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CA FINAL –New Syllabus

STRATEGIC COST MANAGEMENT AND PERFORMANCE EVALUATION

VOLUME – I (Version 4)

(Notes for Private Circulation only)

-: INDEX :-

-: Faculty :-

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About CA Rakesh Agrawal

- He passed his B. Com examination from Ness Wadia College of Commerce, Pune in 1989 with distinction.
- He was the Captain of his college Chess Team.
- He was adjudged as the Best Mountaineer of the College for 1988 – 89 year.
- He received the Gold Medal from University of Pune in the Special subject of Cost & Management Accountancy at B. Com level.
- He passed his M. Com. Exam also from University of Pune (external), with the specialization in Advanced Cost & Management Accounting. Of course, he again cleared this exam with distinction.
- He cleared his ICWA examination in the first attempt in December, 1990 and stood Third in the Pune Chapter of Cost Accountants.
- He started teaching the subject of Costing at Pune Chapter of Cost Accountants in the year 1991, as a visiting faculty.
- He completed his CA Final examination in November 1992 attempt with 32nd Rank in All India Merit.
- He has cleared Information Systems Auditor (ISA) exam of ICAI in the very first attempt.
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- He has also passed the Mutual Fund exam and Derivatives Core Module, conducted by National Stock Exchange.
- He is the Founder of Vidarbha Professional Academy (1996), Nagpur.
- He has launched a free mobile app titled as "Costing Dictionary by CA Rakesh Agrawal". You may download it from Google Playstore.
- He has an online store **www.carakeshagrawal.in** for e-commerce. Students can buy video lectures from this website and study anytime anywhere.
- He is a Teacher by Passion and Chartered Accountant by Profession.
- He is well known for Conceptual Coaching and Student Friendly nature. At the same time he maintains classroom discipline.
- He teaches you a subject for your life time. He also tries to co-relate the subject with day to day life.
- He believes that "Education is not merely getting a Degree, but it is gaining Knowledge".
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Coverage of Syllabus in Version 4

S.N.	Particulars
1.	Entire ICAI Module up to November, 2020 edition
2.	Revisionary Test Papers (RTPs) up to May, 2021
3.	Mock Test Papers (MTPs) up to October, 2020
4.	Past Exam Papers up to January, 2021 exam
5.	Additional Questions uploaded on website up to June, 2021
6.	Additional Case Studies uploaded on website up to June, 2021
7.	Additional Case Scenario uploaded on website up to June, 2021
8.	Old Syllabus CA Final Costing Module - Relevant & selected questions only
9.	Old Syllabus CA Final QT Module - Relevant & selected questions only
10.	Old Syllabus CA Final AMA PM - Relevant & selected questions only
11.	Case Study Digest of ICAI - Issued in February, 2021

Important Note :

Constant change is a way of life today. Inspite of covering the above portion in this version, there is always a possibility that, by the time you appear for your exams; some more exams might have taken place in between, some changes may be proposed by ICAI and so on ...

To keep yourself updated with these changes and updates, I have made a practice to keep on uploading soft copy of Amendment Batch Notes, once in a year. It will be available to you for downloading, free of cost on our website : **www.CaRakeshAgrawal.in**

You may visit **'Student Corner'** section on our website for such changes and free downloads. The answers to subject related common query are also available there. Some tips for how to study, important topics, how to prepare time table, how to deal with theory, how to prepare for case study etc. are also available on our website, at the same place.

Objective :

My objective is that, you should not only clear your exam in the first attempt but you should also make use of this knowledge in your professional career to the extent possible. Getting CA degree is important, but gaining knowledge is also equally important.

With Best Wishes !

1 INTRODUCTION TO STRATEGIC COST MANAGEMENT

"Strategic management is not a box of tricks nor a bundle of techniques. It is analytical thinking and commitment of resources to action." – Peter Drucker

Traditional Cost Management

Traditional cost management system involves allocation of costs and overheads to the production and focuses largely on cost control and cost reduction. The underlying assumption was that with reduced costs and overheads a firm could earn better profits. It involves comparing actual results with the standard expectations (typically budget or standard costs) and analysing the difference. This process is also known as variance analysis. A corrective action would be taken to ensure future outcomes are within the budgeted outcomes.

