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Introduction to Quality Planning

1.1 Quality Definitions

1.1.1 Meaning of Quality

Definition of Quality

Quality is a common word both in the workplace and at home, so it might be interesting to ask exactly what the word quality means. There are certainly numerous definitions of quality. Regarding this ambiguity, the American Society for Quality (ASQ) states that quality is "a subjective term for which each person or sector has its 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; 2) a product or service free of deficiencies" (ASQ, n.d. a).

Several quality pioneers established the foundation of present quality definitions. For example, Dr. Joseph Juran viewed quality as a fitness for use and leading to customer satisfaction (ASQ n.d. a). Philip Crosby thought of quality as a conformance to requirements (Crosby 1979). Formally, ISO 9000:2015 defines quality as the degree to which a set of inherent characteristics fulfills requirements (ISO 2015).

While ambiguous on the surface, defining quality in a given professional field can be an intriguing exercise, which helps us think about its importance as a target, a process, and a system when applying quality principles and approaches to real-world situations. Here are several examples of quality definitions, each of which may reflect aspects to the different fields and view angles of quality practitioners:

"Fit for purpose while robust enough to uphold product/service integrity and value" (Glodowski 2019). This definition addresses the robustness to fit for purpose.

"Quality is the art of always pleasing the customer while ensuring your bottom line is met" (Toure 2019). This definition recognizes quality is the art of meeting a customer's need.

Quality Planning and Assurance: Principles, Approaches, and Methods for Product and Service Development, First Edition. Herman Tang.

"Sincere and considerate actions taken to either fulfill or exceed user expectations" (Mori 2018). This definition focuses on implementation processes and actions.

"The required satisfaction provided by a good or service as expected or imagined by the customer" (Stevens 2018). This definition also touches on an important aspect of the perceived service of quality to customers.

Considering the many aspects of quality illustrated in just these four examples, one may find that it can be difficult to encompass the entirety of such a broad concept in a single sentence. To help with this, one may use a few keywords to understand the general meaning of quality when viewed in relation to industry, goods, and services:

- Quality is customer (or end-user) oriented.
- Quality is a distinctive characteristic or degree of excellence of something.
- Quality is adherence to specifications (or standards/regulations) by a product or service.
- Quality is a summary description of multiple dimensions and aspects.

Readers may have even more keywords to add to this list, simply based on their own experience and insights. In addition, these keywords may have different weights or significance when one addresses unique situations, products, or problems. While the definition of quality can be subjective to person and place, the broader concept is objective as a field of study, and based on the same basic truths about how quality can be defined.

Measurement of Quality

The aforementioned keywords, i.e. customer demands, design specifications, and quality dimensions, represent the references for quality measurement and analysis. As a foundation of quality management, quality measurement is an evaluation:

- Of a specific status or result from a product or service
- Of a process or system of processes involved with a product or service

The first action of a quality measurement process is to collect current data, shown in Figure 1.1. For example, the US Environemental Protection Agency (EPA) measures the quality of the air by collecting and analyzing the presence of specific compounds that cause pollution. Their measurement for reporting is the Air Quality Index (AQI) (EPA 2019). The AQI tells us how clean the air is, and what associated health effects might be a concern.

For the quality of a product, measurement and analysis are based on that product's design specifications. For example, software development has several functional specifications, e.g. technical details, data manipulation, and processing efficiency. The requirements, test processes, and criteria are predefined as a

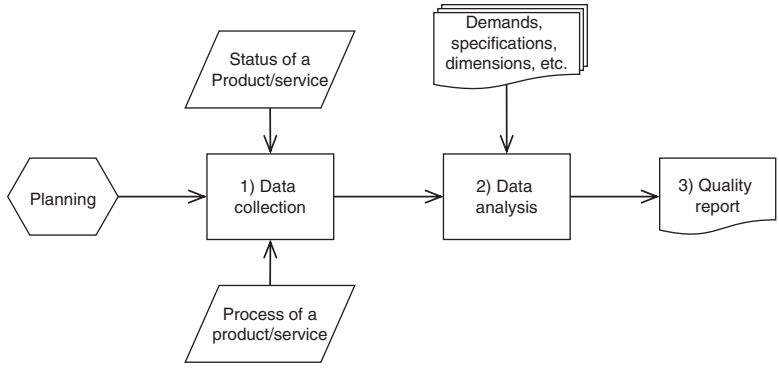

Figure 1.1 Quality measurement and analysis process.

guideline or standard. Also, since the quality of a product or service has multiple dimensions, so too must the corresponding measurements and analyses of that quality, which will be discussed in detail later.

For the quality of a manufacturing or service operation, one may collect process information and output in terms of adherence to standards, design specifications, etc. of that given operation. Measuring output is mainly for determining the status and results of an operation. Measuring the process itself can provide insight into understanding how the output of an operation is generated, thereby helping to find reasons why the output meets (or fails) the requirements of the given input. Therefore, it is often important to measure both process and output.

Quality measurement reports are normally presented in terms of well-defined indexes. For example, a quality indicator of healthcare quality is called the Patient Safety Indicator, which shows avoidable safety events that represent opportunities for improvement in the delivery of care (AHRQ n.d.). Another similar one is called the Prevention Quality Indicator, which is used to identify the conditions in which good outpatient care can potentially prevent the need for hospitalization. Quality indicators are field specific, and often have multiple ones for a product and service. For example, over 30 quality indicators were considered in blood establishments at the international level (Vuk 2012). In addition to direct measurements on a product, process, or service, the quality variance, or the differences between the individual measurements, can be used as an indicator as well.

1.1.2 End-customer Centricity

Internal Customer

A customer is an individual or business entity who receives and uses a product or service. A large or complex business operation has various units, so their

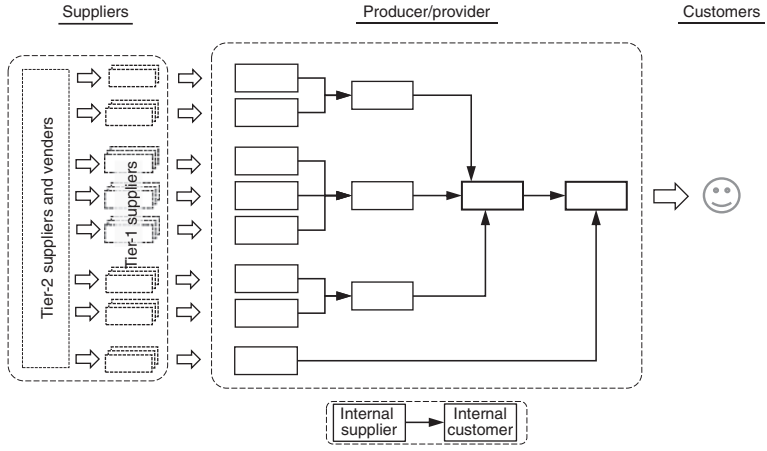

Figure 1.2 Supplier–producer/provider–customer relationship.

working relationship of providing and receiving can be multifaceted, much like the network of a community. An example is shown in Figure 1.2. Suppliers provide parts and/or services to a product producer or service provider. The latter is the customer to the suppliers, while the producer/provider works with suppliers to provide a product or service to ultimate customers.

Inside an organization, there is also a customer–supplier relationship. An internal customer (or client) can be a person, operation, or group within an organization, who performs their jobs when receiving an output, part, and/or assistance from one or more internal persons, operations, or groups. For instance, in a surgical operating room, the ultimate customer is the patient, while the surgeons can be viewed as internal customers of the nurses and technicians who assist the surgeons.

Therefore, an operation in a business system can be viewed as the internal customer of all upstream or supporting operations, and at the same time is an internal supplier to downstream or other associated operations. If one analyzes the suppliers, inputs, process, outputs, and customers (SIPOC) of a business operation, they may know their relationships. Table 1.1 shows an example of a SIPOC analysis for vehicle manufacturing. In a SIPOC analysis, the suppliers and customers can be either internal or external.

The concept of an internal customer can be helpful to build an effective relationship between operations and teamwork for an organization's ultimate customers. In many cases, internal customers are less obvious than external customers because of management structure, lack of financial transaction, and/or complex organizational functions. For example, it can be difficult to define supplier–customer relationships for some departments in a matrix organization.

Table 1.1 SIPOC of vehicle manufacturing operations.

Operation	Supplier	Input	Process	Output	Customer
Part supplier	Part/material manufacturers	Raw materials, parts, etc.	Various	Components, parts, etc.	Vehicle assembly plants
Body shop	Part suppliers	Components, parts, materials	Joining, etc.	Framed car bodies (body-in-white)	Paint shop
Paint shop	Body shop, material suppliers	Body-in-white, materials	Painting, sealing, etc.	Painted car bodies	General assembly shop
General assembly shop	Paint shop, part suppliers	Painted bodies and components	Installation, etc.	Completed vehicles	Car buyers

Toward End-customer Satisfaction

From the viewpoint of quality, the customer of a business is the ultimate end-user of a product or service. Internal suppliers and the relationship between internal suppliers and internal customers are the enablers that satisfy these ultimate end-users. Customer satisfaction as a goal is for ultimate customers, but may or may not be for internal customers. All internal customers and suppliers in a system work together to make their operations smooth and effective to collectively provide a good product or service to the external customers.

In an organization, it is possible that people are more concerned about their internal customers, which sounds parochial and may be disadvantageous to external customers. There can be a conflict of interests between internal customers and external customers sometimes. It is the senior management's responsibility to encourage and guide the internal supplier–customer teamwork for the sake of external customers.

Furthermore, external suppliers or vendors should treat the receivers of their products and services as customers. Altogether, a product or service provider and suppliers should define, plan, and implement collective work for the end-users, as illustrated in Figure 1.3. The producer–supplier partnership works as one team to build a mature trust, help each other, and grow together. Treatments on customer needs and supplier quality will be discussed in depth in Chapters 3 and 6, respectively.

