ESE 2024

UPSC ENGINEERING SERVICES EXAMINATION

Preliminary Examination

General Studies and Engineering Aptitude

Standards and Quality Practices in Production, Construction, Maintenance and Services

Comprehensive Theory *with* Practice Questions
and ESE Solved Questions

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ESE 2024 Preliminary Examination :
Standards and Quality Practices in Production, Construction, Maintenance and Services

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2nd Edition : 2017
3rd Edition: 2018
4th Edition: 2019
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Preface

B. Singh (Ex. IES)

The compilation of this book **Standards and Quality Practices in Production, Construction, Maintenance and Services** was motivated by the desire to provide a concise book which can benefit students to understand the concepts of this specific topic of General Studies and Engineering Aptitude section.

This textbook provides all the requirements of the students, i.e. comprehensive coverage of theory, fundamental concepts and objective type questions articulated in a lucid language. The concise presentation will help the readers grasp the theory of this subject with clarity and apply them with ease to solve objective questions quickly. This book not only covers the syllabus of ESE in a holistic manner but is also useful for many other competitive examinations. All the topics are given the emphasis they deserve so that mere reading of the book clarifies all the concepts.

We have put in our sincere efforts to present detailed theory and MCQs without compromising the accuracy of answers. For the interest of the readers, some notes, do you know and interesting facts are given in the comprehensive manner. At the end of each chapter, sets of practice question are given with their keys and detailed explanations, that will allow the readers to evaluate their understanding of the topics and sharpen their question solving skills.

Our team has made their best efforts to remove all possible errors of any kind. Nonetheless, we would highly appreciate and acknowledge if you find and share with us any printing and conceptual errors.

It is impossible to thank all the individuals who helped us, but we would like to sincerely thank all the authors, editors and reviewers for putting in their efforts to publish this book.

With Best Wishes

B. Singh

CMD, MADE EASY Group

Standards and Quality Practices in Production, Construction, Maintenance and Services

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1 Quality

1.1 What is Quality?

Quality is a relative term and it is generally used with reference to the 'end use of product'. In other words, quality can also be defined as

1. Perfection
2. Fast delivery of product
3. Eliminating waste in product
4. Consistency in performance
5. Total customer service and satisfaction

1.1.1 Definition of Quality

The word quality has diverse definitions, ranging from the conventional to those that are strategic. Conventional definitions of quality usually describe a quality item as one that wears well, is well constructed and will last for a long time. Simply quality refers to one or more desirable characteristics that increases the value of product. It is inversely proportional to the variability.

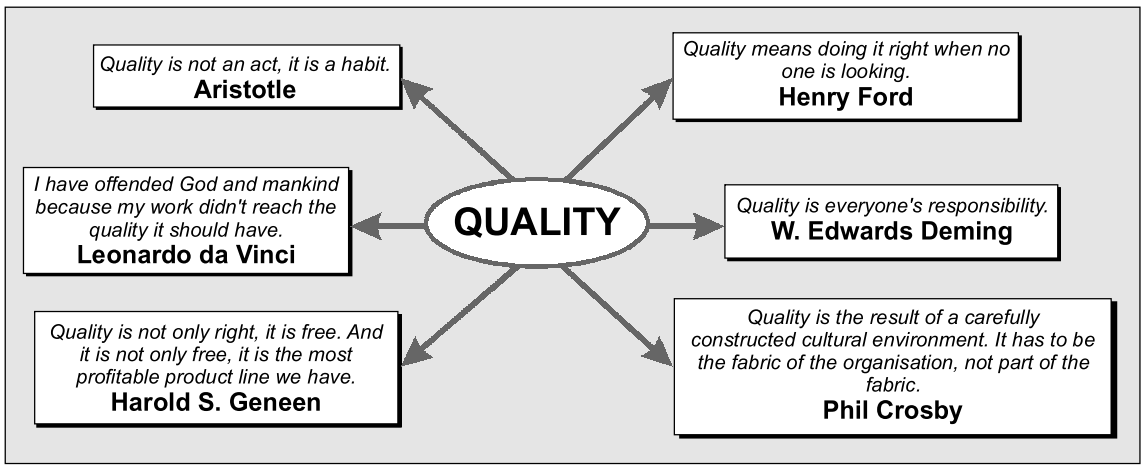


Fig. 1.1

1.1.2 Consequences of Poor Quality

Every manufacturing organisation is concerned with the quality of its product. While it is very important that quality requirements be satisfied and product schedules met, it is also equally important to consider the consequences of poor quality such as:

