1

Quality Improvement and Management

1.1 Introduction

Readers of this book have most likely used or heard the word *quality*. The concept of quality is centuries old. Many authors have defined *quality*, and some of these definitions are as follows:

- Joseph M. Juran defined *quality* as "fitness for intended use." This definition implies that *quality* means meeting or exceeding customer expectations.
- W. Edwards Deming stated that the customer's definition of *quality* is the one that really matters. He said, "A product is of good quality if it meets the needs of a customer and the customer is glad that he or she bought that product." Deming also gave an alternative definition of *quality*: "A predictable degree of uniformity and dependability with a quality standard suited to the customer."
- Philip B. Crosby defined *quality* as "conformance to requirements, not as 'goodness' or 'elegance.'" By *conformance*, he meant that the performance standard must be zero defects and not "close enough." He is known for his concept of "Do it right the first time."

The underlying concept in all these definitions is much the same: consistency of performance and conformance with the specifications while keeping the customer's interests in mind.

1.2 Statistical Quality Control

Statistical quality control (SQC) refers to a set of statistical tools used to monitor, measure, and improve *process* performance in real time.

Definition 1.1 A *process* may be defined as a series of actions or operations that change the form, fit, or function of one or more input(s) as required by a customer. A process may also be defined as a combination of workforce, equipment, raw material, methods, and environment that work together to produce a product. Figure 1.1 shows various steps that usually take place in any process, whether in a manufacturing or non-manufacturing environment.

The quality of the final product depends on how the process to be used is designed and executed.

The concept of SQC is less than a century old. Dr. Walter Shewhart (1931), working at the Westinghouse Hawthorne plant in Cicero, Illinois, drew the first statistical process control (SPC) chart

Statistical Quality Control: Using Minitab, R, JMP, and Python, First Edition. Bhisham C. Gupta.

Companion website: www.wiley.com/go/college/gupta/SQC

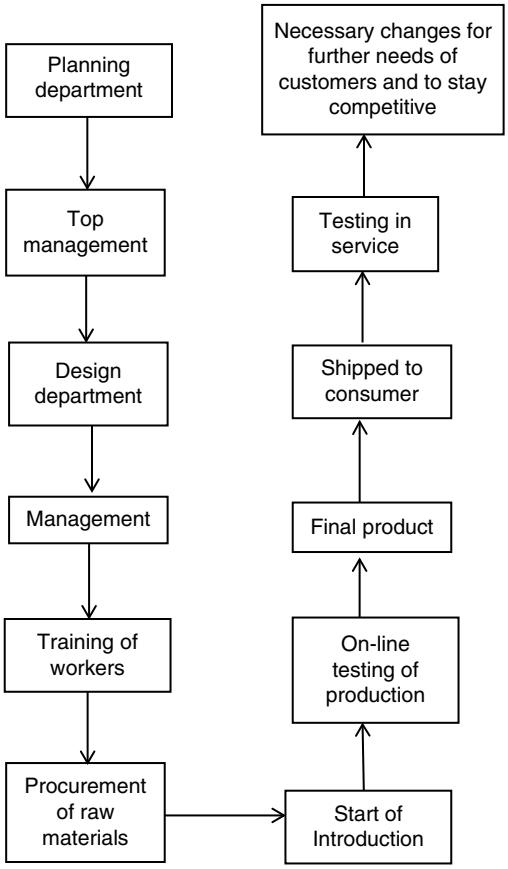

Figure 1.1 Flow chart of a process.

in 1924. While working at Hawthorne, Shewhart met and influenced W. Edward Deming and Joseph Juran; later, they went on to champion Shewhart's methods. Shewhart, Deming, and Juran are often considered the three founders of the quality improvement movement.

As mentioned above, SQC is a set of statistical tools used to monitor, control, and improve process performance. These essential tools are (i) SPC, (ii) acceptance sampling plans, and (iii) design of experiments (DOE). DOE is used to improve the process and find important control factors, whereas SPC monitors these factors so that the process remains in a steady state. SPC is one of the important tools that makes up SQC. However, the term *statistical process control* is often used interchangeably with *statistical quality control*.