A traditional cost management system suffers from the following limitations:

- The focus is on cost control and reduction. However, a broad cost reduction programme doesn't work effectively in today's business environment. If a company targets to reduce the marketing spend by, say, 20% across all the product categories, it is likely that the sales of profitable products is also impacted.
- Traditional cost management system has internal focus and does not look at the external factors of competition, market growth, customer requirement etc.
- A broad-based cost reduction could lead to inferior quality of products & services which might drive away customers resulting in lower sales and profitability.
- The expectations of modern customer are quite different. An excessive focus on cost reduction could impact the quality of product and services and we may loose the customers.
- Traditional cost accounting systems rely on accounting data which can be misleading at times. Financial statements can be a great reporting tool but might not be able to assist in strategic decision making. It does not consider dynamics of marketing and economics.
- There is a limited focus on review and improvisation of existing processes and activities.
- Traditional cost management is a reactive approach to cost management.
- It has a short-term outlook. E.g. saving costs on an annual basis.

Strategic Cost Management

In the modern business environment, it is not sufficient to control costs and a business must focus to manage cost strategically. The businesses today operate in an environment with stiff competition, increasing consumer demands for quality products and technology revolution.

The ultimate objective of a business is to earn better profits and create value for shareholders. This can be achieved by superior performance as compared to the competitors which results in distinctive competitive advantages.

Strategic cost management is the application of cost management techniques so that they improve the strategic position of a business as well as control costs. It also involves integrating cost information with the decision-making framework to support the overall organisational strategy. It is not limited to controlling costs but using cost information for management decision making. The cost management techniques should be such that they improve the strategic position of a business apart from focusing on controlling costs. The basic aim of Strategic Cost Management is to help the organisation to achieve the sustainable competitive advantage through product differentiation and cost leadership.

Strategic cost management lays a greater focus on continuous improvement to deliver superior quality product to the customers. Strategic cost management must be an integral part of the value chain. It needs to include all aspects of the production, purchase, design, manufacturing, delivery and service. It is important that strategic cost management is involved at early stages of a product development cycle to avoid heavy costs of failure.

Example 1 :

The following information is extracted from the financial statements of a company producing products A & B. If the company stops producing product B, the sale of A would fall down by 25%.

(Figures in ₹ lakhs)

Particulars	A	B
Revenue	60	35
Cost of goods sold	35	25
Gross Profit	25	10
Overheads	5	12
Net Profit / (loss)	20	(2)

Analysis :

If the information provided above is approached using a traditional cost management technique, the company might decide to stop production of B because it has a very high overhead cost and also results in a loss of ₹ 2 lacs. It thus appears to be prudent to close down the production of B.

However, with additional information that sale of product A would fall down by 25% if B is not sold the decision might change. The company would lose ₹ 5 lacs (25% of 20 lacs) because of reduced sales of A. The net loss for the company if it decides to stop production of B is ₹ 3 lacs (2 lacs of savings from B and 5 lacs of loss of profits from A). Hence the decision to stop of production B is not prudent.

Example 2

A manufacturing company does not carry out preventive maintenance of its machineries on a regular basis to save costs. Repairs to machinery is carried out as and when a machinery breaks down. This is a traditional approach to cost management where the focus is on cost reduction and cost saving. This is a short- term approach to manage costs.

When machinery breaks down, the company loses more in terms of production loss and idle labour time cost. Lack of regular preventive maintenance and planned shutdown time also reduces the life of the machinery and has a longer- term impact. If the loss of production is significant, the company might lose market share to its competitors. Hence, it is important to look at cost management with a strategic focus.

Example 3

A telecom company closed down some of its customer service centers as a cost cutting measure. This led to overcrowding of customers at other centers and longer waiting time for the customers. The volume of work at other centers increased impacting the performance of employees. Both the customers and employees, two of the key stakeholders, were not happy with the company's decision. This type of business decision can impact the reputation and brand image of the company and impact the sales and profitability in the longer run.

Traditional V/s Strategic Cost Management

Comparison Table

Traditional Cost Management	Strategic Cost Management
1. Short term focus.	1. Long term focus.
2. Excessive focus on cost control and cost reduction.	2. Focus on cost reduction with value enhancement as well.
3. Risk averse strategy.	3. Risk taking strategy with the ability to adapt itself with the changing environment.
4. Costs are associated with the volume of production units or hours.	4. Costs are associated and analysed activity wise for better decision making.
5. More focus on internal factors and internal efficiency of the organisation.	5. Focuses not only on internal factors but external factors also, like - competitors, market share, brand building, corporate image etc.
6. More focus on record keeping, controlling and problem solving.	6. More focus on product differentiation and cost leadership.
7. Failed examples – Nokia phone, Kodak camera, Bajaj scooters etc.	7. Successful examples – Indigo Airlines, Google, Facebook, Royal Enfield Bullet etc.