- Product fails
- Delay in supplying of products
- Market value decreases
- Poor quality of product increases production and market costs
- Damage or injuries resulting from faulty design
- Loss of business because of defective products

1.1.3 Evolution of Quality

Years	Events
1700 - 1900	Quality was largely determined by the "How free from defects a purchased product".
1915 - 1919	W W I - British government began a supplier certification program.
1919	Technical inspection association, this later becomes "Institute of Quality Assurance".
1924	Concept of control charts by W.A. Shehwart.
1928	Acceptance sampling techniques.
1931 - 1933	British textile industry began use of statistical techniques for product/process development.
1944	Industrial quality control.
1954	E.S. Page introduced CUSUM control chart.
1960	The concept of quality control circle or quality circle was introduced in Japan by Ishikawa.
1960	The zero defect program was introduced in U.S. industries.
1975 - 1978	The concept of TQM was developed in the U.S.
1989	Quality engineering comes into picture.
1989	Motorola's six sigma initiative began.

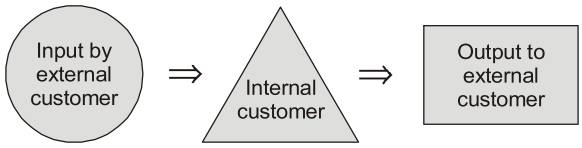
1.1.4 Who are the Customers?

Basically there are two types of customers such as:

- External customer
- Internal customer

External customer: An external customer may be the one who uses the end product or service, the one who purchases the end product or services or the one who influences the sale of product or services. An external customer exists outside the organisation.

Internal customer: Every function within organisation whether it is engineering, order processing or production has an internal customer. That means each functional team is the customer of other functional team.



Customer:

- "Anyone who is impacted by the product or service". There are several customers waiting down the line when a product is being processed through several stages in an organization before it reaches to the final customer. Thus we have people who are impacted within the organization and also people impacted outside the organization.

- Generally, there are two types of customers.

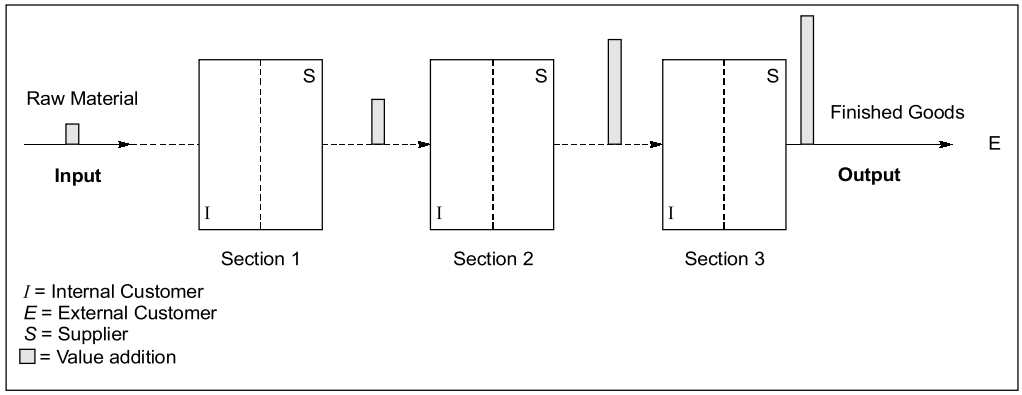


Fig. 1.2 : The Internal and External Customers

Internal Customer: Any individual who receives and uses what a group or organization provides. The person within the company who receives the work of another and adds his or her contribution to the product or service before passifying it on to someone else. Above figure shows that, should section 1 meet the needs of section 2? What happens to section 2 if the section 2 requirements (in terms of quality specifications) are not met by section 1? What if section 1 is not capable of meeting section 2 needs? Should the section 1 work in that case by outsourced? That would mean making section 1 redundant.