1.2.1 Quality and the Customer

The customer or consumer plays a very important role in achieving quality, for it is the customer who defines the quality of the product. If the customer likes the product and is satisfied with it the way it functions, then the probability is high that they will be willing to buy the product again in the future, indicating that you have a quality product. However, quality can also be achieved through innovation. Quality is not static; rather, it is an ongoing process. For example, a given product may be of great quality today – but if no further innovative improvements are made, it may become

obsolete in the future and consequently lose its market share. It should be obvious that the required innovation can only be defined by the producer.

The customer is not in a position to tell how a product should look like 5 or 10 years from now. For example, five decades ago, a customer could not imagine electric cars or self-driven cars, or small computers replacing the huge computers that used to occupy entire rooms. The customer is only the judge of the product in its current form. In other words, a concern about quality begins with the customer, but the producer must carry it into the future. The producer or their team has to incorporate their innovative ideas at the design stage. This is called *continuous improvement* or *quality forever*. We will have a brief look at this concept later in this chapter.

It is important to note that a customer can be *internal* or *external*. For example, a paper mill could be an internal or external customer of a pulp mill. If both the paper and the pulp mill are owned by the same organization, then the paper mill is an *internal* customer; otherwise, it is an *external* customer. Similarly, various departments are internal customers of the Human Resources department. Another example is that students from various departments of a university taking a course from another department are internal customers, whereas a part-time student from outside the university is an external customer. In such cases, the company or organization should not assume that if its internal customers are satisfied, external customers are also automatically satisfied. The needs of external customers may be entirely different from those of internal customers, and the company must strive to meet both sets of needs. Furthermore, the goal of a company or an organization should be that all customers are satisfied not only for the moment but forever.

In summary, to achieve quality and competitiveness, you must first achieve quality today and then continue to improve the product for the future by introducing innovative ideas. To do this, an organization must take the following steps:

1) Make the customer its top priority. In other words, it should be a customer-focused organization.
2) Make sure the customer is fully satisfied and, as a result, becomes a loyal customer. A *loyal* customer is the one who will always give reliable feedback.
3) Create an environment that provides the most innovative products and has as its focus quality improvement as an ongoing process.
4) Take data-driven action to achieve quality and innovation. That is, the organization must collect information systematically, following appropriate sampling techniques to obtain data from internal as well as external customers about their needs and analyzing it to make necessary improvements. This process should be repeated continuously.

1.2.2 Quality Improvement

Different authors have taken different steps to achieve *quality improvement*. In this chapter, we quote the steps suggested by four prominent advocates of quality who revolutionized the field of SQC: Philip B. Crosby, W. Edwards Deming, Joseph M. Juran, and Armand V. Feigenbaum. We first discuss ideas suggested by Crosby, Feigenbaum, and Juran; later, we will look those from W. Edwards Deming.

Following are Juran's 10 steps to achieve quality improvement (Uselac 1993, p. 37; Goetsch and Davis 2006):

1) Build awareness of both the need for improvement and opportunities. Identify gaps.
2) Set goals for improvement.
3) Organize to meet the goals that have been set. They should align with the company's goal.
4) Provide training.

5) Implement projects aimed at solving problems.
6) Report progress.
7) Give recognition.
8) Communicate results.
9) Keep scores. Sustain these and continue to perfection.
10) Maintain momentum by building improvement into the company's regular system.

Next, we summarize Armand V. Feigenbaum's philosophy for total management (Tripathi 2016; Watson 2005):

- Quality of products and services is directly influenced by nine Ms: Markets, Money, Management, Men, Motivation, Material, Machines and Mechanization, Modern information methods, and Mounting product requirements.
- Three steps to quality: (i) management should take the lead in enforcing quality efforts and should be based on sound planning; (ii) traditional quality programs should be replaced by the latest quality technology to satisfy future customers; (iii) motivation and continuous training of the entire workforce gives insights about organizational commitment to the continuous quality improvement of products and services.
- Elements of total quality to enable a *total customer focus* are as follows:
  - Quality is the customer's perception.
  - Quality and the cost are the same, not different.
  - Quality is an individual and team commitment.
  - Quality and innovation are interrelated and mutually beneficial.
  - Managing quality is managing the business.
  - Quality is a principle.
  - Quality is not a temporary or quick fix.
  - Productivity is gained by cost-effective, demonstrably beneficial quality investment.
  - Implement quality by encompassing suppliers and customers in the system.

Feigenbaum was the first to define a system engineering approach to quality. He believed that total quality control combines management methods and economic theory with organizational principles, resulting in commercial leadership. He also taught that widespread quality improvement performance in a nation's leading businesses is directly related to quality's long-term economic impact.