Components of Strategic Cost Management

Strategic Cost Management primary revolves around three business themes -

1. Strategic positioning analysis
2. Cost driver analysis
3. Value chain analysis

Let's discuss each one of them in detail :

1. Strategic Positioning Analysis

Strategic Positioning Analysis is analysing the company's relative position within the industry, to which it belongs.

- Strategic positioning reflects choices a company makes about the kind of value it will create and how that value will be created differently than rivals.
- Strategic Positioning Analysis is concerned with impact of external and internal environment on the overall strategy of a company.
- It is important to take into account the future impact of corporate strategy and to assess whether the current strategy is a suitable fit with the strategic position.
- The following three factors affect the strategic position of a company –
  (a) Organisational values, culture and systems
  (b) External environment like political, economic, social, technological, environmental and legal. It is popularly known as PESTEL analysis and
  (c) Internal environment i.e. internal resources of the company and it's competencies.

2. Cost Driver Analysis

Cost is caused or driven by various factors which are interrelated. Cost is not a simple function of volume or output as considered by traditional cost accounting systems. Cost driver concept is explained in two broad ways in strategic cost management parlance - Structural cost drivers and Executional cost drivers.

Structural cost drivers are the organisational factors which affect the costs of a firm's product. These factors drive costs of an organisation in varied ways. The scale and scope of operation of a company will impact the costs. A larger scale of operations is likely to give an advantage of economies of scale. The usage of technology and complexity of operations also determine the costs of various activities within a firm. The experience or learning curve also impacts the costs being incurred by a firm. The product development process could be costlier earlier and cheaper in later stages of a lifecycle. A simple volume based cost allocation would not be appropriate in such cases.

Executional cost drivers are based on firm's operational decision on how the various resources are employed to achieve the goals and objectives. These cost drivers are determined by management style and policy. The participation of workforce towards continuous improvement, importance of total quality management, efficiency of plant layout etc. are examples of executional cost drivers.

In case of a strategic analysis, volume is not the most appropriate way to explain costs. It is more relevant to explain costs based on strategic choices and executional skills. All costs drivers might not be important at all times. A company must focus on those cost drivers which are of strategic importance.

3. Value Chain Analysis

- Value chain analysis was originally introduced as an accounting tool to understand 'value added' in the various steps of manufacturing process. So that we can determine where cost improvements could be made and value could be added.
- VCA views the entire organisation as a chain of activities which are interrelated and interdependent on each other. The value (i.e. benefit) delivered to the customer gets accumulated over the chain of activities carried out in an organisation.
- If the activities carried out in an organisation add some value to its customer or user, then it is called as value added activity (VA) and if it does not add any value to the customer of user, then it is called as non value added activity (NVA).
- Once we do the analysis of all activities in to VA & NVA, then our objective should be to drop (i.e. stop) the non value added activities and to continue with the value added activities. This will help us in reducing the cost and will make us more cost competitive than our competitors. It is known as cost differentiation advantage.
- At the same time, we should concentrate on VA activities and try to find out the ways and means of carrying out these activities in a more efficient and effective manner, so that the customers and users will receive more value (i.e. benefit) from these activities. Thus we can serve our customers better than our competitors. It is known as value differentiation advantage.
- Michael Porter further classified the activities into (a) Five Primary activities and (b) Four Secondary or Support activities as follows :

Primary Activities	Secondary / Support Activities
• **Inbound logistics** – i.e. activities concerned with receiving, storing and distributing the inputs to the products or services. It includes material handling, stock control, transportation etc. • **Operations** – i.e. converting the raw material in to finished goods. It includes machining, assembly, testing, packaging etc. • **Outbound logistics** – i.e. collection of finished goods, storage and distribution to customers. It includes warehousing, goods handling, transportation etc. • **Marketing and sales** – i.e. advertising, sales promotion, pricing decision, channel management and administration of entire sales activity. • **Services** – i.e. after sales service. In may include installation of goods, training to customers, providing spares, repairs and maintenance etc.	• **Procurement** – i.e. purchase of input material or other resources. In includes identification of suppliers, price negotiations, checking quality of input material etc. (It should not be confused with inbound logistics.) • **Technology development** – i.e. obtaining the know-how to do the things better. It may include product designing, process development etc. • **Human resource management** – i.e. the activities related to manpower development. It may include selection, recruitment, training and rewarding the employees in the organisation. • **Firm infrastructure** – i.e. administrative and managerial activity, which supports all primary activities. It may include planning, finance, control, information management, accounting, legal compliances etc.