External Customer: One who purchases a commodity or service. External customers are the driving forces behind an organization's business.

1.1.5 Dimensions of Quality

As per David Garvin quality of a product can be judged by following eight quality criteria.

1. **Performance:** Basic characteristics of product/service
2. **Aesthetics:** Appearance: Appearance, feel, sound, smell, taste
3. **Special features:** Characteristics that supplement basic functioning
4. **Conformance:** Ability of product to meet customer expectations and standards
5. **Reliability:** Consistency of performance, probability product will operate over time
6. **Durability:** Expected product life
7. **Perceived quality:** Reputation and other indirect measure of quality
8. **Serviceability:** Speed, courtesy, competence and ease of repair

1.1.6 Quality Characteristics

There are number of elements that defines the quality of a product. These elements are called characteristics of quality. It may be:

Physical: length, weight, voltage, viscosity etc.
Sensory: taste, apprearance, colour
Time based: reliability, serviceability, durability

1.2 Traditional Approach vs. Modern Approach Towards Quality

Traditional concept	Modern concept
• Low quality is due to poor working people.	• Low quality is due to poor labour management.
• Quality depends only on production.	• Quality depends on all phases of the production process from the design till the delivery and after sales services.
• Some minor defects and deviations are acceptable.	• The goal is to have defects free product and services.
• The quality control department is a separate unit, checking the finished product.	• Quality is everyone's business. Its total control includes all production phases.

1.2.1 Benefit of Quality

1. Customer satisfaction therefore, customer loyalty and repeat business and referral.
2. Understanding and motivation of employees.
3. Confidence of interested parties in the effectiveness and efficiency of the company.

1.3 Types of Quality

In order to produce goods and services of consistent quality and costs, three types of quality are recognized as these are as follows:

(a) Quality of design
(b) Quality of conformance
(c) Quality of performance

- **Quality of design:** Quality of design is all about set conditions that the product or service must essentially have to satisfy the requirements of the customer. It is also concerned with the **tightness of specifications** for the manufacture of the product. e.g. a part with has a drawing tolerance of ±0.002 mm would be considered to have better quality of design than another with a tolerance of ±0.02 mm.
- **Quality of conformance:** The quality of conformance is concerned with how well the manufactured product conforms to the quality of design. It is basically meeting the standards define in the design phase after the product is manufactured or while the service is delivered.

  It deals with translating user-based characteristics into identifiable product attributes.
- **Quality of performance:** Quality of performance is concerned with how well the manufactured product gives its performance. Meeting customer expectation is the focus when we talk about quality of performance. Quality of performance studies focus on ascentaining how quality characteristics determined in quality of design, and improved and innovated through the quality of conformance studies, perform in market.

  It deals with organizing the manufacturing process to ensure that product quality stringently adheres to specifications.

Remember: 1. Higher quality of design usually costs more.
2. Higher quality of conformance usually costs less.

1.4 Quality Cost

Cost of quality measures the impact of quality in any business. Quality cost are defined as the those costs that are associated with the non-achievements of product or service quality standards and targets to meet customer expectations. Measurement and analysis of various cost aids in tracking the impact of an effective quality management system.