Regard the familiar adage: "the customer is always right." It is important because happy customers are more likely to buy a product or service again from a company who meets or exceeds their needs. Adopting this adage, one also needs to understand the customer expectations and variation of processes, to be

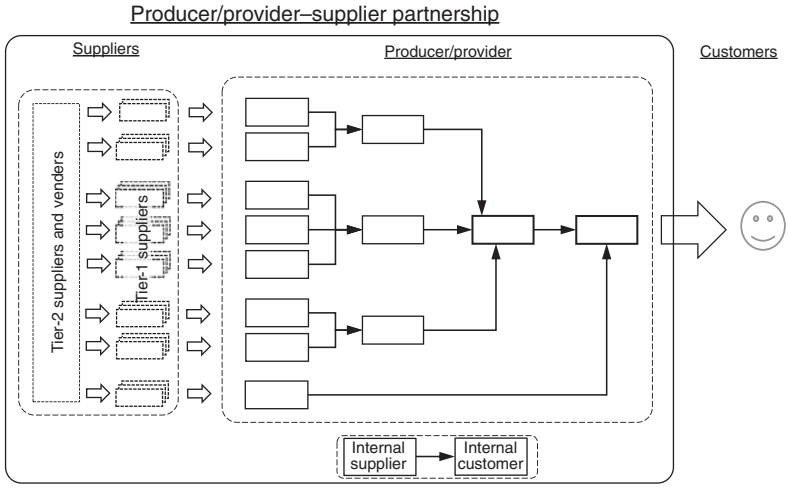

Figure 1.3 Producer/provider–supplier partnership for ultimate customers.

detailed in Chapter 4. With this familiarity, one may have accurate and realistic goals for customer satisfaction, quality planning, and execution.

Customer-centric quality planning and its associated processes take time, and their effects may or may not be immediately visible. Adopting quality-planning principles may also need a culture change for some organizations, particularly those with a well-established process, with a mentality of firefighting problem-solving, and/or with a focus on cost reduction. In such cases, changing the primary motivation to customer satisfaction can meet some resistance.

1.1.3 Dimensions of Product and Service Quality

Product Quality

One can view quality in several aspects. For a product, one may view its quality in performance, features, reliability, aesthetics, and so on. For example, the quality of a passenger vehicle has eight dimensions (Tang 2017), as shown in Table 1.2.

Depending on the type of product, there can be different dimensions or characteristics, such as ergonomic and environmental performances. For example, the serviceability of cellular phones can be ignored, as a broken cellular phone is normally replaced rather than repaired. While the serviceability of automobiles and air conditioners has significant impacts on the after-sales service cost and customer satisfaction (Syahrial et al. 2019). For software products, the

Table 1.2 Quality dimensions of passenger vehicles.

Dimension	Description	Example
Performance	Primary operating characteristics	Acceleration: 8.2 s for 0–60 mph
Safety	Crashworthiness and crash avoidance (performance)	5-star rating of crash tests by NHTSA
Features	Secondary performance characteristics	Folding seats and DVD/TV/ Bluetooth function
Reliability	Probability of working consistently well without major failure	Running three years without major issue
Durability	Measure of a product lifespan (replacement preferred over repair)	Engine 95% reliable (without major issues) in 3 years
Aesthetics	Based on looking, feeling, sound, etc.	Flaming red color (subjective)
Conformance	Meet established standards and expectations	No water leaks
Serviceability	All related to services, including cost, speed, service professionalism	Routine service from a dealer

Source: Tang, H., (2017). *Automotive Vehicle Assembly Processes and Operations Management*, ISBN: 978-0-7680-8338-5, Warrendale, PA: SAE International.

quality model is standardized (ISO 2011) for the eight characteristics of software quality:

1. Functional suitability: Functional completeness, correctness, and appropriateness.
2. Reliability: Faultlessness, availability, fault tolerance, recoverability, and failsafe.
3. Performance efficiency: Time behavior, resource utilization, and capacity.
4. Operability: Understandability, learnability, user error protection, user interface aesthetics, and accessibility.
5. Security: Confidentiality, integrity, non-repudiation, accountability, and authenticity.
6. Compatibility: Co-existence and interoperability.
7. Maintainability: Modularity, reusability, analyzability, modifiability, and testability
8. Flexibility: Adaptability, scalability, installability, replaceability, and portability.

Furthermore, different aspects or dimensions are not equally important, as they depend on the consequence of poor quality of a product or service on average. For example, the safety of passenger vehicles and medical instruments is their most important consideration, thus they are seriously addressed by manufacturers, tightly regulated by the government, and largely expected by customers. The safety of laptops is important as well, but may be less concerning because it has a less serious impact on the safety of a passenger vehicle or medical instrument. Significance of quality dimensions is also related to the type of customers, e.g. age, gender, geographic location, etc. The importance levels of dimensions can be presented in a percentage contribution to the total quality of a product. Figure 1.4 shows an example. It is recommended that a weight for each dimension be developed before the design phases.

Service Quality

The attributes of service quality can be more subjective and more directly relating to a customer's feeling and perception than those of product quality do. In other words, service quality is about the direct relation between a customer's expectations and a provider's performance. An understanding of service quality (SQ) generally is

$$\mathrm{SQ} = \mathrm{P} - \mathrm{E}$$

where P is perceived performance and E is perceived expectations (Lewis and Booms 1983). Note, SQ has multiple dimensions, as do P and E.

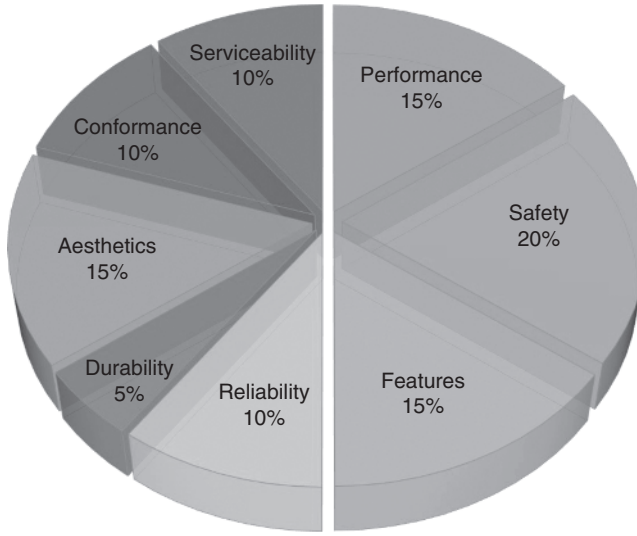

Figure 1.4 Quality dimension distribution of a product.

From a consumer's perspective, service quality includes 10 aspects: reliability, responsiveness, competence, access, courtesy, communication, credibility, security, understanding, and tangibles (Parasuraman et al. 1985). The five main dimensions of service quality, sometimes called the SERVQUAL model, are briefly explained in Table 1.3. For a specific service, though, the dimensions can vary in a given situation. For example, the quality of a restaurant includes six dimensions: food quality, facility comfort, cleanliness, timeliness, aesthetic, and personnel service quality (Tuncer et al. 2020).

As with the dimensions of product quality, the dimensions of service quality are not equally important to one another, or they might carry different weights. For some services, such as personal and computer services, security is very important. In many other cases, responsiveness is a major factor affecting customer satisfaction, e.g. for premium casual restaurants (Saad et al. 2020). In other words, the main dimensions of service quality and their significance depend on the type of service. In addition, the rendering of products or services by a caring, friendly person often is a key to ensuring service quality dimensions.

A service is often associated with a product, either physical products (cars or computers) or nonmaterial products (bank accounts or loan products). In such cases, a product and service can be combined as a package, e.g. specialty software, for customers. On the service side, one quality model in software is called "Quality in Use" (ISO 2016). It has five characteristics to meet user's needs to

Table 1.3 Main dimensions of service quality.

Dimension	Description	Action
Reliability	Ability and correctness as described and promised to perform a service accurately and consistently at the first time	Deliver at the designated time
Responsiveness	Promptness of willingness or readiness to customer needs	Quickly answer and resolve issues
Assurance	Capability to convey trust and confidence with customers (with competence, respect, communication, and attitude)	Build long-term relationship
Empathy	Understanding, caring, and genuine concern, paying individual attention with sincerity for customers	Learn and recognize various needs
Tangibility	Related to physical facilities and company aesthetics appealing to customers	Human representative to customer

achieve specific goals: 1) effectiveness, 2) efficiency, 3) satisfaction, 4) freedom from risk, and 5) context coverage in use.

Quality of Product–service Hybrid

Customers often receive a product and related service as a combination or a product–service hybrid. For example, a wireless phone package includes a cellphone and a service plan as a bundle. In such cases, customer's satisfaction is related to the quality of both product and service. Another example is food, which is a product, and includes some aspects of service. Food quality has nine dimensions (EC n.d.):

- Safety
- Ethical
- Sensory
- Nutrition
- Aesthetical
- Functional
- Convenience
- Authenticity
- Origin

Considering all the characteristics and dimensions of quality, one can see their relationships and contributions to customer satisfaction are complex. The connection between the quality of a product and the associated service is illustrated in Figure 1.5, in terms of common dimensions of quality.

In general, a good product is a foundation of good service, while other characteristics and dimensions influence one another. In planning for optimal quality, one needs to address not only the characteristics and dimensions of a product and service, but also their interactions and integration. The former has been extensively studied, while the latter can be a new research focus.

New technologies, such as artificial intelligence, in products and services, like the digital assistant, play an increasingly important role in customer satisfaction. Their significance and depth of impact on quality are active subjects of contemporary study (Brill et al. 2019).