Philip B. Crosby is well known for his "Quality Vaccine" and 14 steps to quality improvement. The Quality Vaccine consists of the following three ingredients:

- Determination
- Education
- Implementation

Crosby's suggested set of 14 steps to quality improvement are as follows (Goetsch and Davis 2006):

1) Make it clear that management is committed to quality for the long term.
2) Form cross-departmental quality teams.
3) Identify where current and potential problems exist.
4) Assess the cost of quality and explain how it is used as a management tool.
5) Increase the quality awareness and personal commitment of all employees.
6) Take immediate action to correct problems that have been identified.

7) Establish a zero-defects program.
8) Train supervisor to carry out their responsibilities in the quality program.
9) Periodically hold "zero defects days" to ensure that all employees are made aware there is a new direction.
10) Encourage individuals and teams to establish both personal and team improvement goals.
11) Encourage employees to tell management about obstacles they face in trying to meet quality goals.
12) Recognize employees who participate.
13) Implement quality councils to promote continual communication.
14) Repeat everything to illustrate that quality improvement is a never-ending process.

Note that many of these steps are covered if the projects in the Six Sigma methodology are well executed.

1.2.3 Quality and Productivity

During and after World War II, America was under a lot of pressure to increase productivity. The managers of manufacturing companies in America believed that productivity and quality were not compatible, and their way to increase productivity was to hire more workers and put "quality" on the back burner. Japan and Germany were also coming out of the ashes of World War II. So, until 1960, America dominated the world with its productivity – but in 1948, Japanese companies started to follow the work that many pioneers such as Shewhart, Juran, and Deming practiced at Westinghouse. The managers of Japanese companies observed that improving quality not only make their products more attractive but also increased productivity. However, this observation did not sink into the minds of the managers of American companies: they continued working with the assumption that improving quality cost more and inhibited productivity and consequently would mean lower profits.

Deming's famous visit to Japan in (1950) brought about a quality revolution in Japan, and the country became a very dominant power of quality throughout the world. During his visit, he gave a seminar that was attended not only by engineers but also by all the top managers. He told the Japanese managers that "they had an obligation to the world to uphold the finest of management techniques." He warned them against mistakenly allowing into Japanese companies the use of certain Western management practices, such as management by objective and performance standards, saying that "these practices are largely responsible for the failure of Western industry to remain competitive." As Deming noted in his book *Out of the Crisis*, which resulted from his visit to Japan, the chain reaction shown in Figure 1.2 became engraved in Japan as the way of industrial life. This chain reaction was on the blackboard during every meeting he held with top management in Japan.

Furthermore, Deming noted that "Once management in Japan adopted the chain reaction, everyone there from 1950 onward had one common aim, namely, quality." But as remarked earlier, this idea was not adopted by American management until at least the late 1980s. In the 1960s and 1970s, American companies continued to dominate in productivity, mainly by increasing their workforce. However, as a result of ignoring the quality scenario, America started to lose its dominance in terms of competitiveness and thus productivity. During this period, Germany and South Korea also became competitors with America. Ultimately, in the 1990s, American management started to work on quality; and as a result, America began to reemerge as a world-class competitor.

The gurus and advocates for quality – Deming, Feigenbaum, Juran, and Crosby – were the most influential people in making the move from production and consumption to total quality control

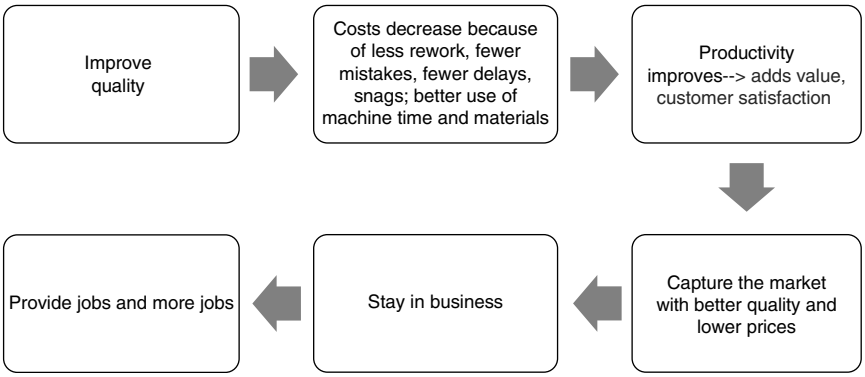

Figure 1.2 A chain reaction chart used by the Japanese companies in their top management meetings.

