CHAPTER

1

INTRODUCTION TO QUALITY

OBJECTIVES

This chapter provides a basic understanding of quality management. It describes basic definitions of quality and premises of quality management with different views of product quality from stakeholder's perspectives. This foundation is essential for software testers to understand the criticality of their position in software development life cycle.

1.1 INTRODUCTION

Evolution of mankind can be seen as a continuous effort to make things better and convenient through improvements linked with inventions of new products. Since time immemorial, humans have used various products to enhance their lifestyle. Initially, mankind was completely dependent on nature for satisfying their basic needs of food, shelter and clothing. With evolution, human needs increased from the basic level to substantial addition of derived needs to make life more comfortable. As civilisation progressed, humans started converting natural resources into things which could be used easily to satisfy their basic as well as derived needs.

Earlier, product quality was governed by the individual skill and it differed from instance to instance depending upon the creator and the process used to make it at that instance. Every product was considered as a separate project and every instance of the manufacturing process led to products of different quality attributes. Due to increase in demand for same or similar products which were expected to satisfy same/similar demands and mechanisation of the manufacturing processes, the concept of product specialisation and mass production came into existence. Technological developments made production faster and repetitive in nature.

Now, we are into the era of specialised mass production where producers have specialised domain knowledge and manufacturing skill required for particular product creation, and use this knowledge and skill to produce the product in huge quantities.The market is changing considerably from monopoly to fierce competition but still maintaining the individual product identity in terms of attributes and characteristics. There are large number of buyers as well as sellers in the market, providing and demanding similar products, which satisfy similar demands. Products may or may not be exactly the same but may be similar or satisfying similar needs/demands of the users. They may differ from one another to some extent on the basis of their cost, delivery schedule to acquire it, features, functionalities present/absent, etc. These may be termed as attributes of the quality of a product.

We will be using the word 'product' to represent 'product' as well as 'service', as both are intended to satisfy needs of users/customers. Service may be considered as a virtual product without physical existence but satisfying some needs of users.

1.2 HISTORICAL PERSPECTIVE OF QUALITY

Quality improvement is not a new pursuit for mankind. The field of quality and quality improvement has its roots in agriculture. Early efforts of quality improvement in agriculture may be attributed to statistical research conducted in Britain, in early 20th century, to assist farmers in understanding how to plan the crops and rotate the plan of cultivation to maximise agricultural production while maintaining the soil quality at the same time.

This work inspired Walter Shewhart at Bell Laboratories to develop quality improvement programs through planned efforts. He adopted the concepts developed initially for agriculture to implement quality improvement programs for products and to reduce the cost to customer without affecting profitability for the manufacturer. Changes brought in by Walter Shelwart motivated Dr Edward Deming to implement quality improvement programs as a way to improve product quality. He devoted his life to teaching and improving quality methods and practices across the world through 'Total Quality Management' methodology.

Dr Deming demonstrated his ideas of 'Total Quality Management' through continual improvement in Japan. Dr Joseph Juran also implemented quality improvement through measurement programs using different quality tools for assessment and improvement. Japanese producers fully embraced quality improvement methodologies and started to integrate the concepts of 'Total Quality Management' in their industries. The Dramatic improvement in quality of products in Japan after 1950 due to the revolutionary ideas of continual improvement through process measurement are still considered legendary.

During last few decades, the Japanese industry has successfully utilised quality tools and 'Total Quality Management' methodologies as part of their successful effort to become a leading nation in manufacturing and supplying a vast array of electronics, automotive and other products to the entire world. Quality of the products is established and continually improved in terms of features, consistent performance, lesser costs, reasonable delivery schedule, etc. in order to enhance the satisfaction of the customer. Japanese products started dictating the quality parameters in world market to the extent that many nations adopted quality improvement programs at national level to face the competition from the Japanese industry. Quality of Japanese products stems from the systematic organisation and understanding of processes used in all aspects of product development, and introduction of tools and methodologies that permit monitoring and understanding about what is happening in different processes of manufacturing and management of interactions of those processes. Japanese quality improvement programs created the sets of interrelated processes which assure the same product quality in repetitive manner and in large number to satisfy the demand of a huge market. Defects are analysed and root causes of the defects are identified and eliminated through continual process improvement. This has helped in optimising the processes to produce better results in repetitive manner.

1.3 WHAT IS QUALITY? (IS IT A FACT OR PERCEPTION?)

What is quality, is an important question but does not have a simple answer. Some people define it as a fact while others define it as a perception of customer/user.

We often talk about quality of a product to shortlist or select the best product among the equals when we wish to acquire one. We may not have a complete idea about the meaning of quality or what we are looking for while selecting a product, if somebody questions us about the reason for choosing one product over the

other. This is a major issue faced by the people working in quality field even today as it is very difficult to decide what contributes customer loyalty or first-time sale and subsequent repeat sale. The term 'quality' means different things to different people at different times, different places and for different products. For example, to some users, a quality product may be one, which has no/less defects and works exactly as expected and matches with his/her concept of cost and delivery schedule along with services offered. Such a thought may be a definition of quality—'**Quality is fitness for use**'.

However, some other definitions of quality are also widely discussed. Quality defined as, '**Conformance to specifications**' is a position that people in the engineering industry often promote because they can do very little to change the design of a product and have to make a product as per the design which will best suite the user's other expectations like less cost, fast delivery and good service support. Others promote wider views, which may include the attribute of a product which satisfies/exceeds the expectations of the customer. Some believe that quality is a judgment or perception of the customer/user about the attributes of a product, as all the features may not be known or used during the entire life of a product. Quality is the extent to which the customers/users believe that the product meets or surpasses their needs and expectations. Others believe that quality means delivering products that,

- Meet customer standards, either as defined by the customer or defined by the normal usage or by some national or international bodies. (Standard may or may not be as defined by the supplier of the product. Typically for consumer goods, standard is defined by market forces and likes and dislikes of users in general.)
- Meet and fulfill customer needs which include expressed needs as well as implied requirements derived by business analysts and system analysts. Expressed needs are available in the form of requirement statement generated by users while implied needs definition may require supplier to understand customer business and provide the solution accordingly.
- One must try to meet customer expectations as maximum as possible. If something is given more than the requirements of the customer, it should be declared before transition, so that customer surprises can be avoided. At the same time, if some aspect of the specified requirements has not been included in the product, it should be declared. This is essential so that the customer may understand the deliverables accordingly. Expectations may be at the top of customer needs and may be useful in creating brand loyalty through customer delight. (Trying to get customer delight after informing customer about it.)
- Meet anticipated/unanticipated future needs and aspirations of customers by understanding their businesses and future plans. One may need to build a software and system considering some future requirements. Every product including software has a life span and due to technological inventions as well as new ways of doing things, older systems become obsolete, either technically or economically. How much of the future must be considered for the given product may be a responsibility of the customer or the supplier or a joint responsibility. Every product has some defined life span and one may have to extrapolate future needs accordingly.

Others may simply ignore these definitions of quality and say, '**I'll know the quality of a product when I see it**'. It seems that we all '**know**' or '**feel**' somehow what the meaning of quality is, though it is very difficult to put it in exact words. Something that fulfills/exceeds customer's preconceived ideas about the quality is likely to be called as a quality product.

We will try to examine tools and methods which can be used to improve product quality through process approach, add value through brainstorming by producers, consumers, customers and all stakeholders about new features which may be included/old features which may be excluded from the product, decrease costs,

improve schedule and help products to conform better with respect to the expressed and implied requirements. Use of quality tools and methodologies can help people engage in production related activities to improve quality of the products delivered to final user and achieve customer satisfaction.

1.4 DEFINITIONS OF QUALITY

For achieving quality of a product, one must define it in some measurable terms which can be used as a reference to find whether quality is really met or not. There are many views and definitions of quality given by stalwarts working in quality improvement and quality management arena. These definitions describe different perceptions toward quality of products. Some of these are,

1. Customer-Based Definition of Quality Quality product must have '**Fitness for use**' and must meet customer needs, expectations and help in achieving customer satisfaction and possibly customer delight. Any product can be considered as a quality product if it satisfies its purpose of existence through customer satisfaction. This definition is mainly derived by an approach to quality management through '**Quality is fitness for use**'.

2. Manufacturing-Based Definition of Quality This definition is mainly derived from engineering product manufacturing where it is not expected that the customer knows all requirements of the product, and many product level requirements are defined by architects and designers on the basis of customer feedback/survey. Market research may have to generate requirement statement on the basis of perception of probable customers about what features and characteristics of a product are expected by the market. A quality product must have a definition of requirement specifications, design specifications, etc. and the product must conform to these specifications. The development methodologies used for the purpose must be capable of producing the right product in first go and must result into a product having no/minimum defects. This approach gives the definition of '**Conformance to requirements**'.

3. Product-Based Definition of Quality The product must have something that other similar products do not have which can help the customer satisfy his/her needs in a better way. These attributes must add value for the customer/user so that he/she can appreciate the product in comparison to competing products. This makes the product distinguishable from similar products in the market. Also, the customers must feel proud of owning it due to its inherent attributes and characteristics.

4. Value- Based Definition of Quality A product is the best combination of price and features or attributes expected by or required by the customers. The customer must get value for his investment by buying the product. The cost of a product has direct relationship with the value that the customer finds in it. More value for the customer helps in better appreciation of a product. Many times it is claimed that '**People do not buy products, they buy benefits**'.