1.1.4 Discussion of Service Quality

Product vs. Service Quality

Comparing the dimensions of product and service, one should consider the separation between unique characteristics of service quality from those of product quality. One attribute of a service is its intangibility. Many types of service provided have no solid proof. The intangibility is difficult to evaluate objectively. For example, one can call a service 800 number for a concern on a

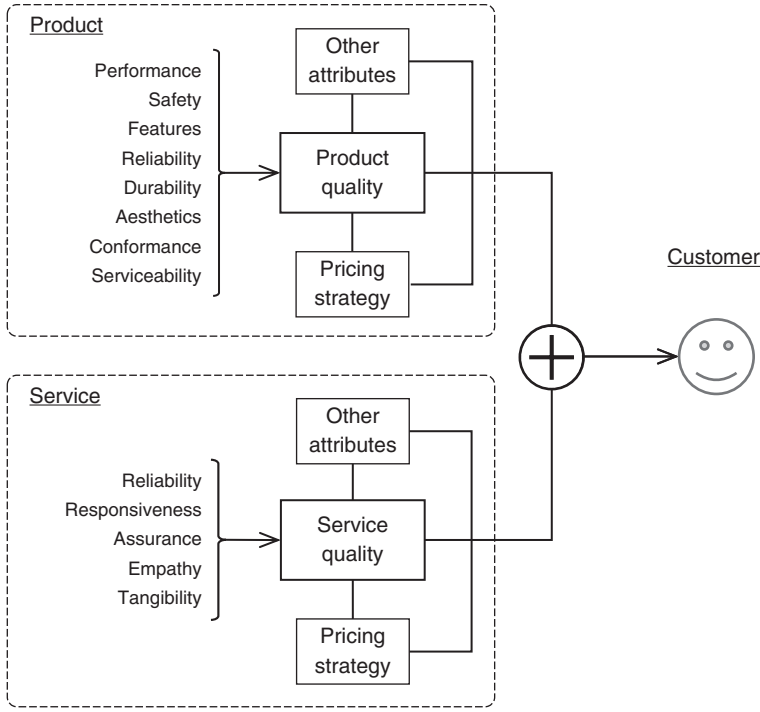

Figure 1.5 Characteristics and dimensions of product and service quality.

defective product. The service representative may resolve the problem by refund, but one might be still unhappy because the representative takes too long or one needs the product now, and the refund does not fulfill the greater need of the customer. Intangibility is also a confounded aspect of service quality, as some other dimensions can be intangible or even invisible, depending on the type of service. Nowadays, more and more services go through the internet, which intensifies their intangibility.

Physical products can be made homogeneously, while a service is often heterogeneous or has a significant variability in each service event, largely because service is highly people driven. For example, in a bank, it is difficult to encapsulate the experience for every customer with a unified criterion. The service performance of different representatives are different, even the same representatives can vary from day to day and customer needs can be even more diverse. Thus, heterogeneity is another characteristic of service quality. A service system should accommodate such variations where anomaly is the norm. Besides, the perception of service quality from all customers is different. Because of these differences, many standards and processes for product quality cannot apply to service quality.

Service is demand driven as a characteristic, in a "pull" fashion that is discussed in Chapter 2. For a product, one can check its quality before the customer gets the product, and have a chance to get it right. A service is inseparable from a demand and typically produced and consumed simultaneously. The production of a service, e.g. online retail, is connected with its consumption. There are limited ways to assess the service while it is happening, and one may have to evaluate and improve it after the fact. Because of this, service quality should be managed differently.

The last key characteristic of service is perishability. While a product can last for some time, a service is only available for observation during a definite period. Further, a service capacity cannot be stored and carried forward for sale in a future time, as excess product might be sitting on a shelf or warehouse. A service cannot be returned or resold once it has been consumed. Therefore, a service provider should utilize its capacity to meet demands with given time windows.

Because of the massive variety of services, dimensions and characteristics can be very different. For example, consulting firms provide services to customers. The customers prioritize receiving knowledge and solutions that are useful in not only current business issues but applied to future business hurdles (Benazic and Varga 2018). Customers' expectations and priorities are unique and vary from one customer to another.

Service Quality Measurement

In addition to the dimensions and characteristics of service quality, measurements and metrics can also be different. Quality measurements can be objective, subjective, or anywhere in between, such as waiting time and patients' perspective satisfaction for the services in a hospital. The satisfaction of the waiting time is affected by other factors, such as a patient's feeling, mood, schedule, the time of a day, and weather. Besides, there can be a certain correlational relationship between objective measurements and perspective data.

To measure a customer's perspective viewpoints and feelings, a questionnaire survey is commonly used. A quick survey with a few questions can be conducted immediately after a service is delivered. Similarly, a follow-up survey of a large service can be conducted with 10–15 questions. Often, an open-ended comment window is also provided for customers to give detailed opinions that a rating question may not be able to capture.

An interesting investigation method of service quality is called mystery shopping. In these cases, an internal or external member of an organization as an undercover investigator examines service quality, based on a defined process. This approach can provide important information and independent observation. As a research approach, the applications of mystery shopping have been growing recently. Studying this approach on its effectiveness and reliability in different fields is also active (Minghetti and Celotto 2013, Blessing et al. 2019, Dutt et al. 2019).

A rating for surveys may be designed in a three-point or five-point (Likert) scale. If on a five-point scale, the levels may be: 1) very unsatisfied, 2) unsatisfied, 3) neutral, 4) satisfied, and 5) very satisfied. For example, one may use the five faces that range from a crying face to a huge smile. The data analysis of a large survey consists of four steps: 1) initial grouping, 2) category development, 3) subset analysis, and 4) thematic coding, which can be done by trained professionals using computer software.

Even though some quality methods, standards, and measurements of product quality may not directly apply to the quality of service, the principles are still good for services, if only applicable with specific focuses or criteria. In many cases, the term "product" can be replaced by "service" with necessary modifications on some approaches and methods. Service quality planning and execution should address the specific characteristics mentioned above.

1.2 Quality System

1.2.1 Quality Management System

Meaning of QMS

When applying quality principles, one must treat quality as an integral part of an entire business system, rather than a technique or department, to make quality planning and execution effective. From this point, quality is not a task but a business foundation and subsystem.

One can view quality management as a collection of quality theories and practices on concepts, principles, methods, and processes. ISO 9001 (ISO 2015) is the international standard that specifies the requirements to implement a quality management system (QMS), with a focus on processes and documentation. Similarly to ISO 9001, there are specific industry and region standards, such as VDA 6.x, that are the German automotive industry standards for QMS (VDA 2016). The effectiveness of these standards and their implementation are evolving, and are the subject of contemporary study, e.g. (Franceschini et al. 2016; Sun et al. 2019; Nurcahyo et al. 2021).

There are other definitions of a QMS, such as "a formalized system that documents processes, procedures, and responsibilities for achieving quality policies and objectives." (ASQ n.d. b) In practice, people may refer to a piece of software, which is used to manage routine quality tasks, as a QMS.

There are different standpoints on the definitive elements of a QMS from various organizations and researchers. The common elements and requirements for a QMS include:

- Quality objectives and policy
- Customer satisfaction focus

- Quality manuals
- Procedures, instructions, and records
- Quality control and assurance processes
- Quality data management
- Continuous improvement opportunities
- Quality analysis

The US FDA declares that a pharmaceutical quality system consists of four elements (FDA 2009):

- Process performance and product quality monitoring system
- Corrective action and preventive action (CAPA) system
- Change management system
- Management review of process performance and product quality

A study was conducted on the significance of the six elements of a QMS, based on a survey of 238 plants in the US, Japan, Italy, Sweden, Austria, Korea, Finland, and Germany (Zeng et al. 2013). The authors found that the six elements have close relationships to the quality management of customer companies with different standardized coefficients, shown in Figure 1.6.

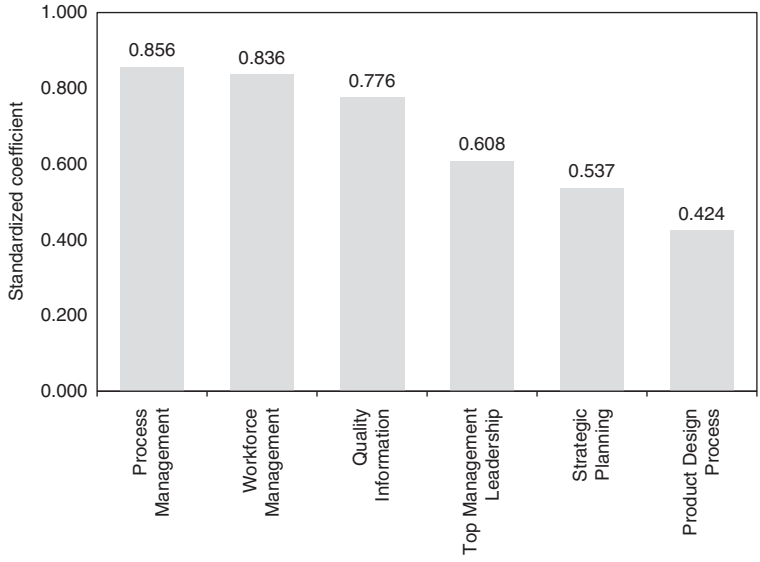

Figure 1.6 Study on six elements of QMS.

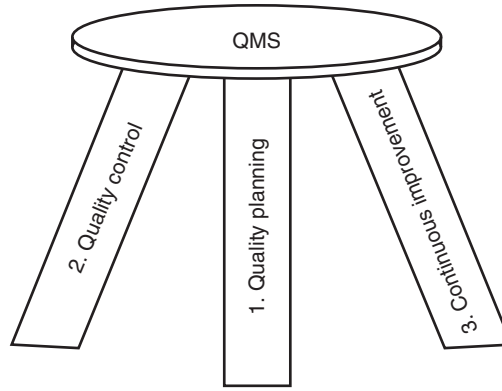

Figure 1.7 Three pillars of QMS.