Cost of quality has following components:

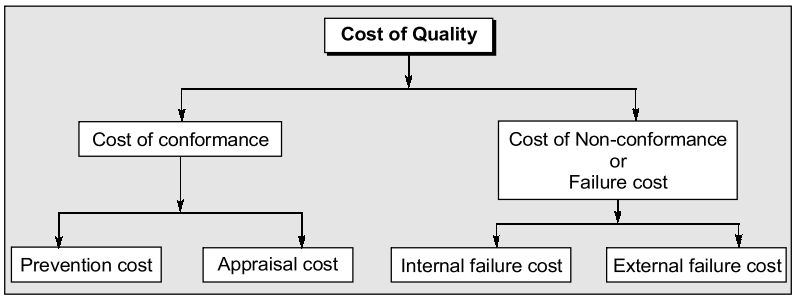


Fig. 1.3 : Cost of quality elements

1.4.1 Cost of Conformance

It is the cost of providing products or services as per the required standards. This can be termed as good time spent. Cost of conformance is further divided into two types:

- Prevention costs
- Appraisal costs

Prevention costs: These are the costs related with attempts made to prevent failure and arises from efforts to keep defect at bay. Whatever the expenditure is made within production system in order to minimize failure and appraisal cost can be termed as prevention cost. It include quality improvement program, maintenance cost, training cost of workers, vendor quality assurance, field testing cost etc.

Appraisal costs: It is the cost associated with measuring, evaluating discovering the defective part within the production system. It includes cost related with inspection cost, cost of equipments, lab cost, auditing cost, prototype testing cost etc.

1.4.2 Cost of Non-conformance or Failure Cost

- These costs are associated with the defective parts or faulty services within a production system.
- These costs result from products or services not conforming to requirements or customer/user needs.
- It can be divided into two types:
  - Internal failure costs
  - External failure costs

Internal failure costs:

- If the defect is detected inside the production system, it is termed as internal failure cots.
- It includes cost related to defective product before they are deliver to customer like rework cost, material and product losses, scrap, breakdown, down time, depreciation on equipment etc.

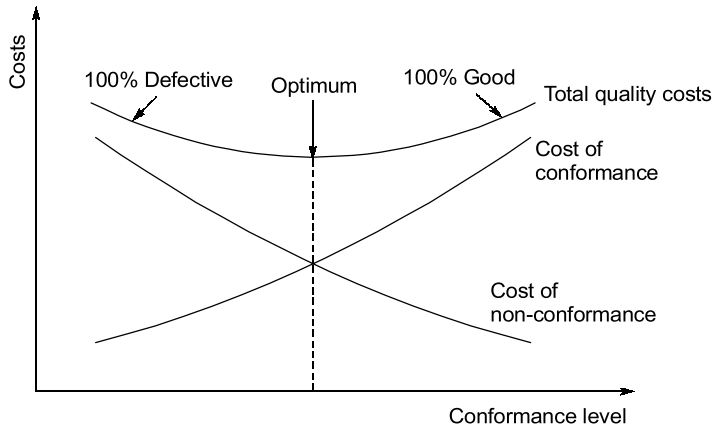


Fig. 1.4 : Model for optimum quality costs

External failure costs:

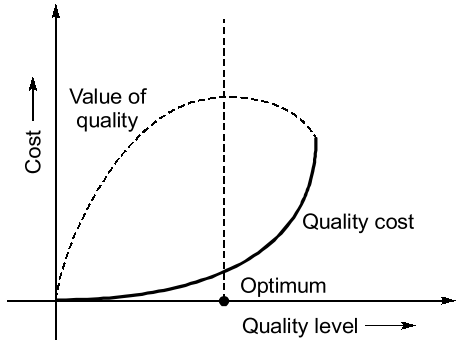
If the defect is defected by the customer while using the product is termed as external failure cost. It is the cost related to delivering substandard product to the customer and it include return goods, replacement cost, loss of good will, warranty cost, liabilities cost etc.

NOTE

1. In manufacturing, quality costs are primarily product oriented, cost of product – 60 to 80%.
2. For services, however, they are generally labour dependent, with labour often accounting for up to 75% of the total costs.
3. Before TQM, Preventive 1%, appraisal 4 to 6%, internal failure 10 to 12%, external failure 10 to 15%.
4. After TQM, Preventive 1%, appraisal 4 to 6%, internal failure + external failure 12 to 15%.
5. World class approach (6σ , 5σ), Preventive 1%, appraisal 4 to 6%, internal failure + external failure 6 to 7%.