5. Transcendent Quality To many users/customers, it is not clear what is meant by a 'quality product', but as per their perception it is something good and they may want to purchase it because of some quality present/absent in the product. The customer will derive the value and may feel the pride of ownership.

Definitions 2, 3 and 4 are traditionally associated with the idea of a product quality that,

- A product must have zero/minimum defects so that it does not prohibit normal usage by the users. When users buy a product, they expect minimum/no failures.

- A product must be something that people will want to receive as it satisfies their needs and supports their expectations. It must suffice the purpose of its existence from the customers view.
- It can be purchased at a reasonable price with relation to the value users may derive from it. The customer may undertake cost benefit analysis of the product and if benefits equal or exceed cost, it may be bought.

Customer centric product development forces the industry to look outside its own premises and thought process, making it compulsory to understand the customer. This forces the producer to create products that prospective customers may want to buy and not ones that designers think people want to receive.

The most interesting definition of quality is, '**I do not know what it is, but if I'm delighted by acquiring it, I'll buy it!**' This means that those products are better in quality which possess some characteristics that attract customers to purchase them. Though the requirements of a product may differ from customer to customer, place to place and time to time, in general, the product must be,

- Less expensive with higher returns or higher values for the customer, satisfying cost benefit analysis. Directly or indirectly, every owner would be performing cost benefit analysis before arriving at a decision to purchase something.
- Inherent of required features or attributes expected by the customer which make it fit for use. If product is of no use to users, they will never purchase it.
- Without any defect or with few defects so that its usage is uninhibited and failure or repairs would be as less as possible. If the product is very reliable, it may be liked by prospective buyers.
- With desirable cosmetic attributes.

Often, we are not aware that we want a certain product, but when we see their attributes, we feel like buying it. It may include cosmetic requirements like user interfaces, ease of use, etc.

Many of the above statements are based upon the users or customers perception about quality of the product that they wish to buy. Some of these characteristics are often attributes of products delivered by Japanese manufacturers to consumer market. Mainly, the contributors to quality would be that the failure rates are less, repairs are easier and fast, products are consistent in performance and work better than other similar products in the market and do not give any surprises to customers during use. The reasons for such improvement in the quality are a continuous/continual improvement in all aspects of product development through requirement capturing, design, development, testing, deployment and maintenance.

There is one more angle to the definition of quality of a product. Any improvement in the product quality must result into a better product, and it must give benefits to the customer finally. The benefits may be in terms of more or better features, less wait time, less cost, better service, etc. Thus, quality improvement has direct relationship with fulfilling customer requirements or giving more and more customer satisfaction.

Many people speak about not only achieving customer satisfaction but exceeding customer expectations to achieve customer delight. There is a signal of caution about exceeding customer expectations. Any feature which surprises a customer may not be appreciated by him/her and may be termed as a defect. Exceeding expectations without informing the customer about what they can expect in addition to defined requirements can be dangerous and may result in rejection of such products.

1.5 CORE COMPONENTS OF QUALITY

Quality of a product must be driven by customer requirements and expectations from the product. Those expectations may be expressed as a part of requirement specifications defined or may be implied one which is generally accepted as requirements. It must have some important characteristics that may help

customer in getting more and more benefits and satisfaction by using the product. Some postulates of quality are,

1.5.1 QUALITY IS BASED ON CUSTOMER SATISFACTION BY ACQUIRING A PRODUCT

Quality is something perceived by a customer while using a product. The effect of a quality product, delivered and used by a customer, on his satisfaction and delight is the most important factor in determining whether the quality has been achieved or not. It talks about the ability of a product or service to satisfy a customer by fulfilling his needs or purpose for which it is acquired. It may come through the attributes of a product, time required for a customer to acquire it, price a customer is expected to pay for it and so many other factors associated with the product as well as the organisation producing or distributing it. All these factors may or may not be governed by the manufacturer alone but may be dependent on quality of inputs. This point stresses a need that a producer must understand the purpose or usage of a product and then devise a quality plan for it accordingly, to satisfy the purpose of the product.

1.5.2 THE ORGANISATION MUST DEFINE QUALITY PARAMETERS BEFORE IT CAN BE ACHIEVED

We have already discussed that quality is a perception of a customer about satisfaction of needs or expectation. It is difficult for the manufacturer to achieve the quality of product without knowing what customer is looking for while purchasing it. If product quality is defined in some measurable terms, it can help the manufacturer in deciding whether the product quality has been achieved or not during its manufacturing and delivery. In order to meet some criteria of improvement and ability to satisfy a customer, one must follow a cycle of 'Define', 'Measure', 'Monitor', 'Control' and 'Improve'. The cycle of improvements through measurements is described below,

- *Define* There must be some definition of what is required in the product, in terms of attributes or characteristics of a product, and in how much quantity it is required to derive customer satisfaction. Features, functionalities, and attributes of the product must be measured in quantitative terms, and it must be a part of requirement specification as well as acceptance criteria defined for it. The supplier as well as the customer must know what 'Must be', what 'Should be' and what 'Could be' present in the product so delivered and also what 'Must not be', 'Should not be' and 'Could not be' present in the product.

- *Measure* The quantitative measures must be defined as an attribute of quality of a product. Presence or absence of these attributes in required quantities acts as an indicator of product quality achievement. Measurement also gives a gap between what is expected by a customer and what is delivered to him when the product is sold. This gap may be considered as a lack of quality for that product. This may cause customer dissatisfaction or rejection by the customer.

- *Monitor* Ability of the product to satisfy customer expectations defines the quality of a product. There must be some mechanism available with the manufacturer to monitor the processes used in development, testing and delivering a product to a customer and their outcome, i.e. attributes of product produced using these processes, to ensure that customer satisfaction is incorporated in the deliverables given to the customer. Deviations from the specifications must be analysed and reasons of these deviations must be sorted out to improve product and process used for producing it. An organisation must have correction as well as corrective and preventive action plans to remove the reasons of deviations/deficiencies in the product as well as improve the processes used for making it.

• *Control* Control gives the ability to provide desired results and avoid the undesired things going to a customer. Controlling function in the organisation, popularly called as 'quality control' or 'verification and validation', may be given a responsibility to control product quality at micro level while the final responsibility of overall organisational control is entrusted with the management, popularly called as 'quality assurance'. Management must put some mechanism in place for reviewing and controlling the progress of product development and testing, initiating actions on deviations/deficiencies observed in the product as well as the process.

• *Improve* Continuous/continual improvements are necessary to maintain ongoing customer satisfaction and overcome the possible competition, customer complaints, etc. If some producer enjoys very high customer satisfaction and huge demand for his product, competitors will try to enter the market. They will try to improve their products further to beat the competition. Improvement may be either of two different approaches viz. continuous improvement and continual improvement as the case may be.

1.5.3 MANAGEMENT MUST LEAD THE ORGANISATION THROUGH IMPROVEMENT EFFORTS

Quality must be perceived by a customer to realise customer satisfaction. Many factors must be controlled by a manufacturer in order to attain customer satisfaction. Management is the single strongest force existing in an organisation to make the changes as expected by a customer; it naturally becomes the leader in achieving customer satisfaction, quality of product and improvement of the processes used through various programs of continuous/continual improvement. Quality management must be driven by the management and participated by all employees.

Management should lead the endeavor of quality improvement program in the organisation by defining vision, mission, policies, objectives, strategies, goals and values for the organisation and show the existence of the same in the organisation by self examples. Entire organisation should imitate the behavioral and leadership aspects of the management. Every word and action by the management may be seen and adopted by the employees. Quality improvement is also termed as a 'cultural change brought in by management'.

Organisation based policies, procedures, methods, standards, systems etc. are defined and approved by the management. Adherence to these systems must be monitored continuously and deviation/deficiencies must be tracked. Actions resulting from the observed deviations/deficiencies shall be viewed as the areas which need improvements. The improvements may be required in enforcement or definition of policies and procedures, methods, standards, etc. Management must have quality planning at organisation level to support improvement actions.

1.5.4 CONTINUOUS PROCESS (CONTINUAL) IMPROVEMENT IS NECESSARY

There was an old belief that quality can be improved by more inspection, testing and rework, scrap, sorting, etc. It was expected that a customer must inspect the product and report the defects or deficiencies so that those will be fixed. Manufacturer was responsible for fixing the defects as and when they were reported by the customer. This added to the cost of inspection, segregation, failure, rework, etc. for the customer and reduced the profit margins for the manufacturer or increased the price for the customer. At the same time, customer's right to receive a good product was withdrawn.

For improving the competitive cost advantage to producer as well as customer, quality must be produced with an aim of first time right and must be improved continuously/continually. For the customer, total cost of product is inclusive of cost of purchase and maintenance. Total cost is more important to him than the purchase tag. The first step for producing quality is the definition of processes used for producing the product and the cycle of

continuous or continual improvement (Plan–Do–Check–Act or Define–Measure–Monitor–Control–Improve) to refine and redefine processes to achieve targeted improvements. It needs 'Planning' for quality, 'Doing' as per the defined plans, 'Checking' the outcome at each stage with the expected results and taking 'Actions' on the variances produced. Refer Table 1.1 for comparison between continuous and continual improvement.