Juran QMS Trilogy

An important visualization for a QMS is to picture three pillars or cornerstones: quality planning, quality control, and continuous improvement (see Figure 1.7). This concept is also known as the Juran trilogy (Juran 1986).

1. A quality journey begins with quality planning. The first task of quality planning is to identify customers and recognize their expectations. Based on the understanding of the voice of customers, one can develop a goal and plan for a product or service, and develop its features. The goal and plan should transfer the vision of an organization to the tasks of every member in the organization, such as managers, engineers, and operators.

Quality planning is a base for the most tasks and activities of quality management practice. The outcomes of quality planning largely affect the work and performance of the other two pillars, as illustrated in Figure 1.8. Good quality planning makes quality control and continuous improvement less challenging and more promising in terms of efforts and costs. Industry practices prove that good quality planning can make later operations (manufacturing, service, etc.) smoother and more cost effective.

2. The second pillar of a QMS is quality control. During the early realization phases of a product or service, one should inspect, monitor, and control the quality of operations and processes. The out-of-control data in the operations and processes need to be analyzed to find root causes for correction. A common practice is to use various statistical process control (SPC) tools to ensure realization operations and processes in control.

3. After an operation and process is under control and stable, the next phase of a QMS is to work on quality continuous improvement. Its purpose is to identify the opportunities to improve the existing performance of a product, process, or service to a higher standard. The common tools for continuous improvement and problem solving are reviewed in Chapter 8.

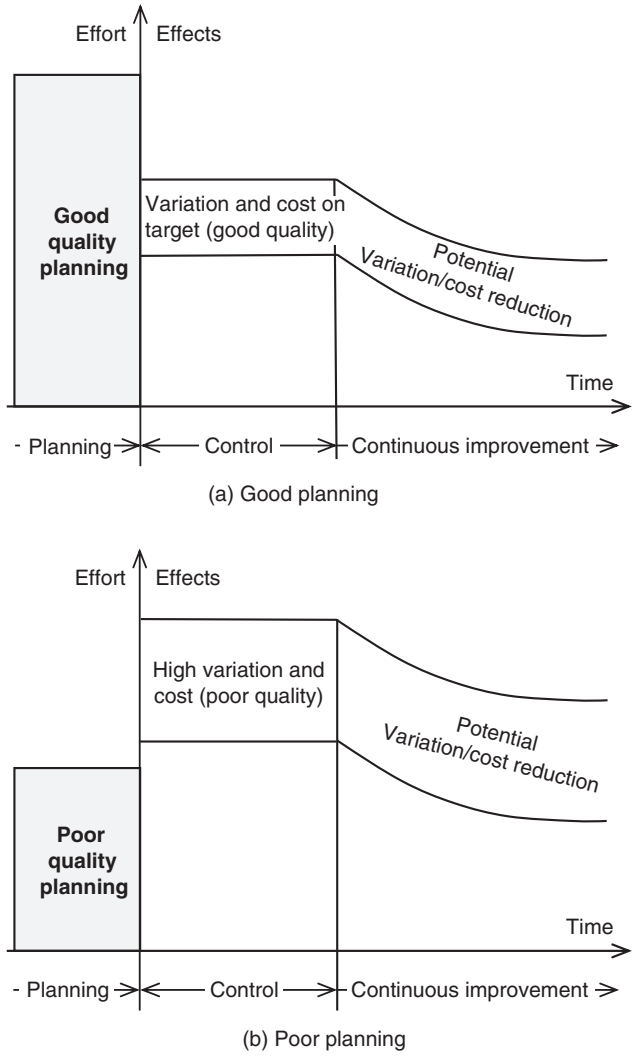

Figure 1.8 Effects of planning on quality control and continuous improvement.

These three QMS pillars can be equally important to a quality system success. In practice, it is often quality planning, as the proactive cornerstone, that becomes the weakest link of a QMS. By design, this book focuses on this proactive pillar of QMS, bearing in mind that many approaches and tools of quality planning can apply for the other two pillars (quality control and continuous improvement).

1.2.2 Discussion of QMS

Quality Department and TQM

To dedicate and implement QMS and its processes and tasks, a quality department is an integral part of an organization. A typical setting is that quality functions are under a vice president or "Chief Quality Officer" of an organization and each product/division has a quality team or responsible person. An example of a quality department and its responsibility in a matrix type of organization is shown in Figure 1.9.

A quality department is responsible for developing and enforcement of quality policies and standards. Three fundamental questions for the quality of leadership and professionals in an organization are:

1. What is the relationship between quality and customer satisfaction?
2. What is the value added and profitability of quality efforts?
3. What are the individual employee's roles to quality in their work?

In many organizations, the answers to these three questions may be unclear. One must understand these questions and resolve them to do quality work effectively. A quality department and personnel are also responsible for the routine quality functions, e.g. inspections, process control, analysis, leading continuous improvement, etc. A survey was conducted, based on 211 Swedish quality managers, to determine what type of quality department had the best impact on an organization (Gremyr et al. 2019). The authors discovered that the most effective organization is that of one which acts as an orchestrator.

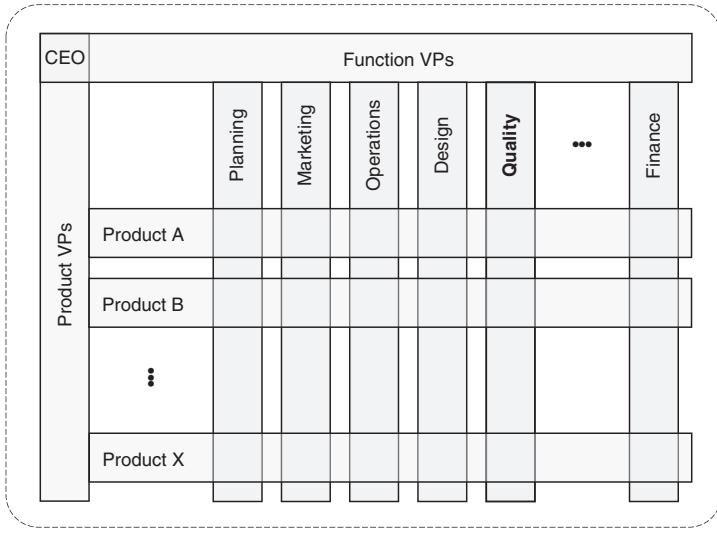

Figure 1.9 Quality department in a matrix organization.

Beyond the functions and efforts of a quality department, employee involvement and commitment is a core of total quality management (TQM). TQM is a participative, systematic management approach to planning and executing quality processes. Under the TQM model, quality is not only the responsibility and central occupation of a quality department, but also the role and responsibility of all employees at all levels, particularly frontline workers. Effective communication is a major enabler to motivate and involve employees in this endeavor (and will be a driving discussion in Chapter 2).

In addition to the employee involvement, the characteristics of TQM also include:

- Customer centric. Customer satisfaction, as a primary goal of a business, determines whether the quality efforts are worthwhile and successful. Driven by customer expectations, continual improvement efforts become a large aspect of TQM (Chapter 3).
- Process oriented. Quality is not only based on the results and outcomes but also on the process (means and techniques) to assure and improve the quality and effectiveness of work (Chapter 4).
- Systematic approach. Developing and implementing proactive and systematic approaches, e.g. failure modes and effects analysis (FMEA) and partnership with suppliers, can make quality work effective (Chapters 5 and 6).
- Data driven. Quality work is guided by reliable data (or facts) that is collected and analyzed (Chapters 7 and 8). Decisions are made with data support.

Beyond these attributes, quality management should be built on the standardization of all quality processes and tasks. A large, complex system, e.g. an automotive company, has various business operations, e.g. functional departments, manufacturing plants, facilities, and working with suppliers. All these processes, regardless of their locations or by whom the work is executed, should follow the same standards to ensure that all stakeholders are invested in the cause of ensuring quality excellence as a habit, not a series of one-off events (Zhou 2012). Furthermore, a standardized QMS should itself be continuously refined with the best practices globally.

QM Standards and IATF 16949

The QMS standards include a collection of policies, processes, documented procedures, and records. Here are some QMS-related standards:

- IATF 16949 Quality Management System Requirements for Automotive Production and Relevant Service Parts Organizations (to be discussed further)
- ISO 13485:2016 Medical Devices – Quality Management Systems – Requirements for Regulatory Purposes
- ISO 22000 Food Safety Management
- ISO/IEC 20000-1:2018 Information Technology – Service Management – Part 1: Service Management System Requirements

- ISO/IEC 27001 Information Security Management
- AS9100D Quality Management Systems – Requirements for Aviation, Space, and Defense Organizations

A well-known industry QMS standard is ISO/TS 16949, which was created for the automotive sector in 1999. The objective of the QMS standard is to harmonize the assessment and certification schemes in the supply chains of the automotive industry worldwide. The principles and methods of the ISO/TS 16949 standard may also be a valuable reference for other industries. ISO/TS 16949:2009 is replaced with IATF 16949:2016. The latest standard shares the seven quality principles:

1. Customer focused: To ensure organizations meet customer requirements and strive to exceed customer expectations.
2. Leadership: To create and maintain the environment and culture so employees are involved in achieving the organization's quality objectives.
3. Engagement of people: To ensure employees' understanding and have the tools to contribute to the organization's success.
4. Process approach: To focus on effective transformation processes from inputs to outputs.
5. Improvement: To strive for continuous improvement.
6. Evidence-based decision making: To use the analysis of data and information for decision making.
7. Relationship management: To form interdependent and a mutually beneficial relationship between an organization and its suppliers to create value for customers.

Based on these seven principles, IATF 16949:2016 is organized into 10 chapters, listed in Table 1.4 (IATF 2016). In addition, a widely used plan–do–check–act (PDCA) process is marked to the corresponding principles of the standard in the table as a practice reference.