1.5 Value of Quality vs. Quality Cost

The return obtained directly or indirectly due to good quality of product is termed as value of quality good quality can earn good response from the customer, increase in market share, firm price policy, higher percentage of successful bids and other benefits to the income of organisation.



1.6 Quality Process

- Quality process can be understand by these three principles such as:
  Quality Control, Quality Assurance and Quality Engineering
- **Quality Control is the ongoing effort to maintain the integrity of a process to maintain the reliability of achieving an outcome.**

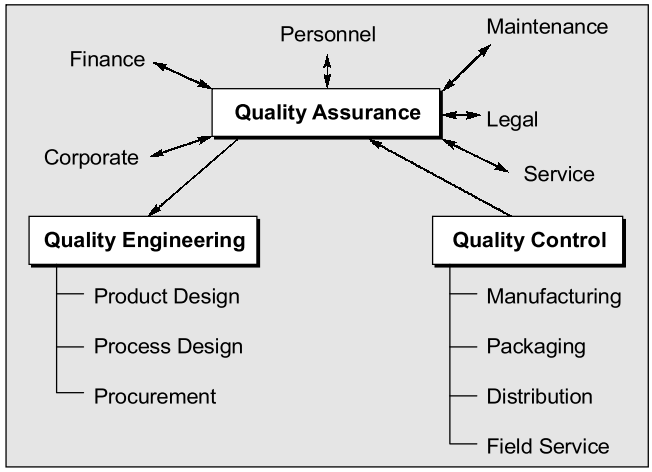


Fig. 1.5

Quality control is focused on fulfilling quality requirements, and as related to clinical trials, it encompasses the operational techniques and activities undertaken within the quality assurance system to verify that the requirements for quality of the trial related activities have been fulfilled.

Quality control is generally the responsibility of the operational units and quality is infused into the outputs and verified as they are being generated. Therefore, quality control is an integral part of the daily activities occurring within each operational unit.

- **Quality Assurance is the planned or systematic action necessary to provide enough confidence that a product or service will satisfy the given requirements of quality.**
  Quality assurance, on the other hand, is focused on providing confidence that quality requirements are fulfilled. As related to clinical trials, it includes all those planned and systemic actions that are established to ensure that the trial is performed and the data are generated, documented (recorded), and reported in compliance with GCP and the applicable regulatory requirements.
- **Quality Engineering refers to purposeful change of a process to improve the reliability of achieving an outcome.**

1.6.1 Quality Assurance vs. Quality Control

- Quality assurance is the planned or systematic action necessary to provide enough confidence that a product or service will satisfy the given requirement of quality.
- Quality control is the ongoing effort to maintain the integrity of a process to maintain the reliability of achieving an outcome.

Quality Assurance	Quality control
• It is process oriented. • It is a managerial tool. • It is a proactive quality process. • Quality assurance means planning done for doing a process. • The goal of quality assurance to prevent the occurance of defects.	• It is product oriented. • It is a corrective tool. • It is a reactive quality process. • Quality control means action has taken on the process on the process by execute them. • The goal of quality control is to identity and correct the defects in the finished product.

Previous ESE Prelims Questions

Q.1 Consider the following regarding quality circle:
1. It is a small group of people working in different areas of an organization with multiple expertise.
2. It consists of people who volunteer themselves.
3. It is a human resource development technique.
4. It is a problem solving forum.

Which of the above statements are correct?
(a) 2, 3 and 4 only (b) 1, 2 and 3 only
(c) 1, 3 and 4 only (d) 1, 2 and 4 only

[ESE-2018]

Ans. (a)

Q.2 **Statement (I) :** The prevention costs increase with the introduction of a quality system and may be a significant proportion of the total quality costs.
Statement (II) : Costs associated with education and training are not included in prevention costs.
(a) Both Statement (I) and Statement (II) are individually true; and Statement (II) is the correct explanation of Statement (I)
(b) Both Statement (I) and Statement (II) are individually true; but Statement (II) is NOT the correct explanation of Statement (I)
(c) Statement (I) is true; but Statement (II) is false
(d) Statement (I) is false; but Statement (II) is true

[ESE-2019]

Ans. (c)

Q.3 Consider the following statements with reference to principal quality objectives:

1. The organization should achieve and sustain the quantity of the product so as to continually meet the purchaser's stated or implied needs.
2. The organization should provide confidence to it own management that the intended quality is being achieved and sustained.
3. The organization should provide confidence to the purchaser that the intended quality is being, or will be, achieved in the delivered product.