Table 1.1 Comparison of continuous and continual improvement

Continuous improvement	Continual improvement
Continuous improvement is dynamic in nature. The changes are done at every stage and every time to improve further.	Continual improvement is dynamic as well as static change management. The changes are done, absorbed, baselined and sustained before taking next step of improvements.
Continuously striving for excellence gives a continuous improvement	Periodic improvements followed by stabilisation process and sustenance represent continual improvement
It has a thrust on continuous refinement of the processes to eliminate waste continuously	Stabilisation of processes at each iteration of improvement where waste is removed in stages
It has high dependence on people having innovative skills tending towards inventions	Less dependence on people and more dependence on innovation processes
Environment is continuously changed	Changes in environment are followed by stabilisation
Sometimes it creates a turbulence in an organisation, if people are not able to digest continuous change	It may be better suited than continuous improvement. It gives a chance to settle the change before next change is introduced

1.6 QUALITY VIEW

Stakeholders are the people or entities interested in success/failure of a project or product or organisation in general. Every project/product/organisation has several stakeholders interested in its betterment. Quality is viewed differently by different stakeholders of the product/project/organisation as per their role in entire spectrum. Some quality models put all stakeholders for the project and product in six major categories. These stakeholders benefit directly or indirectly, if the project/product/organisation becomes successful, and suffer, if the organisation or project fails.

- **Customer** Customer is the main stakeholder for any product/project. The customer will be paying for the product to satisfy his requirements. He/she must benefit by acquiring a new product. Sometimes, the customer and user can be different entities but here, we are defining both as same entity considering customer as a user. Though sometimes late delivery penalty clauses are included in contract, the customer is interested in the product delivery with all features on defined scheduled time and may not be interested in getting compensated for the failures or delayed deliveries.

- **Supplier** Suppliers give inputs for making a project/product. As an organisation becomes successful, more and more projects are executed, and suppliers can make more business, profit and expansion. Suppliers can be external or internal to the organisation. External suppliers may include people supplying machines, hardware, software, etc. for money while internal suppliers may include other functions such as system administrator, training provider, etc. which are supporting projects/product development.

• **Employee** People working in a project/an organisation may be termed as employees. These people may be permanent/temporary workers but may not be contractual labours having no stake in product success. (Contractual workers may come under supplier category.) As the projects/organisations become successful, people working on these projects/in these organisations get more recognition, satisfaction, pride, etc. They feel proud to be part of a successful mission.

• **Management** People managing the organisation/project may be termed as management in general. Management may be divided further into project management, staff management, senior management, investors, etc. Management needs more profit, recognition, turnover improvements, etc to make their vision and mission successful. Successful projects give management many benefits like expanding customer base, getting recognition, more profit, more business, etc.

There are two more stakeholders in the success as well as failure of any project/product/organisation. Many times, we do not feel their existence at project level or even at organisation level. But they do exist at macro level.

• **Society** Society benefits as well as suffers due to successful projects/organisations. It is more of a perception of an individual looking towards the success of the organisation. Successful organisations/ projects generate more employment, and wealth for the people who are in the category of customer, supplier, employee, management, etc. It also affects the resource availability at local as well as global level like water, roads, power supply, etc. It also affects economics of a society to a larger extent. Major price rise has been seen in industry dominated areas as the paying capacity of people in these areas is higher than other areas where there is no such industry.

• **Government** Government may be further categorised as local government, state government, central government, etc. Government benefits as well as suffers due to successful projects/organisations. Government may get higher taxes, export benefits, foreign currency, etc. from successful projects/organisations. People living in those areas may get employment and overall wealth of the nation improves. At the same time, there may be pressure on resources like water, power, etc. There may be some problems in terms of money availability and flow as success leads to more buying power and inflation.

Quality perspective of all these stakeholders defines their expectations from organisation/projects. We may feel that superficially these views may differ from each other though finally they may be leading to the same outcome. If these views match perfectly and there is no gap in the stakeholder's expectations, then organisational performance and effectiveness can be improved significantly as collective efforts from all stakeholders. If the views differ significantly, this may lead to discord and hamper improvement.

Let us discuss two important views of quality which mainly defines the expectations from a project and success of a project at unit level viz. customer's view and developer's view of quality.

1.6.1 CUSTOMER'S VIEW OF QUALITY

Customer's view of quality of product interprets customer requirements and expectation for getting a better product at defined schedule, cost and with adequate service along with required features and functionalities. Customer is paying some cost to get a product because he finds value in such acquisition.

Delivering Right Product The products received by customers must be useful to satisfy their needs and expectations. It may or may not be the correct product from manufacturer's perspective or what business analyst/system designer may think. There is a possibility that development team including testers

may ask several queries about the requirements of the product to get them clarified but the final decision about the requirements definition shall be with customer. If customer confirms that the requirements are correct/not correct, then there is no possibility of further argument about the validity/invalidity of requirements.

Satisfying Customer's Needs The product may or may not be the best product, as per the manufacturer's views or those which are available in the market, which can be made from the given set of requirements and constraints. There are possibilities of different alternatives for overcoming the constraints and implementing the requirements. Basic constraint in product development and testing is that product must be capable of satisfying customer needs. Needs are 'must' among requirements from customer's perspective. They may be part of processes for doing requirement analysis and selection of approach for designing on the basis of decision analysis and resolution, using some techniques such as cost-benefit analysis, etc. which suites best in the given situation. This must help organisation to achieve customer satisfaction through product development and delivery.

Meeting Customer Expectations Customer expectations may be categorised into two parts viz. expressed expectations and implied expectations. Expectations documented and given formally by the customer are termed as 'expressed requirements' while 'implied expectations' are those, which may not form a part of requirement specifications formally but something which is expected by customer by default. It is a responsibility of a developing organisation to convert, as many as possible, implied requirements into expressed requirements by asking queries or eliciting requirements. One must target for 100% conversion of implied requirements into expressed requirements, though difficult, as developer may refuse to accept the defect belonging to implied requirements simply because it is not a part of requirement statement and they may not be aware of such things.

Treating Every Customer with Integrity, Courtesy, and Respect Customer and the requirements assessed (both expressed as well as implied) are very important for a developing organisation as customer will be paying on the basis of value he finds in the product. Definition of the requirements is a first step to satisfy the customer through '**Conformance to Requirements**'. Requirements may be documented by anybody, generally development team, but customer is the owner of the requirements. Organisation shall believe and understand that the customer understands what is required by him. How to achieve these requirements is a responsibility of a developing organisation. He may be given suggestions, sharing some past experiences and knowledge gained in similar projects but manufacturer shall not define requirements or thrust or push the requirements to customer. It is quite often quoted that the customer does not know or understand his requirements. This opinion cannot be bought by anybody.

Customer telephone calls and mails must be answered with courtesy and in reasonable time. The information provided to the customer must be accurate and he/she must be able to depend on this information. The customer is not a hindrance to the project development but he is the purpose of the business and producer must understand this.

1.6.2 SUPPLIER'S VIEW OF QUALITY

Supplier is a development organisation in the context of software application development. Supplier has some expectations or needs, which must be satisfied by producing a product and selling it to customer. Supplier expectations may range from profitability, name in market, repeat orders, customer satisfaction, etc. These expectations may be fulfilled in the following ways,

Doing the Right Things Supplier is intended to do right things for the first time so that there is no waste, scrap, rework, etc. Wastes like rework, scrap, and repairs are produced by hidden factory for which there is no customer. Changes in requirements are considered as problems during product development, if supplier is expected to absorb the costs associated with it. Changes in requirement cause rework of design, development, testing etc. This adds to the cost of development but if the price remains same, it is a loss for manufacturer. It also adds to fatigue and frustration of the people involved in development as they find no value in reworking, sorting, scrapping, etc. Following right processes to get the product required by the customer and achieving customer satisfaction and profits as well as job satisfaction may be the expectations of a supplier. Suppliers may require clear and correct definition of deliverables, time schedules, attributes of product, etc.

Doing It the Right Way A producer may have his own methods, standards and processes to achieve the desired outputs. Sometimes, customer may impose the processes defined by him for building the product on the producer. Ability of development process to produce the product as required by the customer defines the capability of development process. These process definitions may be an outcome of quality standards or models or business models adopted by the supplier or customer. As organisation matures, the processes towards excellence—by refining and redefining processes and process capability—must improve continually/continuously. As the processes reach optimisation, they must result into better quality products and more satisfaction for the customer and also fulfill vendor requirements.

Doing It Right the First Time Doing right things at the first time may avoid frustration, scrap, rework, etc. and improve profitability, reduce cost and improve customer satisfaction for the supplier. Doing right things at the first time improves performance, productivity and efficiency of a manufacturing process. This directly helps in improving profitability and gives advantage in a competitive market. Supplier would always like to follow the capable processes which can get the product right at the first attempt.

Doing It on Time All resources for developing a new product are scarce and time factor has a cost associated with it. The value of money changes as time changes. Thus, money received late is as good as less money received. If the customer is expected to pay on each milestone, then the producer has to deliver milestones on time to realise money on time. Delay in delivery represents a problem with processes, starting from getting requirements, estimation of efforts and schedule and goes upto delivery and deployment.

