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# STANDARDS & QUALITY PRACTICES

IN PRODUCTION, CONSTRUCTION,  
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F-126, (Lower Basement), Katwaria Sarai, New Delhi-110016

**Phone** : 011-26522064, **Mobile** : 8130909220, 9711853908

**E-mail** : info@iesmasterpublications.com, info@iesmaster.org

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# PREFACE

In today's time, minimum assured quality of products and services has become bare essential for private as well as government sectors. It is for this reason that students aspiring for Engineering Services Examination (ESE) should have a well-structured view of the standards and quality practices in production, construction, maintenance and services.

This book helps students build upon concepts from scratch to the advanced level. From evolution of concept of quality to various thinkers and approaches, to statistical tools and accepted sampling parameters as well as six sigma standards have been discussed thoroughly. It further delves into inventory management, and touches upon various aspects of manufacturing vis-à-vis quality, maintenance and reliability.

Being an engineer is about quality assurance in whatever products and services one designs and delivers, as per established standards. Therefore, it is given foremost importance by UPSC.

This revised and updated edition builds on all the important variables that have been cited in previous versions of Engineering Services Examination.

As one go through various topics, concepts, and illustrations, an augmented sketch of all important issues touching standards and quality is drawn. This makes sure that whatever spin is given to questions, one can deduce the correct answer.

IES Master thanks **Mr Ashish Kumar Jha** for his valuable contribution in writing, shaping, and editing of this book.

Any constructive ideas, suggestions, feedbacks for improving the content of future editions will be greatly appreciated.

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**New Delhi, 2018**

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# Basic Concepts of Quality

## 1.1 KEY CONCEPTS RELATED TO QUALITY

### INSIDE

- ❖ Key Concepts Related to Quality
- ❖ Types of Quality
- ❖ Cost of Quality
- ❖ Value of Quality
- ❖ Evolution of Concept of Quality
- ❖ Quality Policy
- ❖ Quality Objectives
- ❖ Quality Assurance and Quality Control
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- ❖ Quality Improvement
- ❖ Quality and Productivity

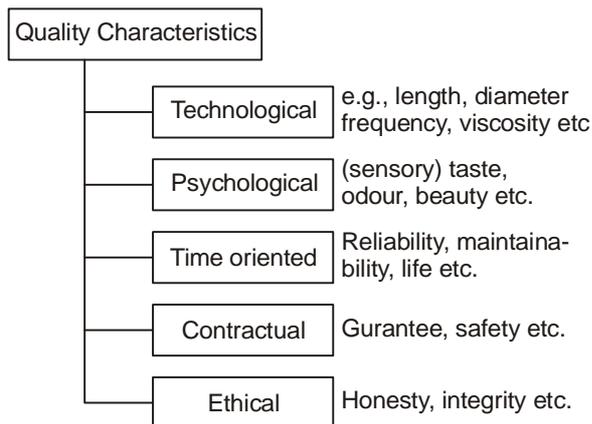
- ❖ Quality depends on the degree of fitness for use of the customer. Hence, a product will have good quality if it is suitable for the purpose for which it is meant.
- ❖ Quality of a product means the conformance to specification. The customer's needs have to be assessed and translated into specifications.
- ❖ The product or service must meet the customer's expectations or needs. The needs can be both stated as well as implied.
- ❖ The product or service should be cost effective or economical. Due to increased competition, the companies have to continuously improve their function and reduce wastages to reduce cost.
- ❖ Reliability is an important indicator of quality over a period of time. It means that the product must perform its intended function over a period of time without failing under given operating conditions.
- ❖ The product should be serviceable. It means that the after-sales service of the product should be quick, cheap and easily available.
- ❖ The product should be durable. Durability means the effective life of the product after which it can no longer be used even after repair.
- ❖ The product or service should have good perceived quality.
- ❖ The product must also have good aesthetics and it should be safe in handling.
- ❖ Quality is a relative term. It is not absolute. It varies with time, space and from person to person.
- ❖ Stiff competition at the national and international level and customer's awareness about the quality of goods and services have made it necessary that companies put increased emphasis in achieving the desired customer satisfaction by running its business at an economical level.
- ❖ Feigenbaum defines quality as : The total composite product and service characteristics of Engineering, Manufacturing, Marketing and Maintenance through which the product and service in use meet the expectation of the customers. Efforts should be made to incorporate the quality at the design stage and maintained in manufacturing which the customer would like to have and is willing to pay for it.