and management. According to Joseph A. DeFeo, president and CEO of the Juran Institute, "the costs of poor-quality account for 15 to 30% of a company's overall costs." When a company takes appropriate steps to improve its performance by reducing deficiencies in key areas (cycle time, warranty costs, scrap and rework, on-time delivery, billing, and others), it reduces overall costs without eliminating essential services, functions, product features, and personnel increases as outlined by Goetsch and Davis (2006). Feigenbaum also said that up to 40% of the capacity of a plant is wasted through *not getting it right the first time*.

Furthermore, we note that often, *flexibility* in manufacturing can increase productivity without affecting quality. For example, the best Japanese automaker plants can send a minivan, pickup truck, or SUV down the same assembly line one after another without stopping the line to retool or reset. One Nissan plant can assemble five different models on one line. This flexibility obviously translates into productivity (Bloomberg Businessweek 2003).

1.3 Implementing Quality Improvement

Earlier in this chapter, we noted that the characteristic of quality improvement is not static; rather, it is an ongoing process. It becomes the responsibility of all management that all appropriate steps are taken to implement quality improvement. The first step by management, of course, should be to transform "business as usual" into an improved business by instilling quality into it. Deming's 14-point philosophy is very helpful to achieve this goal:

1) Create constancy of purpose for improving products and services.
2) Adopt the new philosophy. That is, management must learn about the new economic age and challenges such as competitiveness, and take responsibility for informing and leading their business.
3) Cease dependence on inspections to achieve quality.
4) End the practice of awarding business based on price alone; instead, minimize total costs by working with a single supplier.
5) Constantly improve every process for planning, production, and service.
6) Institute training on the job.
7) Adopt and institute leadership.

8) Drive out fear.
9) Break down barriers between staff areas.
10) Eliminate slogans, exhortations, and targets for the workforce.
11) Eliminate numerical quotas for the workforce and numerical goals for management.
12) Remove barriers that rob people of pride of workmanship, and eliminate the annual rating or merit system.
13) Institute a vigorous program of education and self-improvement for everyone.
14) Put everybody in the company to work to accomplish the transformation.

This philosophy can be used in any organization to implement total quality management (TQM). For more details and examples, we refer you to *Out of the Crisis* (Deming 1986).

1.3.1 Outcomes of Quality Control

The outcomes of quality control are obvious. Some of these outcomes are the following:

- The quality of the product or service will improve, which will make it more attractive and durable. Better quality will result in a higher percentage of the product meeting the specifications of the customer. Consequently, only a small percentage (or none) of the products will be rejected.
- Since few or no products are rejected, fewer need rework, and consequently there are fewer delays in delivery. This makes the customer happy, and they are bound to buy the product again. All this adds up to more savings, and that results in a lower price for the product – which makes it more competitive.
- Consequently, there will be better use of resources, such as manpower, raw material, machine hours, etc. All of these outcomes result in lower costs, better quality, higher productivity, and hence a larger market share.

1.3.2 Quality Control and Quality Improvement

Quality control helps an organization to create products that, simply put, are of better quality. Continuous quality improvement makes operators, engineers, and supervisors more focused on customer requirements, and consequently, they are less likely to make any "mistakes."

1.3.2.1 Acceptance Sampling Plans

Quality control may use a technique called *acceptance sampling* to improve quality. An *acceptance sampling plan* is a method for inspecting a product. Acceptance sampling may inspect only a small portion of a lot or 100% of the lot. In some cases, inspecting 100% of the lot means all products in that lot will be destroyed. For example, if we are testing the life of a new kind of bulbs for a particular type of projector, then inspecting 100% of the lot means all the bulbs in that lot will be destroyed.

But acceptance sampling plans increase quality only of the end product or service, not of what is still being manufactured or of services that are still being performed, which means any defects or errors that occurred during the production process will still exist. In certain service industries, nothing can be done until the service has been fully provided or after it has been provided. For example, if a patient is receiving treatment, then nothing can be done during or after the treatment if the treatment was bad. Similarly, if a dentist has pulled out the wrong tooth, then nothing can be done after the dentist has completed the service. Thus quality improvement is extremely important in such situations. In manufacturing, acceptance sampling very often requires rework on defective units; after rework, these units may turn out to be acceptable or not, depending on what kind

of defects these units had in the first place. All of this implies that acceptance sampling is not a very effective method for quality improvement. We will study acceptance sampling plans in more detail in Chapter 9.