Difference between the two views discussed above (Customer's view vs Supplier's view) creates problem for manufacturer as well as customer when it comes to requirement gathering, acceptance testing, etc. It may result into mismatch of expectation and service level, which would be responsible for introducing defects in the product in terms of functionalities, features, cost, delivery schedule, etc. Sometimes these views are considered as two opposite sides of a coin or two poles of the Earth which can never match. The difference between two views is treated as a gap.

In many cases, the customer wants to dictate the terms as he is going to pay for the product and the processes used for making it, while the supplier wants customer to accept whatever is produced. Wherever the gap is less, the ability of a product to satisfy customer needs is considered better. At the same time, it helps a development organisation as well as a customer to get their parts of benefits from steady processes. On the contrary, larger gap causes more problems in development, distorted relations between two parties and may result into loss for both. Quality processes must reduce the gap between two views effectively. Effectiveness of a quality process may be defined as the ability of the processes and the product to satisfy both or all stakeholders in achieving their expectations.

Figure 1.1 explains a gap between actual product, requirements for the product and customer expectations from the product. It gives two types of gaps, viz. user's gap and producer's gap.

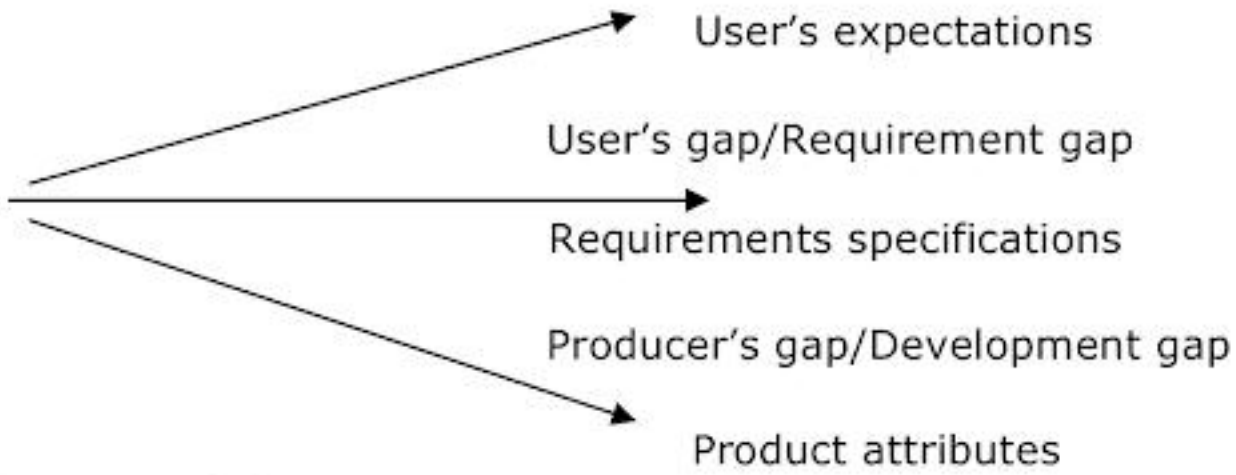

Fig. 1.1 User's gap and Producer's gap

1.6.3 USER'S GAP/REQUIREMENT GAP

User's gap is a gap between requirement specifications for the product and user expectations from it. This gap focuses on the difference in the final product attributes as defined by requirement statements with respect to the intents of the user. Developers must convert user needs into the product requirement specifications and create the product exactly as per these specifications. This may need understanding and interpretation of customer's business flow and requirements, and how the product is intended to be used by the customer to satisfy his business requirements.

Closing User's Gap User's gap represents the failure seen by the customer in terms of difference between user needs and product specifications. An organisation must apply some processes and methods so that user's gap can be closed effectively or reduced to as little as possible. Methods for closing these gaps may depend on organisation's way of thinking, resource availability, type of customer, customer's thought process, etc. Some of these methods are mentioned below.

Customer Survey Customer surveys are essential when an organisation is producing a product for a larger market where a mismatch between the product and expectation can be a major problem to producer. It may also be essential for projects undertaken for a single customer such as mission critical projects where failure of the project has substantial impact on the customer as well as producer. For a larger market, survey may be conducted by marketing function or business analyst to understand user requirements and collate them into specification documents for the product. Survey teams decide present and future requirements for the product and the features required by the potential customers.

For a single customer, a survey is conducted by business analyst and system analyst to analyse the intended use of the product under development and the possible environment of usage. Domain experts from the development side may visit the customer organisation to understand the specific requirements and workflow related to domain to incorporate it into the product to be developed.

Joint Application Development (JAD) Applications are developed jointly by customer and manufacturer where there is close co-ordination between two teams. In joint application development, users or customers may be overseeing the system development and closely monitor requirements specifications, architecture, designs, coding, testing and test results. The applications produced by this method may follow top-down approach where user interfaces and framework are developed first and approved by the users and then logic is build behind it. Some people may call joint application development as an agile methodology of development where developers collaborate with customer during development.

User Involvement in Application Development This approach works on the similar lines of joint application development (JAD). User may be involved in approving requirement specifications, design specification, application user interfaces, etc. He/she may have to answer the queries asked by developers and provide clarifications, if any. An organisation may develop a prototype, model, etc. to understand user requirements and get approval from the user team. If the organisation is producing products for a larger market, few representative users may be considered for collecting requirement specifications, test case designing and acceptance testing of the application under development.

1.6.4 PRODUCER'S GAP/DEVELOPMENT GAP

Producer's gap is a gap between product actually delivered and the requirement and design specifications developed for the product. The requirement specifications written by business analyst may not be understood in the same way by the development team. There are communication losses at each stage and business analyst and developers/testers may not be located next to each other to provide explanation for each and every requirement. More stages of communication may lead to more gaps and more distortion of requirements. The product so produced and requirement specifications used may differ significantly creating producer's gap.

Closing Producer's Gap Producer's gap represents a failure on part of development team to convert requirements into product. Producer's gap can be seen as the defects found in in-house testing. Producer's gap is due to process failure at producer's place and there must be process improvement plans to close this gap.

Process Definition Development and testing processes must be sufficiently mature to handle the transfer of information from one person or one stage to another during software development life cycle. There must be continuous 'Do' and 'Check' processes to build better products and get feedback about the process performance. Such product development has life cycle testing activities associated with development.

Work Product Review As the stages of software development life cycle progresses, one may have to keep a close watch on artifacts produced during each stage to find if any inconsistency has been introduced with respect to earlier phase. Generation of requirement traceability matrix is an important factor in this approach.

1.7 FINANCIAL ASPECT OF QUALITY

Earlier, people were of the opinion that more price of a product represents better quality as it involves more inspection, testing, sorting, etc. and ensures that only good parts are supplied to the customer. Sales price was defined as,

Sales price = Cost of manufacturing + Cost of Quality + Profit

If we consider the monopoly way of life, this approach may be considered good since the price is decided by the manufacturer depending upon three factors described above. Unfortunately, monopoly does not exist in real world. If any product enjoys higher profitability, more number of producers would enter into competition. Number of sellers may exceed number of buyers. When the products produced match in all aspects, the cost would decide the quantity of sale. The competitor who reduces the price, may get more volume of sale if all other things remain constant. Reducing the sales price reduces percentage profit. For maintaining profit, the producer may try to reduce cost of production without compromising on the quality aspect.

Thus, in a competitive environment, the equation changes to

Profit = Sales price – [Cost of manufacturing + Cost of Quality]

1.7.1 COST OF MANUFACTURING

Cost of manufacturing is a cost required for developing the right product by right method at the first time. The money involved in resources like material, people, licenses, etc. forms a cost of manufacturing. The cost of manufacturing remains constant over the time span for the given project and given technology and it has a direct relationship with the efforts. It can be reduced through improvements in technology and productivity but it may need longer time frame. The cost involved in requirement analysis, designing, development and coding are the costs associated with manufacturing.

1.7.2 COST OF QUALITY

Cost of quality represents the part of cost of production incurred in improving or maintaining quality of a product. Some people keep cost of manufacturing and cost of quality as separate while others may include them under cost of production. Cost of manufacturing may be supported by cost of quality and there exists an interrelationship between the two costs.

Cost of quality includes all the efforts and cost incurred in prevention of defects, appraisal of product to find whether it is suitable to customer or not and fixing of defects or failures at various levels as and when they are reported and conducting any retesting, regression testing, etc.

Cost of Prevention An organisation may have defined processes, guidelines, standards of development, testing, etc. It may define a program of imparting training to all people involved in development and testing. This may represent a cost of prevention. Creation and use of formats, templates, etc. acquiring various process models and standards, etc. also represent a cost of prevention. This is an investment by an organisation and it is supposed to yield returns. This is also termed as '**Green money**'. Generally, it is believed that 1 part of cost of prevention can reduce 10 parts of cost of appraisal and 100 parts of cost of failure.

Cost of Appraisal An organisation may perform various levels of reviews and testing to appraise the quality of the product and the process followed for developing the product. The cost incurred in first time reviews and testing is called as the cost of appraisal. There is no return on investment but this helps in identifying the process capabilities and process related problems, if any. This is termed as '**Blue money**' as it can be recovered from the customer. Generally, it is believed that 1 part of cost of appraisal can reduce 10 parts of cost of failure.