- ❖ The product must perform its intended function repeatedly as called upon, over its stipulated life cycle under normal conditions of use. It should be easy to operate or use.
- ❖ The survival of the company depends on the income it gets from selling its products and services, and the ability to sell is based on fitness for use. Hence, the company's functions concerned with quality or achieving fitness for use are known as quality functions. It includes variety of activities. Every one working in the factory or all departments are responsible for the broad quality function. With the aid of market survey, a company determines what qualities are needed by the customers.
- ❖ Research and development specialists create a product concept which can meet these quality needs of the users. Design engineers prepare product and material specifications considering the quality requirements. Process engineers specify the processes, machines and instruments capable of producing the products with the desired quality, and inspecting them. Purchasing specialists buy materials and components possessing appropriate qualities. Operators are trained to use the process and instruments to make the product as per the design. Inspectors examine the product to judge conformance with the design. Consumers use the product and the experience of use becomes the basis for a redesign, or improvement in the product, which starts the cycle all over again.
- ❖ Quality is a perceptual, conditional, and somewhat subjective attribute and may be understood differently by different people. Consumers may focus on the specification quality of a product/service, or how it compares to competitors in the marketplace. Producers might measure the conformance quality, or degree to which the product/service was produced correctly. Support personnel may measure quality in the degree that a product is reliable, maintainable, or sustainable.
- ❖ In the early 1900s, pioneers such as Frederick Taylor and Henry Ford recognized the limitations of the methods being used in mass production at the time and the subsequent varying quality of output, implementing quality control, inspection, and standardization procedures in their work. Later in the twentieth century, the likes of Deming and Juran helped take quality to new heights, initially in Japan and later (in the late '70s and early '80s) globally.
- ❖ Customers recognize that quality is an important attribute in products and services, and suppliers recognize that quality can be an important differentiator between their own offerings and those of competitors (the quality gap). In the past two decades this quality gap has been gradually decreasing between competitive products and services. This is partly due to the contracting (also called outsourcing) of manufacturing to countries like China and India, as well internationalization of trade and competition. These countries, among many others, have raised their own standards of quality in order to meet international standards and customer demands. The ISO 9000 series of standards are probably the best known international standards for quality management, though specialized standards such as ISO 15189 (for medical laboratories) and ISO 14001 (for environmental management) also exist.
- ❖ The introduction of the ISO standards sought to provide organizations with the requirements to create a quality management system (QMS) for a range of different business activities. Additionally, good manufacturing practice standards became more common place in countries around the world, laying out the minimum requirements manufacturers in industries including food and beverages, cosmetics, pharmaceutical products dietary supplements, and medical devices must meet to assure their products are consistently high in quality. Process improvement philosophies such as Six Sigma have further pushed quality to the forefront of business management and operations. At the heart of these and other efforts is often the QMS, a documented collection of processes, management models, business strategies, human capital, and information technology used to plan, develop, deploy, evaluate, and improve a set of models, methods, and tools across an organization for the purpose of improving quality that aligns with the organization's strategic goals.
- ❖ The push to integrate the concept of quality into the functions of the service industry takes a slightly different path from manufacturing. Where manufacturers focus on tangible and visible issues, many quality aspects of the service provider's output are intangible. Other obstacles include management's perceptions not aligning with customer's expectations due to lack of communication and market research and the improper skills of the service personnel. Like

manufacturing, customer expectations are key in the service industry, though the degree with which the service interacts with the customer definitely shapes perceived service quality. Perceptions such as being dependable, responsive, understanding, competent, and clean may drive service quality, somewhat in contrast to factors that drive measurement of manufacturing quality.

- ❖ A physical or chemical property, a dimension, a temperature, pressure, taste, smell or any other requirements used to define the nature of the product or service which contributes to fitness for use is a quality characteristic. Thus, a metal cylinder may be defined by stating the quality characteristics such as, the type of metal, the length, the diameter etc. The quality characteristic contributes to fitness for use for the product.

Quality characteristics can be classified as :



**Example 1**

**Statement (I) :** Quality is essential for survival and growth of an organisation in the present era of tough competition.

**Statement (II) :** The concept of quality is confined only to construction and manufacturing organisations.

[ESE–2018]

Ans: (c)

**1.2 TYPES OF QUALITY**

**(i) Quality of Design**

- ❖ The quality of design of a product is concerned with the tightness of the specifications for manufacture of the product. For example, a part which has a drawing tolerance of  $\pm 0.001$  mm

would be considered to have a better quality of design than another with a tolerance of  $\pm 01$  mm.

- ❖ A good quality of design must ensure consistent performance over its stipulated life span stated in terms of rated output, efficiency, overload capacity, continued or intermittent operation for specified application or service.
- ❖ It should consider possible modes of failure due to stress, wear, distortion, corrosion, shocks, vibrations, high or low temperature, altitude or pressure, environmental conditions etc.
- ❖ However, product design and development is a continuous process which results into evaluation of a product, based on assessed user needs, their feedback after use and development in technology at a given point of time, in a given environment.