1.3.2.2 Process Control

We turn now to process control. In *process control or statistical process control*, steps are taken to remove any defects or errors before they occur by applying statistical methods or techniques of five kinds: define, measure, analyze, improve, and control. We discuss these techniques in Chapter 2. Deming describes *statistical quality* as follows: "A state of statistical control is not a natural state for the manufacturing process. It is instead an achievement, arrived at by eliminating one by one, by determined effort, the *special causes* of excessive variation." Another way of describing statistical quality is as an act of taking action on the process based on the result obtained from monitoring the process under consideration. Once the process-monitoring tools (discussed in detail in Chapters 5–8) have detected any cause for excessive variation (excessive variation implies poor quality), the workers responsible for the process take action to eliminate the cause(s) and bring the process back into control. If a process uses statistical control, there is less variation; consequently, quality is better and is continuously improved. If the process is under control, then it is more likely to meet the specifications of the customer or management, which helps to eliminate or significantly reduce any costs related to inspection.

Quality improvement is judged by the customer. Very often, when a customer is not satisfied with quality improvement, they do not bother to file a complaint or demand compensation if the product is not functioning as it is expected to. On the other hand, if there is significant quality improvement, the customer is bound to buy the product repeatedly. These customers we may define as *loyal customers*. So, quality improvement is best judged by loyal customers, and loyal customers are the biggest source of profit. If there is no significant improvement in quality, then not only do we lose dissatisfied customers but we also lose some of the loyal customers. The loss due to dissatisfied customers or losing loyal customers usually is not measurable – but such a loss is usually enormous, and sometimes it is not recoverable and can cause the collapse of the organization. Thus, quality control and quality improvement are the best sources of good health for any company or organization.

1.3.2.3 Removing Obstacles to Quality

Deming's 14-point philosophy helped Western management transform old-fashioned "business as usual" to modern business, where concern for quality is part of the various problems that face any business. Note, however, that there is a danger that these concerns may spread like wildfire, to the detriment of the business as a whole. Further, some problems are what Deming calls "deadly diseases" and become hurdles on the way to fully implement the transformation (Deming 1986, Chapter 3). Deming describes the deadly diseases as follows:

1) Lack of constancy of purpose to plan products and services that have a market sufficient to keep the company in business and provide jobs.
2) Emphasis on data analysis, a data-based decision approach, and short-term profits. Short-term thinking that is driven by a fear of an unfriendly takeover, and pressure from bankers and shareholders to produce dividends.
3) Performance evaluations, merit ratings, or annual reviews without giving sufficient resources to accomplish desired goals.
4) Job hopping by managers for higher ranks and compensation.

5) Using only visible data or data at hand in making decisions, with little or no consideration of what is unknown or unknowable.
6) Excessive medical costs.
7) Excessive liability cost that is jacked up by lawyers who work on contingency fees and unfair rewards given by juries.

Deadly diseases 1, 3, 4, and 5 can usually be taken care by using a total quality approach to quality management, but this topic is beyond the scope of this book. However, deadly diseases 2, 6, and 7, add major costs to the organization without contributing to the health of the business. They are more cultural problems, but they pressure companies to implement quality improvement and consequently compete globally.

1.3.2.4 Eliminating Productivity Quotas

Numerical quotas for hourly workers to measure work standards have been a common practice in America. This is done by the Human Resources (HR) department to estimate the workforce that the company needs to manufacture X number of parts. While doing these estimates, it could be that nobody bothers to check how many of the manufactured parts that have been produced are defective, or how many of them meet the specifications set by customers or will be rejected/returned. HR normally does not take into account the cost of such events – which, of course, the company has to bear because of rework on defective or nonconforming parts or rejected and trashed parts. All of this adds to the final cost.

In setting up numerical quotas, the average number of parts produced by each worker is often set as a work standard. When we take an average, some workers produce a smaller number of parts than the set standard, and some produce more than the set standard. No consideration is given, while setting the standard, to who produced a small or large number of parts that meet customer specifications. Thus, in this process, workers who produce more parts than the set standard – regardless of whether the parts meet the specifications – are rewarded, while other workers are punished (no raises, no overtime, etc.). This creates differences between workers and, consequently, chaos and dissatisfaction among workers. The result is bad workmanship and more turnover, and workers are unable to take the pride in their workmanship to which they are entitled.