Cost of Failure Cost of failure starts when there is any defect or violation detected at any stage of development including post delivery efforts spent on defect fixing. Any extent of rework, retesting, sorting, scrapping, regression testing, late payments, sales under concession, etc. represents cost of failure. There may be some indirect costs such as loss of goodwill, not getting customer references, not getting repeat orders, and customer dissatisfaction associated with the failure to produce the right product. The cost incurred due to some kind of failure is represented as cost of failure. This is termed as '**Red money**'. This cost affects the profitability of the project/organisation badly.

On the basis of quality focus, organisations may be placed in 2 categories viz. organisations which are less quality conscious (termed as 'q') and organisations which are more quality conscious (termed as 'Q'). The distribution of cost of quality for these two types may be represented as below. Please refer Fig. 1.2

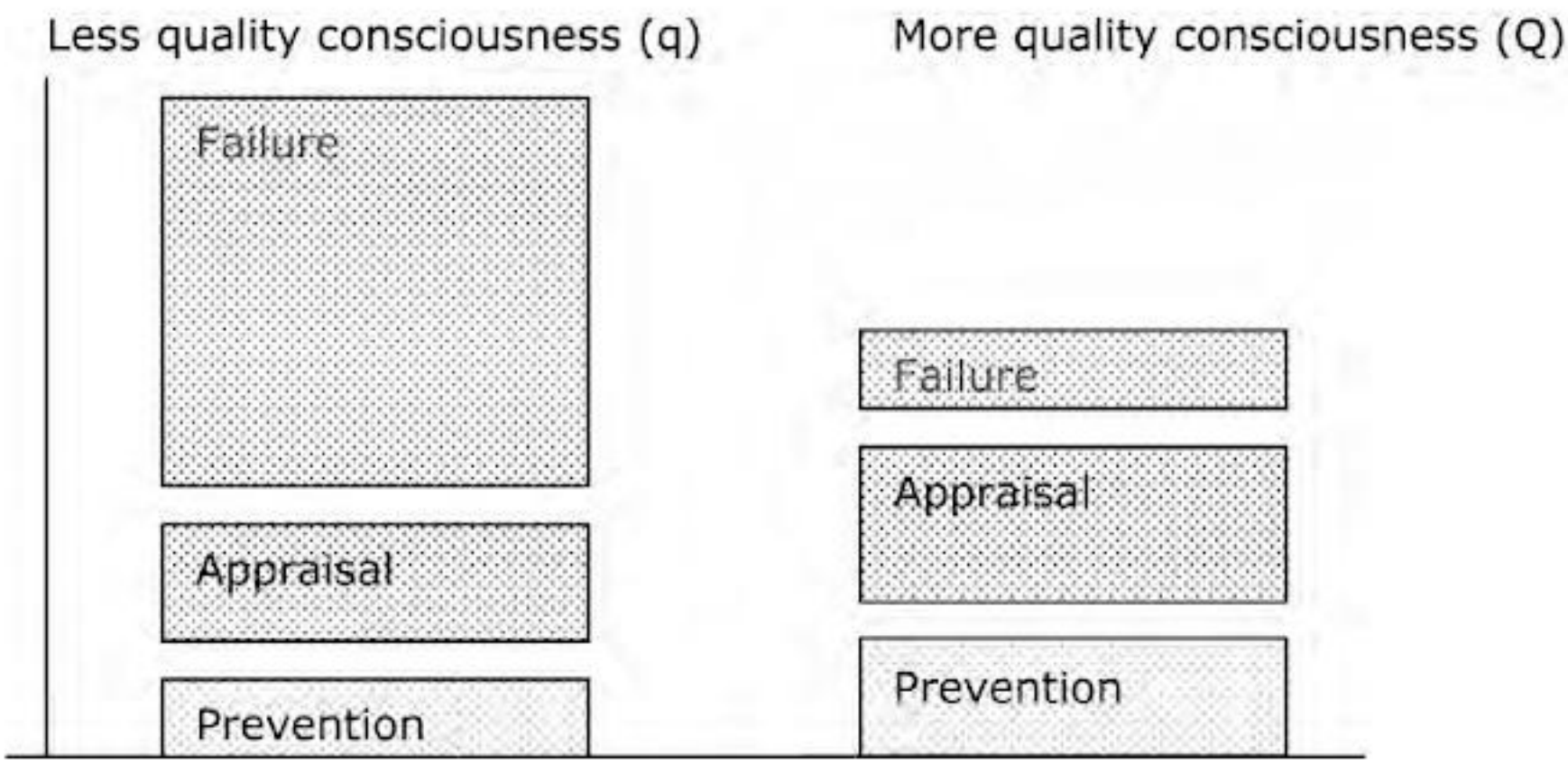

Fig. 1.2 Cost of Quality

The bottommost rectangle represents cost of prevention. As the organisation's quality consciousness increases, prevention cost increases substantially due to introduction of various process requirements. The organisation may have defined processes, methods, work instructions, standards, guidelines, templates, formats etc. Teams are supposed to use them while building a product or testing it, and conduct audits which need resources, time and money. Project teams may create project plan, test plan, assess the risks and issues faced during development, decide on the actions to reduce their probabilities/impacts, etc. More cost of prevention may be justifiable for a project/product only if it reduces the cost of failure.

Middle rectangle represents cost of appraisal. As quality consciousness increases, cost of appraisal also increases. An organisation may prepare various plans (such as quality plan and test plan) and then review these plans, write the test cases, define test data, execute test cases, analyse defects and initiate actions to prevent defect recurrence. There may be checklists, guidelines, etc. used for verification and validation activities. The cost incurred in appraisal must be justifiable and must reduce cost of failure.

The topmost rectangle represents cost of failure. Cost of failure includes the cost associated with any failure which may range from rework, retesting, etc. including customer dissatisfaction or loss of revenue, etc. As quality consciousness improves, failure cost must reduce representing better quality of products offered and higher customer satisfaction. Thus the overall cost of quality must reduce as quality consciousness of the organisation increases.

1.8 DEFINITION OF QUALITY

Let us try to redefine and understand the meaning of the term 'Quality' with a new perspective. Many definitions of the word 'Quality' are available and are used at different forums by different people. Most of these definitions show some aspect of quality. While no definition is completely wrong, no definition is completely right also. Few of the definitions prescribed for quality are,

- **Predictable Degree of Uniformity, Dependability at Low Cost and Suited to Market** This definition stresses on quality as an attribute of product which is predictable and uniform in

behavior throughout product usage and stresses on the ability of a product to give consistent results again and again. One must be able to predict the product behavior beforehand. It talks about reduction in variability of a product in terms of features, performance, etc. It also defines the dependability aspect of quality product. One must expect reliable results from quality products every time they are used. Quality product must be the cheapest one as it talks about reducing failure cost of quality like rework, scrap, sorting, etc. The most important thing about product quality is that it must help the product to suite the market needs or expectations. This necessitates that the manufacturer should produce those products which can be sold in the market.

- **Degree to Which a Set of Inherent Characteristics of the Product/Service Fulfills the Requirements** This definition of quality stresses the need that the product must conform to defined and documented requirement statement as well as expectations of users. Higher degree of fulfillments of these requirements makes a product better in terms of quality. There must be something in the product, defined as 'attributes of product', which ensures customer satisfaction. The attributes must be inborn in the product, indicating capable processes used for developing such a product.

- **Ability of a Product or Service That Bears Upon Its Ability to Satisfy Implied or Expressed Need** This definition of quality of product is derived from the approach of '**Fitness for use**'. It talks about a product achieving defined requirements as well as implied requirements, satisfying needs of customer for which it is being used. Better ability of a product to fulfill requirements makes a product better, from quality perspective.

1.9 CUSTOMERS, SUPPLIERS AND PROCESSES

For any organisation, there are some suppliers supplying the inputs required and some customers who will be buying the outputs produced. Suppliers and customers may be internal or external to the organisation. In the larger canvas, an entire organisation can be viewed as the component in a huge supply chain of the world where products are made by converting some inputs which may act as inputs to the next stage. External suppliers provide input to the organisation and external customers receive the output of the organisation. In turn, suppliers may be customers for some other organisations and customers may be acting as suppliers for somebody else down the line.

Internal Customer Internal customers are the functions and projects serviced and supported by some other functions/projects. System administration may have projects as their customer while purchasing may have system administration as their customer. During value chain, each function must understand its customers and suppliers. Each function must try to fulfill its customer requirements. This is one of the important considerations behind 'Total Quality Management' where each and every individual in supply chain must identify and support his customer. If internal customers are satisfied, this will automatically satisfy external customer as it sets the tone and perspective for everybody.

External Customer External customers are the external people to the organisation who will be paying for the services offered by the organisation. These are the people who will be actually buying products from the organisation. As the organisation concentrates on external customer for their satisfaction, it must improve quality of its output.

1.10 TOTAL QUALITY MANAGEMENT (TQM)

'**Total quality management**' principle intends to view internal and external customers as well as internal and external suppliers for each process, project and for entire organisation as a whole. The process and factions

of an organisation can be broken down into component elements, which act as suppliers/customers to each other during the workflow. Each supplier eventually also becomes a customer at some other moment and vice versa. If one can take care of his/her customer (whether internal or external) with an intention to satisfy him, it may result into customer satisfaction and continual improvement for the organisation.