**Various Factors Controlling Quality of Design are as under :**

- ❖ For customer goods, the important factor which governs the quality of design, is the type of customers in the market. The study of optimum quality of design involves market survey. It is the study of :
  - Consuming habits of people.
  - The prices they are willing to pay for various products and services.
  - The choice of design of the product which meets the needs of the customers. (User needs based on feedback and specific application.)
- ❖ For example, variety of vehicles with difference in size, capacity, performance and capabilities are found in the market to suit various applications e.g., for passenger transport, goods transport, ambulance for hospitals and vehicles for defence service etc.
- ❖ The quality of design, thus, depends upon the type of customers (rich, middle, poor etc.) to provide the intended function with the greatest overall economy.
- ❖ For capital goods, the decision is usually governed by such considerations as intended life, environmental condition, reliability, importance of continuity of service, maintainability etc.
- ❖ From company's point of view, profit is more important. It is not necessary that the company should manufacture 100 percent quality products. The market segment to which management desires to cater should be considered. Profit can be maximised by producing products in different grades to suit different types of customers.



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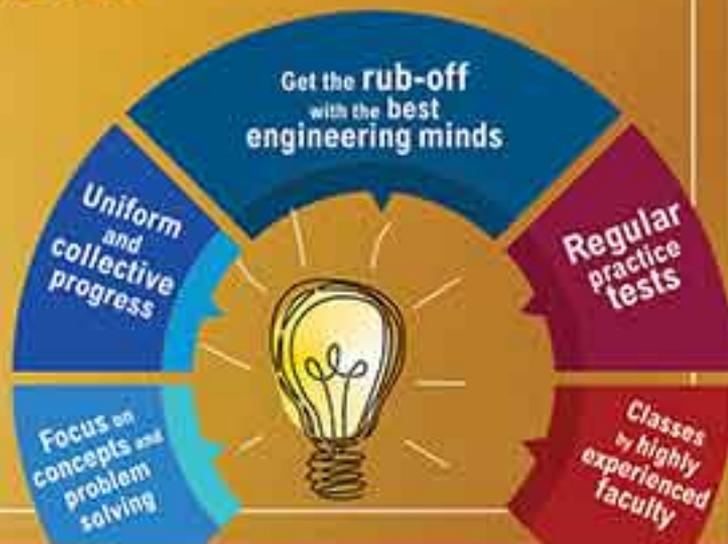
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## Questions

1. Which of the following statements correctly define Quality?
  - (i) Meeting both internal and external customer's expectations.
  - (ii) Degree of excellence at an acceptable price.
  - (iii) Fitness for use or purpose.
  - (iv) Meeting product specifications.

(a) Only (i), (ii) & (iii)    (b) Only (i) and (iii)  
 (c) Only (ii) and (iv)    (d) All of above
2. Consider the following statements:
  1. The terms such as delighting customers, robustness, reducing variability can be associated with quality.
  2. The driving force to determine the level of quality that should be designed into a product of service is the customer.
  3. Reliability does not have a time dimension.

Which of the above statements are correct?

(a) 1 and 2                      (b) 2 and 3  
 (c) 1 and 3                      (d) 1,2 and 3
3. Read the following statements and select the correct option.
  - (i) Quality of design enables achievement of required product features and characteristics.
  - (ii) Quality of conformance enables achievement of freedom from deficiencies.

(a) Only (ii) is true.  
 (b) Both (i) and ii) are false.  
 (c) Both (i) and (ii) are true.  
 (d) Only (i) is true.
4. Consider the following statements:
  1. Quality of design is influenced by many factors, such as product type, cost, profit policy, demand of the product, availability of parts and materials, and product reliability.
  2. Quality of conformance is basically meeting the standards defined in the design phase after the product is manufactured or while the service is delivered.
  3. Quality of Performance measures the degree to which the product or service satisfies the customer from the perspective of both quality of design and the quality of conformance.

Which of the above statements are correct?

- (a) 1 and 2                      (b) 2 and 3  
 (c) 1 and 3                      (d) 1,2 and 3

5. Consider the following statements:

1. Cost of quality is a methodology that allows an organization to determine the extent to which its resources are used for activities that prevent poor quality, that appraise the quality of the organization's products or services, and that result from internal and external failures.
2. Having such information allows an organization to determine the potential savings to be gained by implementing process improvements.

Which of the above statements are correct?

- (a) 1 only                      (b) 2 only  
 (c) both 1 and 2              (d) none

6. Match the following:

**List I**

- A. Prevention cost  
 B. Appraisal cost  
 C. Internal failure cost  
 D. External failure cost

**List II**

1. Arise from detecting defects through inspection.
2. Arise from defects that actually reach customers.
3. Arise from efforts to prevent defects from occurring at all.
4. Arise from defects caught internally and dealt with by discarding or repairing the defective items.