PRACTICAL QUESTIONS on VCA

Q. 1 : [May 2012 - Old Syllabus - 5 Marks]

State whether each of the following independent activities is value-added or non-value-added:

(i) Polishing of furniture used by a systems engineer in a software firm.

(ii) Maintenance by a software company of receivable management software for a banking company.

(iii) Painting of pencils manufactured by a pencil factory.

(iv) Cleaning of customers' computer key boards by a computer repair centre.

(v) Providing brake adjustments in cars received for service by a car service station.

Q. 2 : [Nov. 2013 - Old Syllabus - 4 Marks]

In Value Chain analysis, business activities are classified into primary activities and support activities. Classify the following under the more appropriate activity.

(i) Order processing and distribution

(ii) Installation, repair and parts replacement

(iii) Purchase of raw material and other consumable stores

(iv) Transforming inputs into final products

(v) Selection, promotion, appraisal and employee relations

(vi) Material handling and warehousing

(vii) General management, planning, finance, accounting

(viii) Communication, pricing and channel management.

Q. 3 : [May 2015 - Old syllabus – 4 Marks]

Classify the following business activities into primary and support activities under Value Chain Analysis:

(i) Material Handling and Warehousing.

(ii) Purchasing of Raw Materials, Supplies and other Consumables.

(iii) Order Processing and Distribution.

(iv) Selection, Placement and Promotion of Employees

Q. 4 : [Case Scenario - ICAI Module]

ABC Ltd. is engaged in business of manufacturing branded readymade garments. It has a single manufacturing facility at Ludhiana. Raw material is supplied by various suppliers.

Majority of its revenue comes from export to Euro Zone and US. To strengthen its position further in the Global Market, it is planning to enhance quality and provide assurance through long term warranty.

For the coming years company has set objective to reduce the quality costs in each of the primary activities in its value chain.

Required :

State the primary activities as per Porter's Value Chain Analysis in the value chain of ABC Ltd. with brief description.

Solution 4 :

Primary activities are the activities that are directly involved in transforming inputs into outputs and delivery and after-sales support to output. Following are the primary activities in the value chain of ABC Ltd. :-

1. **Inbound Logistics:** These activities are related to the material handling and warehousing. It also covers transporting raw material (yarn or fabric) from the supplier to the place of processing inside the factory at Ludhiana.

2. **Operations:** These activities are directly responsible for the transformation of yarn or fabric into final readymade garments for the delivery to the consumers.

3. **Outbound Logistics:** These activities are involved in movement of readymade garments to the point of sales. Order processing and distribution are major part of these activities.

4. **Marketing and Sales:** These activities are performed for demand creation and customer solicitation. Communication, pricing and channel management are major part of these activities.

5. **Service:** These activities are performed after selling the goods to the consumers. Installation, repair and parts replacement are some examples of these activities.

STRATEGIC FRAMEWORK FOR VALUE CHAIN ANALYSIS

Value Chain analysis requires internal information (for internal value chain) and external information (for industry value chain). The Value Chain analysis requires strategic framework for organising varied information. The following three are generally accepted strategic framework for Value Chain analysis.

1. Industry structure analysis
2. Core competencies analysis
3. Segmentation analysis

These can be discussed further in details as follows :

1. Industry Structure Analysis - Porter's Five Forces Model

Michael Porter says that a business manager should not waste his time and energy in analysing everything in the market to understand the competition. On the contrary, he suggests that a business manager should focus only on the five areas known as five major forces of competition. These are – (a) Threat of new entrants (b) Bargaining power of customers (c) Bargaining power of suppliers (d) Rivalry among current players and (e) Threats from substitutes. Let's discuss each one of them –

1. **Threat of new entrants :** New entrants are always a powerful source of competition. The new capacity and product range may add up to the existing competitive pressure. If the new entrant is a big player, then the competition may become intense and will reduce the profitability of existing players. For example – entry of Reliance Jio in mobile phone service, entry of Air Asia and Vistara in airline industry etc.

2. **Bargaining power of customers :** It is another force that influences the competitive condition of the industry. It becomes significant if the buyers form the groups or cartels. It is more likely to happen in industrial products. For example – two top CDMA players i.e. Reliance and Tata Teleservices had put a combined pressure on Qualcomm to reduce the royalties payable on CDMA based handsets. The bargaining power of customers not only influences the sales price, but can also influence the cost and investment made by the producer. Because, the customer will demand better and better services for lower and lower price.