Supply chain relationship may be defined graphically as, shown in Fig. 1.3.

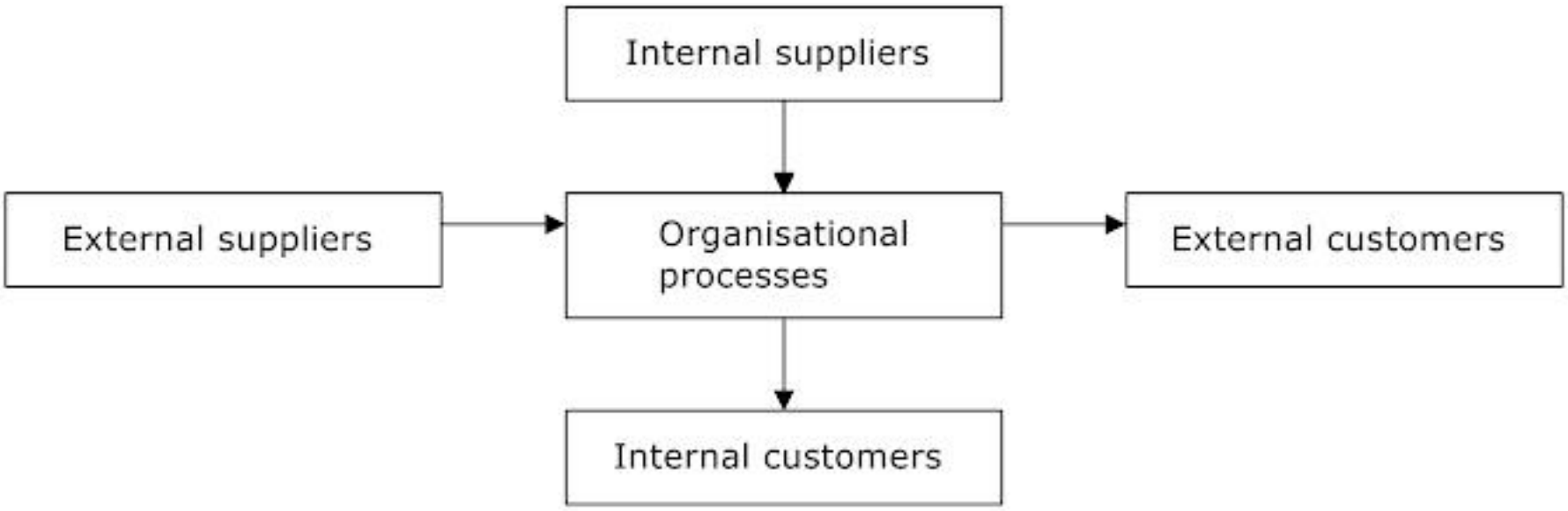

Fig. 1.3 Supply chain relationship between suppliers and customers

'Total quality management' (TQM) is the application of quality principles to all facets and business processes of an organisation. It talks about applying quality methods to the entire organisation whether a given function or part of the organisation faces external customer(s) or not. One clear definition of quality involves satisfying one's customer irrespective of whether he/she is outside or inside the organisation. This implementation of customer satisfaction has different meanings for different parts of an organisation.

Quality Management Approach Dr Edward Deming implemented quality management system driven by '**Total Quality Management**' and '**Continual Improvement**' in Japanese environment. It resulted into repetitive, cost effective processes with an intention to satisfy customer requirements and achieve customer satisfaction. Implementation was inclined toward assessment of quality management system which was adoptive to the utility of tools for understanding data produced by the process measurements. Dr Deming proposed principles for quality management that are widely used by the quality practitioners.

1.11 QUALITY PRINCIPLES OF 'TOTAL QUALITY MANAGEMENT'

'Total quality management' works on some basic principles of quality management definition and implementation. These have evolved over a span of experimentation and deployment of quality culture in organisations.

1.11.1 DEVELOP CONSTANCY OF PURPOSE OF DEFINITION AND DEPLOYMENT OF VARIOUS INITIATIVES

Management must create constancy of purpose for products and processes, allocating resources adequately to provide for long term as well as short term needs rather than concentrating on short term profitability: suppliers and organisation must have an intent to become competitive in the world, to stay in business and to provide jobs to people and welfare of the society. The processes followed during entire lifecycle of product

development from requirement capturing till final delivery must be consistent with each other and must be followed over a larger horizon. Decisions taken by management at different instances must be consistent and based upon same standards, rules and regulations. Different initiatives by management must have relationships with each other and must be able to satisfy the vision of the organisation.

1.11.2 ADAPTING TO NEW PHILOSOPHY OF MANAGING PEOPLE/ STAKEHOLDERS BY BUILDING CONFIDENCE AND RELATIONSHIPS

Management must adapt to the new philosophies of doing work and getting the work done from its people and suppliers. We are in a new economic era where skills make an individual indispensable. The process started in Japan and is perceived as a model throughout the world for improving quality of working as well as products. We can no longer live with commonly accepted levels of delays, mistakes, defective materials, rejections and poor workmanship. Transformation of management style to total quality management is necessary to take the business and industry on the path of continued improvements.

1.11.3 DECLARE FREEDOM FROM MASS INSPECTION OF INCOMING/ PRODUCED OUTPUT

It was a common belief earlier that for improving quality of a product, one needs to have rigorous inspection program followed by huge rework, sorting, scrapping, etc. It was believed that one must check everything to ensure that no defect goes to customer. But there is a need for change in thinking of management and people as mass inspection results into huge cost overrun and product produced is of inferior quality. There must be an approach for elimination of mass inspection followed by cost of failure as the way to achieve quality of products. Improving quality of products requires setting up the right processes of development and measurement of process capabilities and statistical evidence of built-in quality in all departments and functions.

1.11.4 STOP AWARDING OF LOWEST PRICE TAG CONTRACTS TO SUPPLIERS

Organisations must end the practice of comparing unit purchase price as a criterion of awarding contracts. Vendor selection must be done on the basis of total cost including price, rejections, etc. Organisations must perform measurements of quality of supply along with price and do the source selection on the basis of final cost paid by it in terms of procurement, rework, maintenance, operations, etc. It must reduce the number of suppliers by eliminating those suppliers that do not qualify with statistical evidences of quality of their supply. This will automatically reduce variation and improve consistency. Aim of vendor selection is to minimise total cost, not merely initial cost of purchasing, by minimising variations in the vendor supplied product. This may be achieved by moving towards lesser/single supplier, on a long term relationship of loyalty and trust. Organisations must install statistical process control in development even at vendor site and reduce the variation in place of inspecting each and every piece.

1.11.5 IMPROVE EVERY PROCESS USED FOR DEVELOPMENT AND TESTING OF PRODUCT

Improve every process of planning, production and service to the customer and other support processes constantly. Processes have interrelationships with each other and one process improvement affects other processes positively. Search continually for problems in these processes in terms of variations in order to

improve every activity in the organisation—to improve quality and productivity and decrease the cost of production as well as cost of quality continuously. Institutionalise innovations and improvements of products and processes used to make them. It is managements job to work continually for optimising processes.

1.11.6 INSTITUTIONALISE TRAINING ACROSS THE ORGANISATION FOR ALL PEOPLE

An organisation must institute modern methods of training which may include on-the-job training, classroom training, self study, etc. for all people, including management, to make better use of their abilities. New skills are required to keep up with the changes in materials, methods, product and service design, infrastructure, techniques and service. Skill levels of people can be enhanced to make them suitable for better performance by planning different training programs. Training—technical as well as nontechnical—should focus on improving present skills and acquiring new skills. Customer requirements may also change and people may need training to understand changes in customer expectations. Suppliers may be included in training programs to derive better output from them.

1.11.7 INSTITUTIONALISE LEADERSHIP THROUGHOUT ORGANISATION AT EACH LEVEL

An organisation must adopt and institute leadership at all levels' with the aim of helping people to do their jobs in a better way. Responsibility of managers and supervisors must be changed from controlling people to mentoring, guiding, and supporting them. Also, their focus should shift from number of work items to be produced to quality of output. Improvement in quality will automatically improve productivity by reducing scrap, inspection, rework, etc. Management must ensure that immediate actions are taken on reports of inherited defects, maintenance requirements, poor tools, fuzzy operational definitions and all conditions detrimental to quality of products and services offered to final users.

1.11.8 DRIVE OUT FEAR OF FAILURE FROM EMPLOYEES

An organisation must encourage effective two-way communication and other means to drive out fear of failure from the minds of all employees. Employees can work effectively and more productively to achieve better quality output when there is no fear of failure. People may not try new things if they are punished for failure. Management should not stop or discount feedback coming to them even if it is negative. Giving positive as well as negative feedback should be encouraged, and it must be used to perform SWOT analysis followed by actions. Fear is something which creates stress in minds of people, prohibiting them from working on new ways of doing things. Fear can cause disruption in decision-taking process which may result into excessive defense and also, major defects in the product. People may not be able to perform under stress.

1.11.9 BREAK DOWN BARRIERS BETWEEN FUNCTIONS/DEPARTMENTS

Physical as well as psychological breaking down of barriers between departments and staff areas may create a force of cohesion. People start performing as a team and there is synergy of group activities. People in different areas must work as a team to tackle problems that may be encountered with products and customer satisfaction. Ultimate aim of the organisation must be to satisfy customers. All people working together and helping each other to solve the problems faced by customers can help in achieving this ultimate aim.