1.3.3 Implementing Quality Improvement

It is the responsibility of top management to lead the quality improvement program and, by removing any barriers, to implement the quality improvement program. Then the process owners have the responsibility to implement quality improvement in their company or organization. To do this, they first must understand that quality improvement takes place by reducing variation. The next step for them to understand is what factors are responsible for causing variation. To control such factors, the best approach is if management collaborates with the workers who work day in and day out to solve problems, who know their jobs, and who know what challenges they are facing. By collaborating with workers, management can come to understand everything about quality improvement and what is essential to achieve it. This, of course, can be achieved if management has better communication with those workers who do work for quality improvement.

The next step after the implementation of quality improvement is to focus on customers and their needs. By focusing on customers, loyal customers are created, and they can be relied on for the future of the company. Note that when there is focus on the needs of customers, the use of SPC tools becomes essential to achieve the company's goals, which in turn helps improve quality on

a continuous basis. According to Crosby, quality improvement is based on four "absolutes of quality management":

1) Quality is defined as *conformance to requirements* (a product that meets the specifications), not as "goodness" or "elegance."
2) The system for causing quality is *prevention* (eliminating both *special and common causes* by using SPC tools), not appraisal.
3) The performance standard must be *zero defects,* not "close enough."
4) The measurement of quality is the price of *nonconformance* (producing defective parts, or parts that do not meet specifications), not indices.

Thus, to implement quality improvement, top management should follow these absolutes. Management must also implement training for workers so that they understand how to use all the tools of SPC and thus can avoid any issues that infiltrate the system. Management must make sure that supplier(s) also understand that quality improvement is an ongoing part of the company's policy and get assurance from suppliers that they will also use SPC tools to maintain the quality of everything they supply.

1.4 Managing Quality Improvement

Managing quality improvement requires accountability, daily defect analysis, preventive measures, data-driven quality, teamwork, training, and optimizing process variables.

Managing quality improvement is as important as achieving improved quality. Managing quality improvement becomes part of implementing quality improvement. Quality management plays a key role in the success of achieving total quality.

Hiring a consulting firm that "specializes in quality improvement" and not taking control into their own hands is the biggest mistake made by top management of any organization. Hiring a consulting firm means top management is relinquishing their responsibility for sending the important message to their employees that quality improvement is a never-ending policy of the company.

Top management should play an important role in team building and, as much as possible, should be part of the teams. Top management and supervisors should understand the entire process of quality improvement so that they can guide their employees appropriately on how to be the team players. Teamwork can succeed only if management supports it and makes teamwork part of their new policy. Forming a team helps to achieve quality improvement, and establishing plans is essential: it is part of the job or process of managing quality improvement.

Another part of quality improvement is that management must provide the necessary resources and practical tools to employees who are participating in any project to achieve quality improvement. Arranging 5- or 10-day seminars on quality improvement for employees without giving them any practical training and other resources is not good management practice.

1.4.1 Management and Their Responsibilities

The management of a company must create an environment of good communication so that everyone in the company knows their duties and goals or purpose. Management must make sure the purpose remains steadfast and does not change if a top manager leaves the company. Management must keep the communication lines with employees open so that they know which direction the business is moving and what their responsibilities are to take the business where it would like to be

in 5 or 10 years. In discussing his 14 points, Deming says, "Adopt the new philosophy. We are in a new economic age created by Japan. Western management must awaken to the challenge, must learn their responsibility, and take on leadership for change."

It is the responsibility of management to have a continuous dialogue with customers and suppliers. Both customers and suppliers play an important role in achieving quality improvement. Management must make a commitment to sustained quality improvement by providing resources for education and practical training on the job and showing their leadership. This can be done if they are willing to increase their understanding and knowledge about every process that is taking place to improve quality. Leadership that just passes on orders but doesn't understand anything about the processes that are in the works or under consideration for the future will be disappointed and will also disappoint their customers and investors.

1.4.2 Management and Quality

In this modern era, management and quality go hand in hand. Global customers are not only looking at the quality of the product they buy but also are looking at who manufactured it and how much they are committed to backing it up. Customers are also interested in determining the reliability of that commitment. Global competition puts so much pressure on management that they must make quality their top priority for the company. Managers can no longer satisfy employees, customers, or investors with just encouraging words: they must show solid outcomes, such as how much sales have gone up, how many new customers have been attracted, and the retention rate of old customers. All of this will fall in line only if management has made quality an important ongoing process.