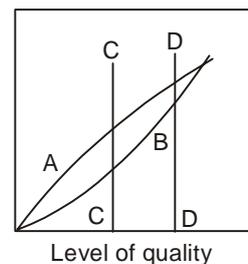
Which of the following is true?

- (a) A-3, B-1, C-4,D-2  
 (b) A-1, B-3, C-4,D-2  
 (c) A-3, B-1, C-2,D-4  
 (d) A-1, B-3, C-2,D-4

7. Which of the following costs are not included in the cost of prevention?

- (a) Quality planning
  - (b) Training and workforce development
  - (c) Product design verification
  - (d) Test and inspection of purchased materials
8. Which of the following statements is not correct regarding cost of quality?
- (a) Out of prevention cost, appraisal cost, internal failure cost and external failure cost, the most expensive cost of quality is the external failure cost.
  - (b) The most effective way of achieving the highest quality at the lowest cost is by developing robust and reliable processes that produce quality product on a consistent basis.
  - (c) Efforts should be made to reduce the internal failure costs to zero as internal failures produce scrap.
  - (d) It is not possible to reduce the activities of inspection even by developing robust processes.
9. **Assertion :** As the level of defect increases, the cost of prevention and appraisal increases.  
**Reason :** As the level of defect decreases, the cost of non-conformance decreases.
10. In reference to Total quality cost (TQC) which of the following statements are correct:
- (i) TQC consist of "Cost of conformance" and "Cost of non-conformance"
  - (ii) Cost of conformance implies expenses required for producing quality product.
  - (iii) Cost of non-conformance is loss because of defects in the product.
- (a) Only (i) and (ii) are correct.
  - (b) (i), (ii) and (iii) are correct.
  - (c) Only (i) is correct.
  - (d) Only (i) and (iii) is correct.
11. Which of the following costs will be included in cost of prevention?
- (i) Cost of quality planning.
  - (ii) Cost of training of workers to make quality products.
  - (iii) Cost of information collection and analysis about number and types of defects.
  - (iv) Cost of retest after rectification of a product

- (a) Only (i) (ii) and (iii)
  - (b) Only (i) (iii) (iv)
  - (c) Only (iii) and (iv)
  - (d) Only (ii) and (iv)
12. Any cost arising out of claim of customer regarding a defective product within its guarantee period should be included in
- (a) Appraisal Cost
  - (b) Cost of internal failure
  - (c) Cost of external failure
  - (d) Prevention cost
13. What should the company focus on to achieve quality more economically?
- (a) External Failure Cost
  - (b) Internal Failure Cost
  - (c) Prevention Cost
  - (d) Appraisal Cost
14. Which of the following quality costs are failure costs?
- (a) Customer Survey Cost
  - (b) Calibration Cost
  - (c) Product recall cost
  - (d) Pre-dispatch inspection cost
15. The graph shows the results of various quality levels for a component



Consider the following statements:

1. Curve A shows the variation of value of components
2. Curve B shows the variation of cost of the component
3. The preferred level of quality is given by line CC
4. The preferred level of quality is given by line DD

Which of these statements are correct?

- (a) 1, 2 and 3
- (b) 2, 3 and 4
- (c) 1, 3 and 4
- (d) 1, 2 and 4

## ANSWER KEY

1. (d)	6. (a)	11. (a)	16. (d)	21. (c)	26. (c)
2. (a)	7. (d)	12. (c)	17. (b)	22. (c)	27. (c)
3. (c)	8. (d)	13. (c)	18. (a)	23. (d)	28. (a)
4. (d)	9. (d)	14. (c)	19. (a)	24. (c)	
5. (c)	10. (b)	15. (a)	20. (c)	25. (b)	

## EXPLANATIONS

1. (d) All above statements are definitions of quality given by different quality gurus.
3. (c) Both statements are true as quality in design ensures that product features required by the customer are incorporated in product's design and expressed as product specifications. Quality of conformance ensures that there is no gap between actual product features and designed specifications.
10. (b) Cost of conformance is the price paid for prevention of poor quality (to avoid failure in product or services) and cost of non-conformance which is the of losses incurred due to failure of product or service because of poor quality. Thus, TQC will depend on how much an organisation is spending to prevent poor quality and how much cost it is incurring because of failures due to poor quality. Mathematically,
- $$\text{TQC} = \text{Cost of Conformance (COC)} + \text{Cost of non Conformance (CONC)}.$$
11. (a) (i) (ii) and (iii) are the components of Prevention Cost while (iv) i.e. Cost of retest of a product after its rectification shall be added to cost of internal failures.
12. (c) Cost of failures in a product within its warranty period after it has been sold to the customer is added to cost of external failure.

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