1.11.10 ELIMINATE EXHORTATIONS BY NUMBERS, GOALS, TARGETS

Eliminate use of slogans, posters and exhortations of the work force, demanding 'Zero Defects' and new levels of productivity, without providing methods and guidance about how to achieve it. Such exhortations create adverse relationships between supervisors and workers. Main cause of low quality and productivity is in the processes used for production as the numbers to be achieved may be beyond the capability of the processes followed by the workers. This may induce undue frustration and stress and may lead to failures. The Organisation shall have methods to demonstrate that the targets can be achieved with smart work.

1.11.11 ELIMINATE ARBITRARY NUMERICAL TARGETS WHICH ARE NOT SUPPORTED BY PROCESSES

Eliminate work standards that prescribe quotas for the work force and numerical goals for managers to be achieved. Substitute the quotas with mentoring and support to people, and helpful leadership in order to achieve continual improvement in quality and productivity of the processes. Numerical goals should not become the definition of achievement/targets. There must be a methodology to define what achievement is and what must be considered as a stretched target.

1.11.12 PERMIT PRIDE OF WORKMANSHIP FOR EMPLOYEES

Remove the barriers that take away the pride of workmanship for workers and management. People must feel proud of the work they are doing, and know how they are contributing to organisational vision. This implies complete abolition of the annual appraisal of performance and of 'management by objective'. Responsibility of managers and supervisors must be changed from sheer numbers to quality of output. Management must understand 'managing by facts'.

1.11.13 ENCOURAGE EDUCATION OF NEW SKILLS AND TECHNIQUES

Institute a rigorous program of education and training for people working in different areas and encourage self-improvement programs for everyone. What an organisation needs is not just good people; it needs people who can improve themselves with education to accept new challenges. Advances in competitive position will have their roots in knowledge gained by people during such trainings.

1.11.14 TOP MANAGEMENT COMMITMENT AND ACTION TO IMPROVE CONTINUALLY

Clearly define top management's commitment to ever-improving quality and productivity and their obligation to implement quality principles throughout the organisation. It is not sufficient that the top management commits for quality and productivity but employees must also see and perceive their commitment. They must know what it is that they are committed to—i.e., what they must do in order to show their commitment.

1.12 QUALITY MANAGEMENT THROUGH STATISTICAL PROCESS CONTROL

Dr Joseph Juran is a pioneer of statistical quality control with a definition of improvement cycle through Define, Measure, Monitor, Control and Improve (DMMCI). One must understand the interrelationships among

customers, suppliers and processes used in development, testing, etc. and establish quality management based on metrics program. There are three parts of the approach, namely,

1.12.1 QUALITY PLANNING AT ALL LEVELS

Quality is not an accident but is a result of deliberate effort to achieve something which is defined in advance. An organisation must have a definition of what they wish to achieve. Quality improvement must be planned at all levels of organisation and then only it can be achieved. Quality planning happens at two levels viz. organisation level and individual department function project level.

- *Quality Planning at Organisation Level* Quality must be planned at organisation level first. It must be in the form of policy definition and strategic quality plans on the basis of vision, mission(s) and policies set by senior management. Planning process must attempt to discover who the customers are at present and who will be the customers in future, and what are and will be their needs and expectations from the organisation. The needs of the present or future customers must be expressed in numeric terms so that the actions can be planned and progress can be measured. The presence or absence of different attributes to the extent required shall define the quality level of the product or services.

- *Quality Planning at Unit Level* Quality planning at unit level must be done by the people responsible for managing the unit. Operational quality plans must be in sink with organisational policies and strategies. Project plan and quality plan at unit level must be consistent with the strategic quality plans at organisation level and must be derived from the organisation's vision and mission(s).

1.12.2 QUALITY CONTROL

Quality control process attempts to examine the present product at various levels with the defined standards so that an organisation may appraise the outcome of the processes. Removing defects in the processes to improve their capability can help to reach new levels of improved quality. (e.g., process improvement must be targeted towards lowering defects, reducing cost, and improving customer satisfaction.) It must measure the deviations with respect to the number of achievements planned in quality planning so that the organisation can initiate the actions to reduce the deviations to minimum level.

1.12.3 QUALITY IMPROVEMENT

Improvement process attempts to continuously improve the quality of the process used for producing products. Quality of the process is measured on the basis of the attributes of the products produced. There is no end to quality improvements and it needs to take newer challenges again and again. Finding deviations in the attributes of products and processes with respect to planned levels and permissible tolerances available shall guide the organisation to find the weak areas where actions may be prioritised.

1.13 QUALITY MANAGEMENT THROUGH CULTURAL CHANGES

Philip Crosby's approach to quality improvement is based on cultural change in an organisation towards total quality management. Quality management through cultural change defines quality improvements as a cultural change driven by management. It involves,

- Identifying areas in which quality can be improved depending upon process capability measurements and organisational priorities. An organisation must setup crossfunctional working groups (quality circles or

quality improvement teams) and try to improve awareness about the customer needs, quality and process measurements. The organisation may not be able to improve in all areas at a time and prioritisation may be essential depending upon some techniques such as Pareto analysis, Cost benefit analysis, etc. It must prioritise the improvements depending upon the resources available and efforts/investments required and the benefits derived from such improvements.

- Instituting teams representing different functions and areas for quality improvement can help in setting the change of culture. Improving quality of the processes of development, testing, managing, etc. is a team work led by management directives. A single person may not be able to institutionalise improvements across the organisation. Improvements in processes automatically improve the product and customer satisfaction.
- Setting measurable goals in each area of an organisation can help in improving processes at all levels. Goals may act as stretched targets with respect to what is currently achieved by the organisation. Goals may be set with reference to customer expectations or something which may give competitive advantage to the organisation in the market.
- Giving recognition to achievers of quality goals will boost their morale and set a positive competition among the teams leading to organisational improvements. This can lead to dramatic improvements in all areas. Management must demonstrate commitment to quality improvement, and recognition of achievements is a step in this direction.
- Repeating quality improvement cycle continuously by stretching goals further for next phase of improvements is required to maintain and improve the status further. The organisation must evaluate the goals to be achieved in short term, long term, and the combination of both to realise organisational vision.

1.14 CONTINUAL (CONTINUOUS) IMPROVEMENT CYCLE

Plan, Do, Check, and Act (PDCA) Cycle Continual (Continuous) improvement cycle is based on systematic sequence of Plan–Do–Check–Act activities representing a never ending cycle of improvements. PDCA cycle was initially implemented in agriculture. It was implemented later in the electronic industry. TQM has made the PDCA cycle famous in all industries. PDCA improvement cycle can be thought of as a wheel of improvement continually (continuously) rolling up the problem-solving hill and achieving better and better results for the organisation in each iteration. Stages of continual (Continuous) improvement through PDCA cycle are,

Plan An organisation must plan for improvements on the basis of its vision and mission definition. Planning includes answering all questions like who, when, where, why, what, how, etc. about various activities and setting expectations. Expected results must be defined in quantitative terms and actions must be planned to achieve answers to these questions. Quality planning at unit level must be in sync with quality planning at organisation level. Baseline studies are important for planning. Baseline studies define where one is standing and vision defines where one wishes to reach.

Do An organisation must work in the direction set by the plan devised in earlier phase for improvements. Plan is not everything but a roadmap. It sets the direction but execution is also important. Actual execution of a plan can determine whether the results as expected are achieved or not. Plan sets the tone while execution makes the plan work. 'Do' process need inputs like resources, hardware, software, training, etc. for execution of a plan.

Check An organisation must compare actual outcome of 'Do' stage with reference or expected results which are planned outcomes. It must be done periodically to assess whether the progress is in proper direction or not, and whether the plan is right or not. Expected and actual results must be in numerical terms, and compared at some periodicity as defined in the plan.

Act If any deviations (positive or negative) are observed in actual outcome with respect to planned results, the organisation may need to decide actions to correct the situation. The actions may include changing the plan, approach or expected outcome as the case may be. One may have to initiate corrective and/or preventive actions as per the outcome of 'Check'. When expected results and actuals match with given degree of variation, one may understand that the plan is going in the right direction. Running faster or slower than the plan will need action. Figure 1.4 shows diagramatically PDCA cycle of continual improvement.