1.2.3 Quality Target Setting

Target Setting Process

An organization and the development projects of a product or service should have a quality goal or target, which is often defined by a qualitative statement, such as:

- "Our quality goal is simple: Making your product, to your standards, every time" (East West 2020).
- "The TI quality goal is to ensure that its products meet customer expectations" (TI n.d.).
- "Patient safety – having the right systems and staff in place to minimise the risk of harm to our patients and being open and honest and learning from mistakes if things do go wrong" (Guy 2020).

Table 1.4 Main contents of IATF 16949:2016.

Chapter (Section)	Title	Content	PDCA
1–3	Introductions	Scope, normative references, terms, and definitions.	NA
4	Context of Organization	Requirements for interested parties and their needs and expectations. Definitions of the requirements for determining the scope of a QMS and general QMS requirements.	Plan
5	Leadership	Leadership commitment to a QMS, corporate responsibility, and quality policy.	
6	Planning	Risks, opportunities, and risk analysis. Requirements for preventive actions, contingency plans, objectives, plans, etc.	
7	Support	Requirements for people, infrastructure, work environment, resources, knowledge, competence, awareness, communication, etc.	
8	Operation	Requirements on planning, product review, design, purchasing, creating the product or service, and controlling the equipment used to monitor and measure the product or service.	Do
9	Performance Evaluation	Assessment of customer satisfaction, internal audits, monitoring products and processes, and management review.	Check
10	Improvement	Requirements for problem solving, corrective actions, error-proofing, and continual improvement.	Act

Source: Based on IATF, (2016). IATF 16949 Quality management system requirements for automotive production and relevant service parts organizations, International Automotive Task Force

Target setting is a planning process to establish a goal, which can be presented in terms of various aspects, e.g. revenue, profit, quality, and market share. A quality target should be included in the business goals of an organization.

A target setting process follows five steps, and these steps are defined with explicit responsibility and timing, as shown in Figure 1.10. Before starting target setting, supporting and related data must be collected. After the five-step target setting process, the subsequent step is to develop an executable plan for the targets.

1. To propose preliminary quality targets. Preliminary targets can be based on customer expectations and rivals' performances. For example, the expected manufacturing quality of a product is 95% without any type of repair or rework, which is also called first-time quality or first-time-through quality.
2. To do a data analysis, based on the current performance, resources, etc. to understand and justify the selected preliminary targets.

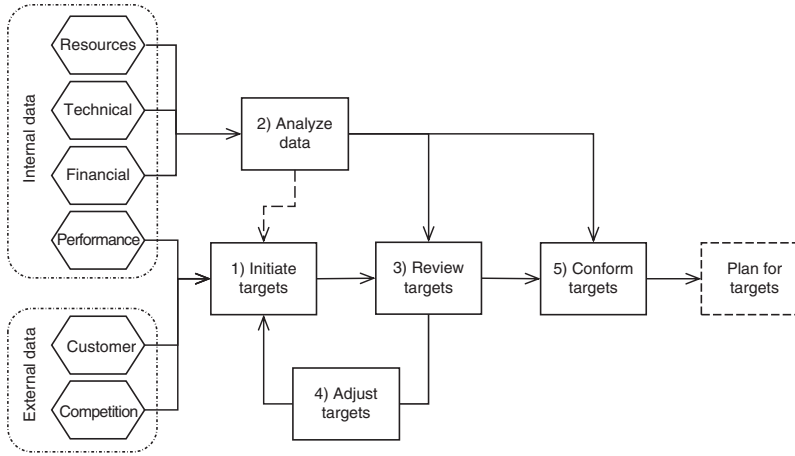

Figure 1.10 Target setting process flow.

3. To review the preliminary targets, based on the analysis results of internal and external data. This step is the core of a setting process to have aggressive, yet feasible targets.
4. To adjust the targets if the preliminary ones are deemed too easy or aggressive to achieve for a period, e.g. in a year, if necessary. The adjusted targets must be supported by the data.
5. To confirm and approve the targets for prosecution.

Considerations in Target Setting

The considerations for a quality objective include being specific, measurable, achievable, relevant, and time-bound. Combined with objective measurability, a mnemonic acronym specific, measurable, achievable, relevant, and time-bound (SMART) may be used for all five aspects.

A key to the success of quality planning and execution is target measurability. A qualitative quality goal can be vague because of the difficulty of measuring it. For example, it is unclear how to measure "customer expectations" and "minimized" risks without some sort of quantifiable metric or dataset for analysis. Thus, it is recommended that a target statement be quantitatively defined. Here are a few examples of targets with measurable criteria:

- "Quality goal = 40 ppm (815k pcs annual volume) for all products" (Futaba 2017).
- "Achieve inpatient HCAHPS (Hospital Consumer Assessment of Healthcare Systems and Providers) overall rating and the overall quality of care score at or above the 75th percentile" (Sparrow 2019).
- "On-time Deliveries – we seek to have an on-time delivery rate of 95% or higher." (Genesis n.d.)

Target setting is predictive in nature, so the targets may not be perfectly accurate with some of the uncertainties inherent to a business environment. Often, a target is a bit aggressive aiming at the industry benchmark or best in class, as an easy one may not be very meaningful. Target setting must consider multiple constraints and feasible factors, and is subject to adjustment. For example, a national pizza chain Dominos made its delivery goal too aggressive – "30 minutes or it's free" – in the 1980s and was largely discontinued in the early 1990s (Janofsky 1993). Figure 1.11 illustrates an example of the current status, next-year target, and benchmark for target setting. In addition, a target can be set as a range, while the upper limit may be a stretch goal.

The ambitious and achievable quality goals can be set by applying the Hoshin planning approach (discussed in Chapter 2) with good communications. For a complex product or service, the system quality target needs to break down scientifically to its main elements and/or realization processes. For example, a car can only satisfy its quality targets if all of its functions are themselves of good quality. In addition, achieving a target is a process. Frequent reviews on the progress of the quality goals are necessary, particularly for aggressive goals. Quality verification and validation are discussed in depth in Chapter 4.

1.2.4 Cost of Quality

Types of Quality Cost

In addition to the technical dimensions of quality above mentioned, financial aspects related to quality are important, as they are in line with the financial and non-financial performances of an organization. Understanding the relationship between quality and cost (both up-front investments and operational

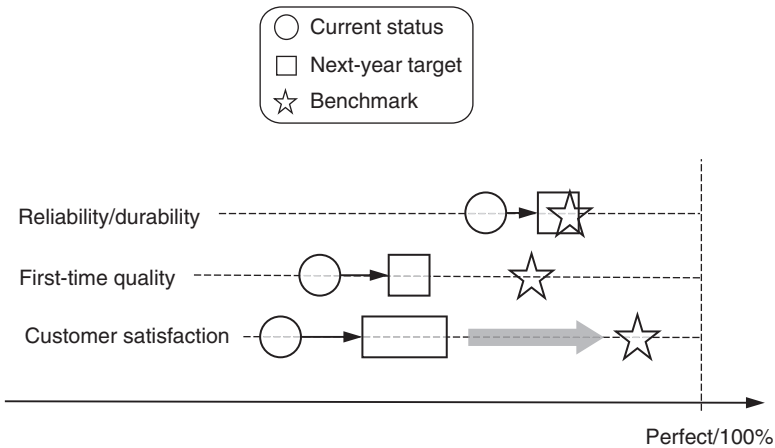

Figure 1.11 Targets vs. current performance levels and benchmarks.

expenditures) can encourage managers and employees to pay close attention to quality planning and operational effectiveness.

Cost of quality can be discussed in different ways. The cost comes from the investments and efforts to ensure good quality and the consequences of poor quality (see Figure 1.12). There are many elements related to these good and poor quality categories. The kind and number of elements depend on the types of a product and service.

The cost of *good* quality is the investments in early design phases and later operation phases. For example, developing a quality function deployment (QFD, discussed in Chapter 3) and failure modes and effects analysis (FMEA in Chapter 5) must be planned and conducted in development phases as up-front investments. Supplier selection, certification, and monitoring are the tasks to prevent and control supplier quality issues (Chapter 6). Maintenance is an important investment to operational quality and effectiveness. The up-front efforts and investments for good quality can be a challenge to development budget, time commitment, and may sometimes clash with traditional corporate culture.

In most cases, the cost of *poor* quality is incurred in the operation and execution of a project or service, and is directly measurable. It is called the cost of "poor" quality, because the efforts and expenditures are for the quality issues or defects already occurred. It is important to understand that most quality issues and defects can be avoided by being proactive and doing preventive tasks. For example, lack of proper maintenance has a direct relationship to some types of

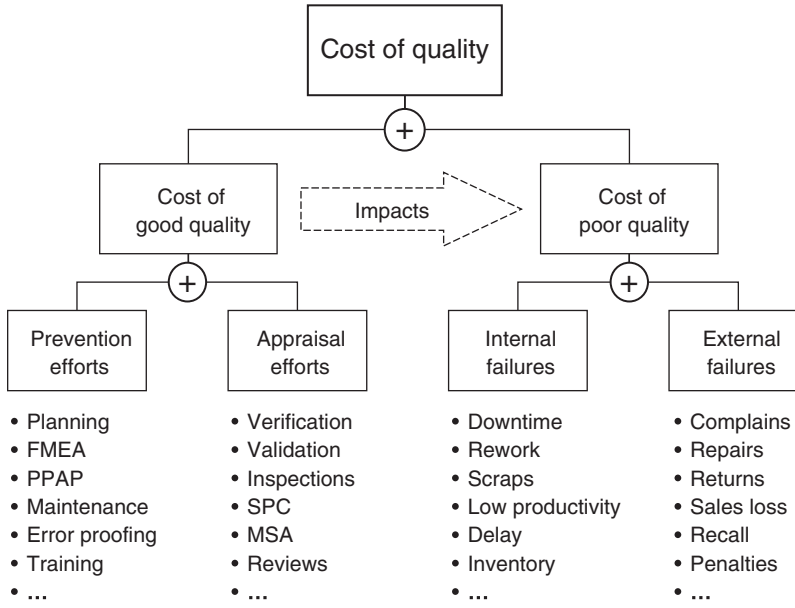

Figure 1.12 Elements of cost of quality.

poor quality. In other words, the efforts and investments for good quality can significantly reduce the cost of poor quality. That is, an ounce of prevention is worth a pound of cure (Franklin 1735).