Furthermore, management must understand that the customer defines quality, so management must make commitments to customers about the increased quality and value of the company's products. In addition, management should understand that it is the employees who build the quality into products. Thus, management must make commitments to employees and give them the resources and tools they need. Management must also obtain the same kind of commitments from suppliers. Any sloppiness on the part of suppliers can ruin all the plans for ongoing process improvement or quality improvement. In the modern economic age, only companies and managements that make such commitments and follow through on them can assure themselves a bright future, job guarantees, and better compensation for their employees.

Management and quality are a two-way street. Any company with good management delivers better quality, and having better quality means there is good management.

1.4.3 Risks Associated with Making Bad Decisions

It is important to note that whenever decisions are made based on samples, you risk making bad decisions. Bad decisions in practice lead to difficulties and problems for producers as well as consumers. These bad decisions in statistical terms are referred to as *type I and type II errors* as well as *alpha* (α) and *beta* (β) risks, respectively. It is important to know the following key points about these risks:

- Sooner or later, a bad decision will be made.
- The risks associated with making bad decisions are quantified in probabilistic terms.
- α and β risks added together do not equal 1.
- Even though α and β go in the opposite direction (that is, if α increases, β decreases), there is no direct relationship between α and β.
- The values of α and β can be kept as low as you want by increasing the sample size.

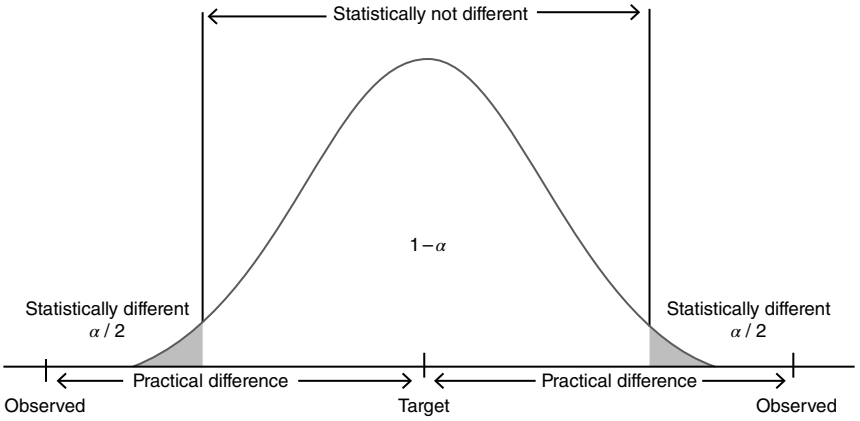

Figure 1.3 Detecting practical and statistical differences.

Definition 1.2 *Producer risk* is the risk of failing to pass a product or service delivery transaction on to a customer when, in fact, the product or service delivery transaction meets customer quality expectations. The probability of making a producer risk error is quantified in terms of α.

Definition 1.3 *Consumer risk* is the risk of passing a product or service delivery transaction on to a customer under the assumption that the product or service delivery transaction meets customer quality expectations when, in fact, the product or service delivery is defective or unsatisfactory. The probability of making a consumer risk error is quantified in terms of β.

In Figure 1.3, our comparison points change from the shaded region under the distribution tails to the center of the distribution. A practical decision then requires that we consider how far off the intended target the observed process behavior is as compared with the statistical difference identified in Figure 1.3. Note that differentiating between a practical and statistical difference is a business or financial decision. When making a practical versus a statistical decision, we may well be able to detect a statistical difference; however, it may not be cost-effective or financially worth making the process improvement being considered.

1.5 Conclusion

In this chapter, we have given a general overview of quality improvement and its management. For more details on these topics, we refer you to the works of Philip B. Cosby, W. Edwards Deming, Joseph M. Juran, and Armand V. Feigenbaum (see the Bibliography). Also, the Six Sigma methodology, which we introduce in the next chapter, is a step forward to help achieve and manage quality improvement, since understanding the idea of Six Sigma means customer requirements must be met. In the remainder of this book, we discuss statistical techniques and SPC tools that are essential to implementing the Six Sigma methodology for improving process performance.