Which of the above statements are correct?

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

[ESE : 2022]

Ans. (c)

Q.4 The quality characteristics can be categorized in which of the following groupings?

1. Sensory characteristics
2. Structural characteristics
3. Statistical characteristics
4. Time oriented characteristics

Select the correct answer using the code given below:

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

[ESE : 2022]

Ans. (d)

Quality Characteristics:

1. Structural characteristics
2. Sensory characteristics
3. Time oriented characteristics
4. Ethical characteristics

Q.5 What are the major categories for quality costs?

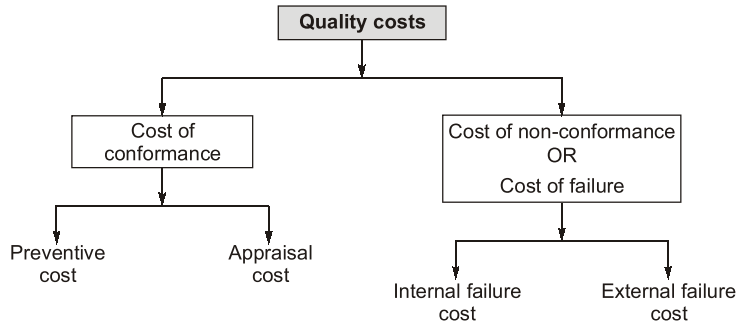
1. Prevention costs
2. Appraisal costs
3. Production costs
4. Internal failure costs

Select the correct answer using the code given below:

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

[ESE : 2022]

Ans. (b)



Q.6 Consider the following statements regarding production:

The major aspects of production that may lead to sickness are

1. Increase in the cost of production.
2. Decrease in the quantity of production.
3. Quality of product not meeting the standards/customer expectation.
4. Producing more quantity than can be sold, leading to accumulation of stock.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1, 2, 3 and 4

(c) 2 and 3 only (d) 1, 3 and 4 only

[ESE : 2022]

Ans. (b)

The major causes that may lead to sickness in production are insufficient resources and improper production and marketing policies. These causes lead to aspects such as

1. Increase in the cost of production.
2. Decrease in the quantity of production.
3. Quality of product not meeting the standards/customer expectation.
4. Producing more quantity than can be sold, leading to accumulation of stock.

Objective Brain Teasers

Q.1 The difference between internal and external customer is

(a) internal customer usually work in the business, external customer do not.

(b) external customer care about what they receive, internal customer do not.

(c) internal customer do not evaluate quality, external customer do.

(d) quality oriented business care only about external customer.

Q.2 Cost claimed by customer in guarantee period regarding defective product is

(a) Appraisal cost

(b) Cost of internal failure

(c) Prevention cost

(d) Cost of external failure

Q.3 Which of the following is considered as dimension of quality?

(a) Taste (b) Product life

(c) Easy to repair (d) All of the above

Q.4 Match the following:

List-I

A. Quality Control

B. Quality Assurance

C. Quality Engineering

List-II

1. Purposeful change of a process to improve the reliability of achieving an outcome
2. Maintaining the integrity of a process to maintain reliability of achieving an outcome
3. Providing confidence that quality requirements of product/service are fulfilled.

Codes:

	A	B	C
(a)	1	2	3
(b)	1	3	2
(c)	2	3	1
(d)	2	1	3

Q.5 How can be quality be computes?