Total Quality Cost

The total quality cost can be an assessment by combining both good and poor quality costs. Figure 1.13 shows a general relationship between the total quality cost and good and poor quality costs. The figure also illustrates an overall negative correlation between the cost of good quality and the cost of poor quality.

The total quality cost has the lowest point for a specific product or service, shown as "economic quality" in the figure. For most luxury brands of products and services, the companies strive for the lowest failure rates or "best quality" (illustrated in the figure) possible even with a high total quality cost. Some business operations, such as airplane transportation and surgical procedures, must be at the highest safety quality possible, which comes at a price premium. Most business operations are in between the "economic quality" and "best quality" ranges. A key question is where the best balance point is when considering the total cost of quality and the quality to customer satisfaction for a product or service.

Quality planning affects the quality performance and quality cost. In general, the prevention and appraisal efforts are planned in the early phases of product and service development to reduce failures and defects. The quality assurance from planning efforts and approaches is sometimes called "built-in quality," and this concept is detailed in depth in later chapters.

Considering the total quality cost makes economic sense. A challenge is to quantify the total cost curve in the figure and know the approximate locations

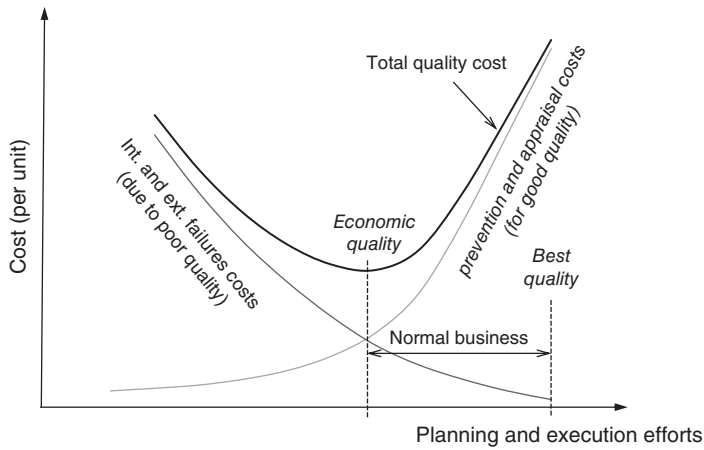

Figure 1.13 Economic quality and best quality.

of "economic quality" and "best quality" for a product or service. Such questions require a dedicated data analysis, based on historical data and market benchmarking. Based on a total cost curve, management can make an informed decision on quality investments and quality targets. Another issue in putting this concept to practice is an up-front financial constraint. It can be difficult to allocate a sufficient budget on good quality costs to ensure that a product or service meets its quality goals in an effective way.

1.3 Quality Planning

1.3.1 Planning Process Overview

Definition of Quality Planning

Dr. Juran described quality planning as a systematic process for developing services and processes that ensure customer needs are met (DeFeo 2016). Juran's definition was originally for manufacturing industries, but its concept is suitable for all types of business operations when their primary purpose is to serve their customers.

Quality planning is vision and goal driven. Visions and goals are long-term and mid/short-term objectives, respectively, for the value of products and services, based on customer expectations. A vision is normally set at the top level of an organization. For example, "Mayo Clinic will provide an unparalleled experience as the most trusted partner for health care" (Mayo Clinic n.d.). A quality goal is more specific for a product and at department levels. For instance, a quality goal of a vehicle model is 140 problems per 100 vehicles (the US industry average in 2020 was 166 problems per 100 vehicles (Power 2020)).

Quality planning can start from the vision established and a gap analysis. The inputs to quality planning include project plan, assets (controllable resources), and capability, as shown in Figure 1.14 as a system overview. As an input, risk analysis and strengths–weaknesses–opportunities–threats (SWOT) analysis built a foundation to quality planning, which is discussed in depth in Chapter 2. Depending on a development project, more input information may be needed, such as existing similar parts, lessons learned, product mixes, quality specifications, supplier quotes, and feasibility studies.

The outputs of quality planning are the deliverables used to meet goals and the processes used to achieve those goals. The experience of professionals, cross-functional teamwork, and corporation culture all play assurance roles to quality planning. Common outputs from quality planning can be one or all of the following documents (DOD n.d.):

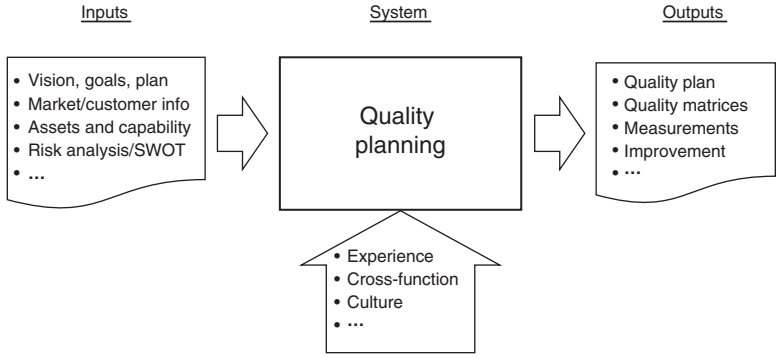

Figure 1.14 Inputs, system, and outputs of quality planning.

1. Quality management plan: The plan addresses how program management will implement the organization's quality policy and achieve quality goals. Two samples of quality plan reports are shown in Figure 1.15.
2. Quality metrics: Quality metrics detail the definitions and descriptions of how to measure quality performance around a product or service.
3. Process improvement plan: The improvement plan details the purpose, process flow, analysis, and targets that are conceived to improve existing customer value.
4. Other elements, such as a quality baseline and quality assurance description, may be included in a quality plan.

Role of Quality Planning

Quality planning is an integral part of corporate strategic management, to set long-range (5–10 years) quality goals and annual quality objectives. That means that the quality management plan, quality metrics, and continuous improvement plan are established as part of a corporate strategic plan, and revisited every year for updates. Strategic planning is further discussed in Chapter 2.

The major milestones in realization for a new product or service, viewed in terms of that product or service's lifespan, are illustrated in Figure 1.16. Quality planning efforts are integrated in early phases, such as design and process. Quality planning is for the quality assurance and control of a new product or service. The results of quality planning affect multiple phases, from design to launch of a product or service and to regular operations. Without excellent quality planning, the quality execution in development phases may be envisioned as akin to "birth defects," which can be difficult to fix in later life and adversely affect development results and effectiveness.

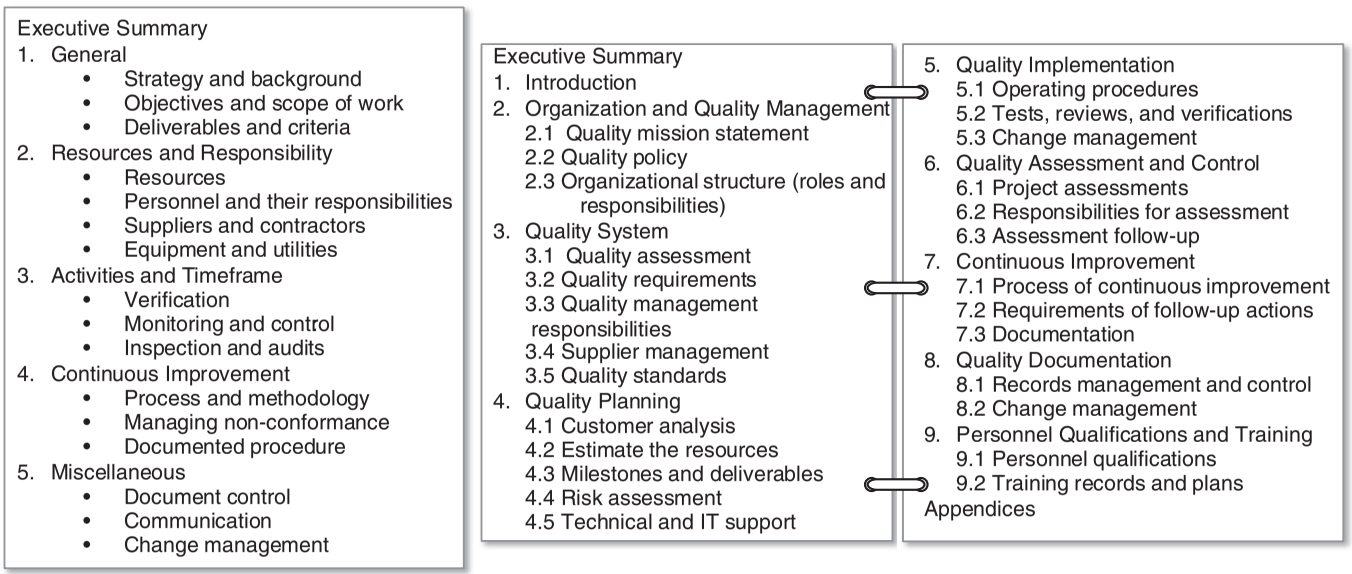

Figure 1.15 Sample quality planning reports.