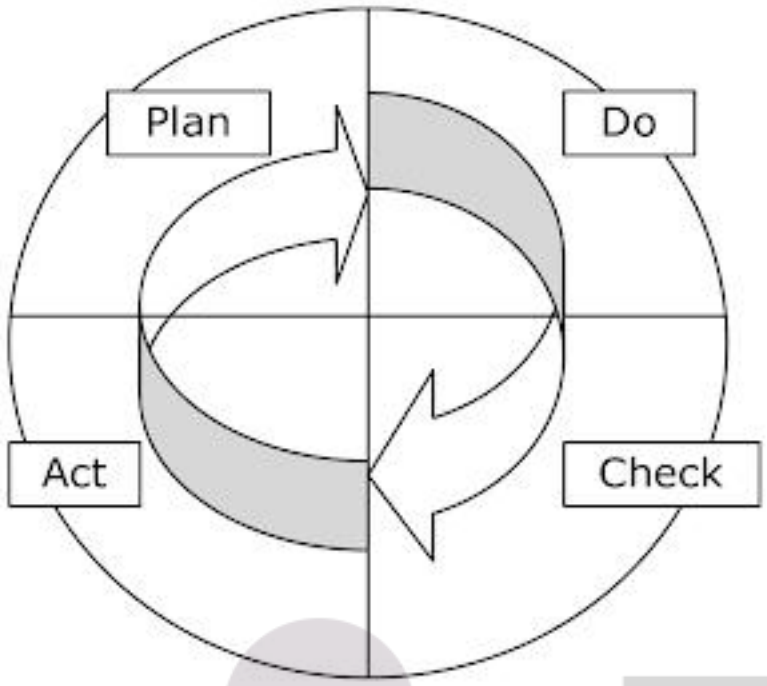

Fig. 1.4 Continual improvement cycle (PDCA cycle)

1.15 QUALITY IN DIFFERENT AREAS

Let us try to understand quality attributes of various products in different areas. Different domains need different quality factors. They may be derived from the customers/users of the domains. Here are few examples of some domains showing customer expectations in terms of quality for various products. These are generic expectations of customers in certain areas and may differ for some individual examples depending upon specific requirements. Definition of quality expectations will vary from instance to instance depending on the domain under consideration, type of product, type of customer, other competitive products, and their features. The table below lists different areas representing different domains and indicates some factors that might be considered related to quality in these areas. Table 1.2 shows some common expectations from customers.

Table 1.2 Products and expected attributes

Product/Service category	Expected attributes
Airlines Industry	On time arrival and departure, comfortable journey, low cost service, reliability and safety.
Health Care Industry	Correct diagnosis and treatment, minimum wait time, lower cost, safety and security.
Food Service Industry	Good product, good taste, fast delivery, good ambience, clean environment.
Consumer Products Industry	Properly made to suite individuals, defect free products, cost effective.
Military Services	Rapid deployment, decreased wages and cost, security.
Automotive Industry	Defect free product, less fuel consumption, more power, safe journey.
Communications Industry	Clear communications, faster access, cheaper service.

There are some common denominators in all these examples which may be considered as the quality factors. Although the terms used to explain each product in different domain areas vary to some extent, almost all areas can be explained in terms of few basic quality parameters. These are defined as the basic quality parameters by stalwarts of quality management.

- Cost of the product and value which the customer finds in it
- Service offered to the customers, in terms of support by the manufacturer
- Time required for the delivery of product
- Customer satisfaction derived from the attributes and functionalities of a product
- Number of defects in the product or frequency of failures faced by users

1.16 BENCHMARKING AND METRICS

Benchmarking is an important concept used in Quality Function Deployment (QFD). It is the concept of creating qualitative/quantitative metrics or measurable variables, which can be used to assess product quality on several scales against a benchmark. Typical variables of benchmarking may include price of a product paid by customer, time required to acquire it, customer satisfaction, defects or failures, attributes and features of product, etc. **Metrics** are defined for collecting information about the product capabilities, process variability and outcome of the process in terms of attributes of products. Metric is a relative measurement of some parameters of a product which are related to the product and processes used to make it. An organisation must develop consistent set of metrics derived from it's strategic business plan and performance of benchmark partner.

1.17 PROBLEM SOLVING TECHNIQUES

Improving quality of products and services offered to customers requires methods and techniques of solving problems associated with development and processes used during their lifecycle. An organisation must use metrics approach of process improvement because it needs to make quantitative measurements. These measurements can be used for problem solving using quantitative techniques.

Problem solving can be accomplished by both qualitative and quantitative methods but problem definition becomes easier when we put them against some measures or comparators.

- Qualitative problem solving refers to understanding a problem solution using only qualitative indexes such as high, medium, low, etc. depending on whether something is improving or deteriorating from the present status and so forth. This is a typical scenario for low maturity organisations where the problems are much broader and can be classified in different bands very easily. For initial stages of improvement, qualitative problem solving is sufficient to get faster results. It saves time in defining and measuring data accurately and basic maturity can be achieved.
- Quantitative problem solving requires specification of exact measures in numerical terms such as 'the cost has increased 32.5% during the last quarter' or 'the time required to produce one product unit is reduced by 32 minutes'. For highly matured organisations, quantitative analysis is required for further improvements as basic improvements are already done. It must follow the cycle of Define, Measure, Monitor, Control and Improve. Measurement of processes and products may need good measuring instruments with high level of accuracy and repeatability.

Given quantitative data, one can use statistical techniques to characterise a process. Quantitative methodologies make it possible to analyse and visualise what is actually happening in a process. Process variations can be understood in a better way and actions can be initiated to reduce the variability.

1.18 PROBLEM SOLVING SOFTWARE TOOLS

While buying software for data management and statistical analysis, many organisations find it to be a big investment in terms of money, resources, etc. One must answer the question 'Why should one use software tools to solve problems about quality?' There are some advantages and disadvantages associated with usage of such tools for problem solving.

Advantages of Using Software Tools for Analysis and Decision Making

- Accuracy and speed of the tools is much higher compared to performing all transactions and calculations manually. Calculations can form the basis for making decisions and hence should be as accurate as possible.
- Decision support offered by the tool is independent of personal skills and there is least variation from instance to instance. Tools can support in some fixed range depending upon its logic. Some tools can learn things and use them as required.
- Tools can implement theoretical means of assessing metrics about quality as defined by business law. There is no manual variation.
- Tools alleviate the hard work required to perform hand or calculator driven computations and give more accurate and faster results.
- Tools can be integrated with other systems to provide a systematic and highly integrated means of solving problems

Disadvantages of Using Computer Tools for Analysis and Decision Making

- These programs and tools need training before they can be used. Training incurs cost as well as time. Some tools need specific trainings to understand them and use them.
- All softwares/hardwares are prone for defects and these tools are not exceptions to it. There can be some mistakes while building/using them. Sometimes these mistakes can affect the decisions drastically.
- Decision has to be taken by human being and not by the tool. Tools may define some options which may be used as guide. Some tools can take decision in the limited range.
- Tools may mean more cost and time to learn and implement. Every tool has a learning curve.

1.18.1 TOOLS

Tools are an organisations analytical asset that assist in understanding a problem through data and try to indicate possible solutions. Quality tools are more specific tools which can be applied to solving problems faced by projects and functional teams while improving quality in organisations. Tools may be hardware/software and physical/logical tools. We will learn more about quality tools in Chapter 16 on 'Qualitative and Quantitative Analysis'.

1.18.2 TECHNIQUES

Techniques indicate more about a process used in measurement, analysis and decision making during problem solving. Techniques are independent of tools but they drive tool usage. Techniques do not need tools for application while tools need techniques for their use. Same tool can be used for different purposes, if the techniques are differed. Table 1.3 gives a difference between tools & techniques.

Table 1.3 Difference between tools and techniques

Tools	Techniques
Usage of tool is guided by the technique. Tool is of no use unless technique (to use it) is available.	Technique is independent of any tool.
Different techniques may use the same tool to achieve different results.	Same technique may use different tools to achieve the same result.
Tool improvement needs technological change.	Technique change can be effected through procedural change.
Contribution of tools in improvement is limited.	Contribution of techniques in improvement is important.

Quality tips

- Try to define quality perspective for the organisation and set of products and projects executed by it.
- Define customer expectations rather than going for system requirement specifications.
- Assess the cost spent by an organisation under various heads of quality. Testers have to play a significant role in reducing cost of quality and improving profitability of the organisation.
- Understand and improve every aspect of an organisation through approaches, techniques and tools to enhance customer satisfaction and goodwill for the organisation. This can help the organisation to prosper in the long term.

Summary

In this chapter, we have seen various definitions of quality as understood by different people and different stakeholders. It also covered the definitions by quality stalwarts and different international standards. Then, we studied the basic components to produce quality, and the views of customers and producer on quality. As a tester, one must understand different gaps like user gap, and producer gap, and how to close them to achieve customer satisfaction.

We have described various cost components like manufacturing cost and cost of quality. Cost of quality concepts with its three components viz. preventive cost of quality, appraisal cost of quality and failure cost of quality are described along with the importance of cost of prevention, and how it affects cost of quality and improves profitability.

We have seen different approaches to continually (continuously) improving quality. We have covered 'TQM principles of quality management', and 'DMMCI principles of continual improvement' through quality planning, quality control and quality improvement. We have also discussed a theory of 'Cultural change principles of quality management'.

Finally we have introduced the concept of problem solving through usage of tools and techniques. We have also briefly elucidated the concept of benchmarking.

1) Explain 'quality' in terms of the generic expectations from any product.
2) Differentiate between continuous improvement and continual improvement.
3) Define the stakeholders for successful projects at micro level and for successful organisations at macro level.
4) Define 'quality' as viewed by different stakeholders of software development and usage.
5) Explain customers view of quality.
6) Explain suppliers view of quality.
7) Define 'User's gap' and 'Producer's gap' and explain how these gaps can be closed effectively.
8) Describe various definitions of quality as per international standards.
9) Describe definition of quality as per Dr Deming, Dr Juran and Philip Crosby.
10) Describe 'Total Quality Management' principles of continual improvement.
11) Describe cultural change requirement for quality improvement.
12) Differentiate between tools and techniques.