(a) $\text{Quality} = \frac{\text{Expectation}}{\text{Performance}}$

(b) $\text{Quality} = \frac{\text{Performance}}{\text{Expectation}}$

(c) Quality = Performance + Expectation

(d) Quality = Performance – Expectation

Q.6 Identify the example of external failure costs

(a) quality planning

(b) re-inspection

(c) material review

(d) customer returns

Q.7 Which one of the following depicts aesthetics, which is dimension of quality?

(a) Exterior finish (b) Quality of work

(c) Ranking first (d) Ease of repair

Q.8 Type of waste are

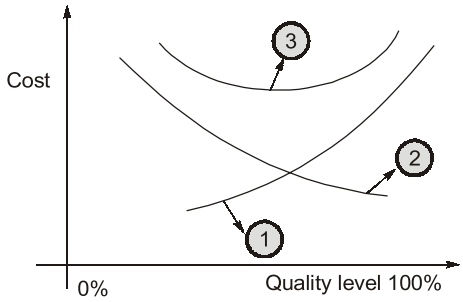
(i) Waiting time (ii) Transport

(iii) Processing waste

The correct answer is
(a) (i) only (b) (i) and (ii)
(c) (ii) and (iii) (d) (i), (ii) and (iii)

Q.9 Which of the following would be considered an appraisal cost of quality?
(a) Training workers to perform their job
(b) Purchasing better tool for workers to perform their job
(c) Repairing an item under the warranty
(d) Running a functional test on each item before it is boxed for the shipment

Q.10 Identify the following curves.



(a) 1-cost of failure, 2-cost of conformance, 3-total quality cost
(b) 1-cost of conformance, 2-cost of non-conformance, 3-preventive cost
(c) 1-cost of conformance, 2-cost of non-conformance, 3-total quality cost
(d) 1-preventive cost, 2-appraisal cost, 3-internal failure

Q.11 Cost of failure includes
(a) Monitoring and control
(b) Quality planning
(c) Rejection and rework
(d) All of the above

Q.12 Which one of these reflects an internal failure cost?
(a) Inspection
(b) Rework
(c) Customer complaint
(d) Replacement of defective product

Q.13 Which of the following includes in cost of quality?
(a) cost of appraisal (b) cost of prevention
(c) cost of failure (d) All of the above

Q.14 Cost incurred to correct an identification defect before the customer receives the product.
(a) Appraisal cost
(b) Internal failure cost
(c) External failure cost
(d) None

Q.15 Cost related to training process capabilities studies, surveys of vendors/suppliers/contractor.
(a) Prevention cost
(b) Appraisal cost
(c) Internal failure cost
(d) External failure cost

Q.16 Which of the following is/are correct?
1. An external customer exists outside the organization and generally falls into three categories; current, prospective & lost.
2. Every person in a process is considered a customer of the preceding operation.

(a) 1 only (b) 1 and 2
(c) 2 only (d) None

Q.17 Which of the following is correct?

(a) $\text{Value} = \dfrac{\text{Quality} \times \text{Service}}{\text{Cost} \times \text{Cycle time}}$

(b) $\text{Value} = \dfrac{\text{Quality} \times \text{Cost}}{\text{Service} \times \text{Cycle time}}$

(c) $\text{Value} = \dfrac{\text{Cost} \times \text{Cycle time}}{\text{Quality} \times \text{Service}}$

(d) $\text{Value} = \dfrac{\text{Service} \times \text{Cycle time}}{\text{Quality} \times \text{Cost}}$

Q.18 Which one of the following is/are correct regarding cost of quality?
1. **Internal failure costs:** Cost generates before a product is shipped as a result of nonconformance to requirements.
2. **External failure costs:** Cost generates after a product is shipped as a result of nonconformance to requirements.

(a) 1 only (b) 2 only
(c) 1 and 2 (d) None

Answers

1. (a)	**2.** (d)	**3.** (d)	**4.** (c)	**5.** (b)
6. (d)	**7.** (a)	**8.** (d)	**9.** (d)	**10.** (c)
11. (c)	**12.** (b)	**13.** (d)	**14.** (b)	**15.** (a)
16. (b)	**17.** (a)	**18.** (c)		

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