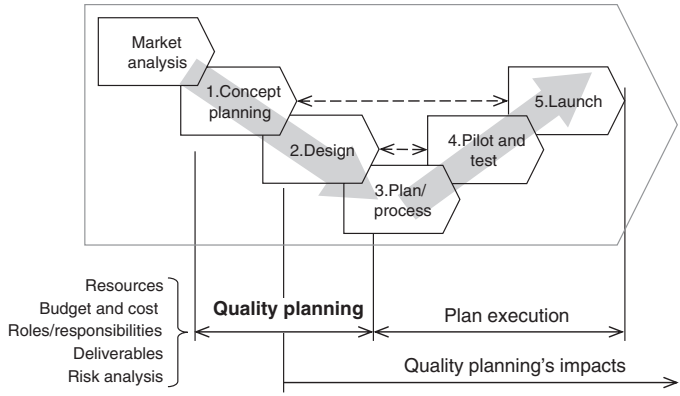

Figure 1.16 Quality planning in product/service realization.

The functionality and role of quality planning apply to the lifecycle of a product, which is important for durable goods, such as vehicles, home appliances, and consumer electronics. The entire lifecycle of a product has five stages, shown in Figure 1.17. In such cases, quality planning has an additional segment for the after-sales service of a durable product.

Quality planning for a product lifecycle is similar, in principle and process, to that for the development stages. One important difference is that quality planning needs to account for future resource allocation, because after-sales service is related to the sales volume changing over time. After-sales services have a few

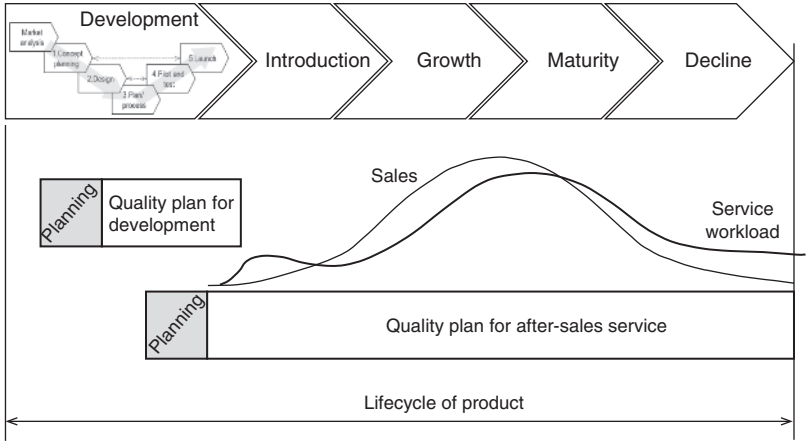

Figure 1.17 Quality planning in lifecycle of durable goods.

major functions, such as pre-installation, user training, warranty, technical support, and return/replacement. The quality attributes of an after-sales service also include spare part availability, warranty policy, responsiveness to customer complaints, accessibility to service personnel, technical competence of service people, etc.

1.3.2 Considerations in Quality Planning

Key Factors of Quality Planning

To identify the key elements of quality planning, a study used a structured, mixed method (Tallentire et al. 2019). The authors collected data via a series of interviews and focus groups and then did inductive thematic analysis. They concluded the five key elements in a quality-planning process as shown in Figure 1.18. Note that the five elements can influence each other.

1. Culture and leadership for improvement. Corporate culture is linked to several dynamics, e.g. policy, teamwork, organizational structure, and communication. An effective indicator of good corporate culture is the feelings of staff, at all levels, of the trust, respect, and encouragement that they associate with their professional environment. Leadership involvement and guidance is an essential ingredient of quality planning and execution.
2. Engaging and empowering staff. The purpose of engaging and empowering employees is to connect their work with the organizational vision and goals. Additionally, engagement and empowerment involves the infusion of motivation, energy, and enthusiasm. For example, management encourages employ-

Figure 1.18 Key factors of quality-planning process.

ees to find a link between what matters to them, and what matters to their organization. Chapter 2 will specifically discuss the Hoshin planning approach on this subject.

3. Forming collaborations and networks. In the short term, collaborations and networks are about teamwork to effectively foster and support quality planning and execution, for the sake of customers. The coordination of collaborations and networks is key for the effectiveness of planning.
4. Building improvement capacity and capability. This element is the evaluation and training of quality skills of individual employees as a building block of organizational capacity and capability. Main tasks are to assess the quality skills of employees, and help them establish individual development plans.
5. Spreading and sustaining changes. Solid achievements, e.g. improvements, new processes, revised standards, and lessons learned, are worthy references for similar situations, other departments, and even across industry. Thus, dissemination should be encouraged as contributions to a quality community at large.

Focuses of Quality Planning

Quality planning is an integral part of development project planning. Thus, it is vital to embed quality-planning objectives, efforts, targets, tasks, etc. into the entire development project, and coordinate with other functional teams. While planning, quality professionals address the following common items from the quality side of operations and strategy:

1. Deliverables: These include the quality goals and criteria to customer satisfaction, with a defined period or due time. They must be measurable against the predefined, satisfactory criteria. For example, the warranty cost of a new vehicle model will be reduced by 20% in the second year.
2. Roles and responsibilities: These are the duties of personnel and departments who do quality tasks and achieve quality goals. Some quality tasks and issues are complex and cross-functional, related to budget, resources, skills, etc. Such items typically require coordination and/or approval from higher management in the organization.
3. Quality assurance activities: These include the planned processes and efforts of teams to execute a quality plan within a given budget. The activities also come with defined timelines.
4. Resources: These are the people, capital, facilities, and materials required for the successful development of a product or service. The budget should be itemized and justified, considering equipment acquisition, operation, maintenance, personnel, utilities, historical data, etc.
5. Risk analysis and management: These are required for large projects, and recommended for all projects. The details of risk analysis and management are discussed in Chapter 2.

Beyond these, specific considerations may be required in quality planning for some products or services. For example, architecture and codes need to be assessed for software development, and security reviews are needed as a primary task for a network communication project.

1.3.3 Quality-planning Guideline (APQP)

APQP Process

For product development, a common approach for quality planning in the automotive industry is called APQP. APQP was developed in 1994 and revised as the second edition in 2008 (AIAG 2008). Other industries have developed their own specifications and standards, such as for software development (DOE 1997), aerospace suppliers AS9145 (SAE 2016), and environment projects (SC 2016). Some industries refer to such guidelines as a quality assurance program plan (QAPP). Here though, APQP, as a typical approach, is used as an example for further discussion.

APQP integrates quality planning into the five phases of product development (Figure 1.19). In the figure, the overall development process (Figure 1.16) is also included at the bottom of Figure 1.19. The five phases are not necessarily in purely sequential order; they can have overlaps and loops. There are various methods and tools used in the five phases, which are discussed in the following chapters.

APQP is a preventive approach to quality during development, with supporting processes of validation, evidence, and documentation. Implementing APQP may force a relatively drastic change in corporate culture and the existing practice of quality work from reactive (or firefighting) to proactive in work style and scope. For example, the quality of parts and services from suppliers are assured by the APQP approach rather than primarily by monitoring and reactions.

The APQP efforts can be organized either by part if it is unique or by part family. For a part family, limited APQP reviews and validation may be conducted to certain child parts. A product development often is on a unique part, also referred to as an engineering-to-order (ETO) product. Most service development falls into this category as well. In such cases, APQP efforts may be planned as two sections: one on common elements and features of similar parts, and another on non-standard elements and characteristics with specific reviews.

Inputs and Outputs of APQP Phases

A key characteristic in an APQP process is that the output items of the previous step are the inputs to the next step (Figure 1.19). The inputs and outputs of APQP phases are summarized in Table 1.5. Some outputs of a phase are just a general reference and so are the inputs to a phase, as they can be product dependent. The last column of this table lists the main sections of this book for reader quick reference.

