generally known to exist about customer satisfaction.

- It costs 5 or 6 times more to attract a new customer than it does to keep an existing one.
- Between 94 and 96 percent of dissatisfied customers don't complain, they just walk away and about 91 percent of them don't come back.
- Between 54 and 70 percent of customers who complain will do business with the company again if their complaints are resolved satisfactorily; this number increases to around 95 percent if the complaint is resolved quickly.
- A typical dissatisfied customer will tell 8 to 10 people about their problem; one in five will tell 20 (and the Internet now makes it possible to tell thousands). A satisfied complainer will tell an average of five people about how a problem was resolved to their satisfaction.
- It takes about 12 positive service encounters to make up for a single negative one.
- Only about five percent of customers who cannot buy a product because it's out of stock return to make the originally planned purchase.
- Around 68 percent of customers stop doing business with suppliers because they perceive an attitude of indifference toward them; only 14 percent leave because they are dissatisfied with a product, and only 9 percent leave for competitive reasons.
- Between 80 and 90 percent of customers who defect say they are "satisfied;" but "very satisfied" customers are four to seven times more likely to repeat their purchase within the next 18 months than those who were merely "satisfied."
- An increase of as little as five percent in customer retention can result in an 80 to 100 percent increase in profits.
- Businesses with low quality service average only one percent return on sales and lose market share at a rate of two percent annually; businesses with high-quality service average a 12 percent return on sales and gain market share at the rate of 6 percent annually (and charge significantly higher prices).

Source: The British Quality Foundation, "Back to Basics," *Quality World* 32 (5; May 2006), p. 37.

### FIGURE 2.7 The Impact of Customer Satisfaction

## Quality Management in the Supply Chain

Most companies not only have customers they want to satisfy, but they are also customers of other companies, their *suppliers*, within a company's supply chain. Companies know that to satisfy its

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customers requires not only their own commitment to quality, but also the support and resources of its suppliers. This is especially true of companies that outsource many of their activities to suppliers. Companies and their suppliers joined together in a supply chain must work together to meet the needs of the company's customers. A partnership exists between the supplier and its customer wherein the supplier is expected to manage its own quality effectively so that the company it supplies can count on the quality of the materials, parts, and services it receives.

Many companies reduce their number of suppliers in order to have more direct influence over their suppliers' quality and delivery performance, which was one of Deming's 14 points. It is based on the notion that if a company has a major portion of a supplier's business, then the supplier is more willing to meet the customer's quality standards. The company and supplier enter into a business relationship referred to as **partnering**, in which the supplier agrees to meet the company's quality standards, and in return the company enters into a long-term purchasing agreement with the supplier that includes a stable order and delivery schedule.

**Partnering** A relationship between a company and its supplier based on mutual quality standards.

In order to ensure that its supplier meets its quality standards, a company will often insist that the supplier adopt a QMS similar to its own, or a company's QMS will include its suppliers. Still other companies require that their suppliers achieve ISO 9001 certification, an international quality standard that ensures a high industry standard of quality as its QMS; some companies require their suppliers to follow Baldrige National Quality Award guidelines or even enter the Baldrige Award competition as their QMS.

At the other end of a company's spectrum from its suppliers is its direct relationship with its own customers. An important component of any QMS is the company's ability to measure customer satisfaction; to "hear" what the customer wants. The company needs to know if its QMS is effective. Is the company meeting customer expectations? Are its products or services meeting their fitness for use definition? Is it what the customer wants, does the customer like it, does the customer need it, would the customer like it changed? A QMS requires that some form of measurement system be in place to answer these questions and provide data about the customer's level of satisfaction. It is a well-established fact of consumer behavior that unhappy customers will tell almost twice as many others about their quality problems as they will about satisfactory products or services.

Along the Supply Chain

## Achieving Quality in Target's Supply Chain

Target, a *Fortune 500* company headquartered in Minneapolis, Minnesota, is one of the largest and best known retail chains in the United States, with over 900 stores in 49 states, over 365,000 employees, and revenues over \$70 billion. Target's supply chain includes 37 distribution centers across the United States and four warehouse centers near U.S. coastal ports that receive overseas shipments from suppliers around the world. For its hard good (nonfabric) products such as toys, furniture, electronics, sporting goods, and kitchen goods, Target works with over 3000 factories around the world, and because of its large network of suppliers and factories, realizing its commitment to total quality requires constant diligence.

Quality is an essential component of Target's global sourcing process so that quality is achieved while products are moving through the supply chain before they reach store shelves. The ultimate goal is to drive variability out of the supply chain. However, with an enormous number of hard good products coming from those 3000 factories, the opportunities for variability to enter the supply chain are substantial. Suppliers are required to sign a "standards of supplier engagement" agreement that clearly spells out Target's quality requirements. When a factory enters the Target supply chain, it is subjected to a thorough evaluation with a rating system that includes an assessment of product quality, which determines if a supplier can use the factory. Also, every factory must meet Target's global social compliance requirements regarding worker treatment, which are nonnegotiable and are the most important part of Target's partnering relationship with its suppliers.

Target works with existing factories and suppliers that experience failures to improve performance. However, repeated failures result in an end to the relationship. Target uses various statistical quality control tools in its evaluations, plus it also employs Six Sigma throughout its supply chain and business processes, in formal project management, problem solving, and process improvement.

Research how other large companies with a global supply chain might use formal rating systems to evaluate suppliers.

Sources: Based on William H. Murphy, "Bull's Eye: An Inside Look at How Target Ensures Quality in a Complex Supply Chain," *Quality Progress* (June 2010), pp. 22–29; and the Target website at [www.target.com](http://www.target.com).