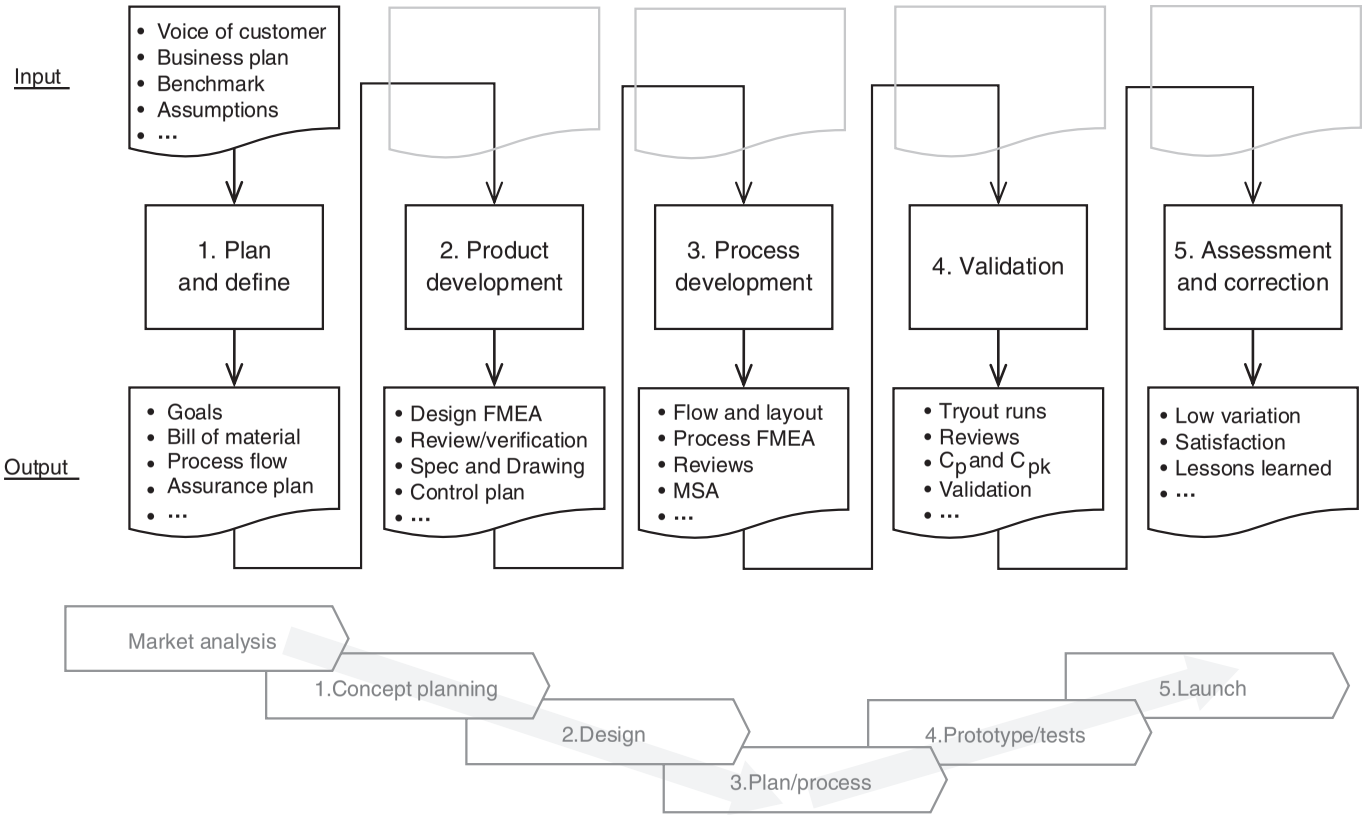

Figure 1.19 Five phases of APQP in product development.

Table 1.5 Inputs and outputs of five phases of APQP.

Phase	Function	Input	Output	This book section
1	Plan and define program	Voice of the customer Business plan/ market strategy Product/process benchmark data Product/process assumptions Product reliability studies Customer inputs	Design goals Reliability and quality goals Preliminary bill of material Preliminary process flow chart Special product/ process characteristics Management support	3.1 4.4 6.3 3.1 2.1
2	Product design and development		Design FMEA Design for manufacturability and assembly Design verification Design reviews Prototype build control plan Engineering drawings Engineering specifications Material specifications Drawing and specification changes Equipment, tooling, facilities requirements Special product and process characteristics Gauge/testing equipment requirements Team feasibility and management support	5.1–5.3 4.2 4.1 4.2 7.3 3.1 7.1 2.1

Continued

Table 1.5 Continued

Phase	Function	Input	Output	This book section
3	Process design and development		Shipment packaging requirements	
			Product/process quality system review	1.2
			Process flow chart	6.3
			Floor plan layout	
			Characteristics matrix	8.2
			Process FMEA	5.1–5.3
			Pre-launch control plan	5.4
			Process instructions	
			Measurement system analysis plan	7.1
			Preliminary process capability study plan	7.2
			Management support	
4	Product and process validation		Significant production run	4.2
			Measurement system evaluation	7.1
			Preliminary process capability study	7.2
			Product part approval	6.1–6.4
			Production validation testing	7.2
			Packaging evaluation	
			Production control plan	5.3
			Quality planning sign-off	7.4
			Management support	
5	Feedback, assessment, and corrective action		Reduced variation	4.4
			Improved customer satisfaction	3.3
			Improved delivery and service	8.1
			Effective use of lessons learned/best practice	

1.3.4 Service Quality Planning

In service industries, they have similar quality-planning guidelines but often in different names, for example:

- Quality Assurance Project Plans (EPA 1996)
- Quality Assurance Guidelines (NIH n.d.)
- Standard Guide for Quality Planning and Field Implementation of a Water Quality Measurement Program (ASTM 2018)

Several quality-planning guidelines have been developed within individual industries and regions. For example, in Canadian healthcare, an organization called Collaborative for Excellence in Healthcare Quality (CEHQ) developed the Guide to Developing and Assessing a Quality Plan – For Healthcare Organizations. The CEHQ emphasizes that a quality plan should include the following key factors (CEHQ 2012):

1. Be aligned with the strategic plan
2. Tie in the current quality framework
3. Be a progress from previous quality plans
4. Have a clear description and be easy to follow
5. Have measurable goals
6. Define targets of quality indicators
7. Have a formal evaluation plan
8. Be feasible, based on available resources
9. Have an influence on cultural change in quality

A quality plan may be presented in the shape of a house. Its roof is the goal and there are several pillars support the goal. Discussed before, the supporting pillars are not necessarily equally important to the goal. Figure 1.20 shows two examples of strategic quality plans: one is a university's plan (GWU n.d.) on the left, the other, a hospital's plan (JHM n.d.), in the form of a house structure, based on their original statements.

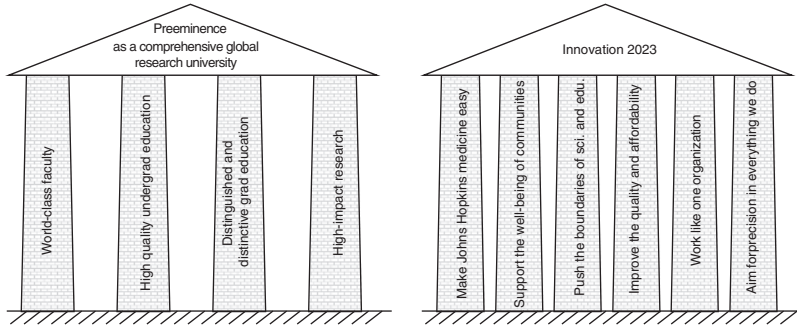

Figure 1.20 Examples of strategic quality plan.

Juran presented quality planning and cultural transformation in five simple phases, called the Juran Roadmap (Juran n.d.), which may be viewed as a generic planning process. The five phases are:

1. To decide: To consider certain factors, such as competitive, regulatory, financial, and/or cultural factors, and make a decision to move forward agreed upon by the leadership.
2. To prepare: Senior management to prepare to articulate the strategy, direction, and plan to achieve the transformation.
3. To launch: To educate the organization on the transformative direction, what values to change, what support structure to assist in the transformation, and how people/performance to be measured and evaluated.
4. To expand: To develop the transformation into all other parts of the organization.
5. To sustain: To adapt and embed the new values into the business ecosystem.

As a summary, one may see that quality planning is a common practice across many professional disciplines. Quality planning practice follows a general set of principles, and has specific focuses, based on the types of business. It may be an excellent idea to review commonalities between the guidelines of different businesses, and think about improving current practices with the specific concerns in a discipline, in addition to evaluating how the different specifics for these businesses might unify, under a broader domain-wide guideline.

Summary

Quality Definitions

1 Quality can have a different, subjective definition for different fields and applications.
2 Quality should be customer oriented, and have multiple dimensions.
3 A department can be an internal customer if it has suppliers within an organization.
4 The dimensions of product quality include performance safety, feature, reliability, durability, aesthetics, conformance, and serviceability.
5 The dimensions of service quality include reliability, responsiveness, assurance, empathy, and tangibility.

Quality System

6 A quality management system (QMS) is a business foundation and subsystem, built of policies, processes, procedures, information, and responsibilities.

7 The Juran trilogy QMS comprises three cornerstones: quality planning, quality control, and continuous improvement.
8 Quality targets should be specific, measurable, achievable, relevant, and time-bound (SMART).
9 Cost of quality is a vital factor for quality planning; the source categories of cost of quality include prevention, appraisal, internal failure, and external failure.
10 Total cost of quality should be systematically optimized for a product, process, or service.

Quality Planning

11 Quality planning is vision and goal driven, with multiple inputs and outputs.
12 The outputs of quality planning include management plans, quality metrics, improvement plans, etc.
13 Quality planning starts during the early phases of development, and applies to the lifecycle of a product or service.
14 The key factors of quality planning include culture and leadership, employee engagement, teamwork, improvement capacity and capability, and sustaining changes.
15 APQP is a proactive approach. While originally designed for product development, its principle can apply to the service sectors as well.

Exercises

Review Questions

1 List five keywords for a definition of quality and explain why they are important.
2 Find a product or service and discuss how to measure its quality.
3 What is your definition of a QMS?
4 List the elements in ISO 9001 or a QMS standard in an industry.
5 Explain the meanings of the internal suppliers and internal customers with an example.
6 Discuss the relationship between internal customers and external customers.
7 Use an example to discuss the dimensions of a product.
8 Use an example to discuss the dimensions of a service.
9 Discuss that service quality (SQ) is SQ = P – E with an example.
10 Review the role of quality planning in the Juran trilogy QMS.
11 Review the functions of a quality department in an organization.
12 Discuss a principle of IATF 16949:2016 QMS with an example.

13 Set and review a quality target for a new product or service development.
14 Explain the meanings of economic quality and best quality for a product or service.
15 List three key input factors for quality planning and discuss their roles.
16 Find the vision statement of an organization and review the quality element in that vision statement.
17 For the work of quality planning, select two focuses for discussion.
18 Discuss an appliance that has quality planning for both product development and after-sales service.
19 Explain how the outputs of an APQP phase are the inputs to the next phase.
20 Discuss if the tasks in different APQP phases can be partially overlapped.

Mini-project Topics

1 Search sources and compare the definitions and meanings of the quality in your discipline. Please provide and justify your opinion about which definitions are more appropriate.
2 Compare the dimensions of a product and service and discuss both a common dimension and unique dimension.
3 Select a characteristic of service quality and discuss how to address it in planning.
4 One states ISO standard on a QMS is more on processes and documentation, while Juran's QMS has three functional subsystems. Review the connection between both QMS principles.
5 Review IATF 16949 for its applications.
6 Study the advantages and roadblocks of employee involvement with quality.
7 When is the best quality justifiable to a product or service when considering costs?
8 Find a quality planning report and analyze its key elements.
9 Study the link between the vision statement and quality targets of an organization.
10 Search an APQP-like procedure for a service industry.

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