3. **Bargaining power of suppliers :** Sometimes, suppliers can also exercise their bargaining power over the companies. Specially, if the suppliers are limited in number or they supply a specialized product, then there is a better chance to exhibit their bargaining power. The bargaining power of suppliers will determine the cost of raw materials and other inputs. Thus it will affect the profitability adversely.

4. **Rivalry among current players :** When we use the word competition, it means rivalry among the current players in the market. Competitors put pressure on your price, cost, service quality, advertisement, product development etc. For example – Ola & Uber, Flipkart & Amazon, Indian Airlines & Indigo, Unilever & Patanjali, Apple & Samsung and so on. This list could be unending.

5. **Threats from substitutes :** Substitute products are the hidden source of competition in an industry. If the substitute product serves the same purpose of the customer at a lower price, then it is bound to affect the profitability of your company. Whenever substantial investment in R&D is made, threats from substitute products can be expected. For example – live coaching v/s virtual coaching, jute bags v/s nylon bags, watches & audio player v/s smart phones etc. Substitutes will limit the prices and profits in an industry.

The above five forces together determine industry attractiveness and profitability. Porter stresses that competition does not mean only the rivalry between the competitors, but it could be new entrants, customers bargaining power, suppliers bargaining power, threats from substitutes etc. The collective strength of all these forces decides the attractiveness and profitability of the entire industry. The strength of these forces may vary from industry to industry.

2. Core Competencies Analysis :

Industry structure analysis is well suited to describing what of competitiveness, i.e. what makes one firm or one industry more profitable than another. But understanding the particulars of such advantages as low cost, quality, customer service and time to market may still leave the question of why largely unanswered. Thus, industry structure analysis must be supplemented by an equally explicit core competence analysis.

Core competencies are created by superior integration of technological, physical and human resources. They represent distinctive skills as well as intangible, invisible, intellectual assets and cultural capabilities. Cultural capabilities refer to the ability to manage change, the ability to learn and team working. Organisations should be viewed as a bundle of a few core competencies, each supported by several individual skills.

For instance, Microsoft's only asset is its human imagination. This company excelled in inventing new ways of using information technology for a wide variety of end users. Applying the value chain approach to core competencies for competitive advantage includes the following steps :

1. Validate core competencies in current businesses;
2. Export or leverage core competencies to the value chains of other existing businesses;
3. Use core competencies to reconfigure the value chains of existing businesses; and
4. Use core competencies to create new value chains.

3. Segmentation Analysis :

Industries are sometimes collections of different market segments. Vertically integrated industries are good examples of a string of natural businesses from the source of raw material to the end use by the final consumer. Several firms in the paper and steel industries are vertically integrated. Not all firms in an industry participate in all segments.

If the nature and intensity of Porter's five forces or the core competencies vary for various segments of an industry, then the structural characteristics of different industry segments need to be examined. This analysis will reveal the competitive advantages or disadvantages of different segments. A firm may use this information to decide to exit the segment, to enter a segment, reconfigure one or more segments, or embark on cost reduction or cost differentiation programs. e.g. An advertisement campaign successful in USA may fail in India.

Segmentation Analysis may be done in the following different ways :

- **Identify segmentation variables and categories :** An industry might be divided into multiple segments depending upon the nature and complexity of the industry. The segmentation could be based on the nature of products or geographies or customers.
- **Construct a segmentation matrix :** After the segments are identified, a segmentation matrix (generally two way) can be created. ITC could create a matrix based on the nature of products (Cigarettes, Hotels, Textile, Paper etc.) and geographies (North, East, West and South). Another way could be to create a matrix using products and distribution channel (wholesale, retail, direct).
- **Analyse segment attractiveness :** The segmentation matrix could be used to evaluate profitability and performance of each of the segment. The interrelationship between various segments (say distribution channels, similar products) must also be considered while analysing segmental attractiveness.
- **Identify key success factors for each segment :** Each segment identified must be assessed with a relevant measure of performance. It could be quality of product, service, timeliness of delivery etc. A single performance measure across all segments is not advisable. A measure which suits the service segment will not suit the manufacturing segment.
- **Analyse attractiveness of broad versus narrow segment scope :** The company must identify whether it wants to be in a broad segment or a narrow one. Narrower segments could be risky for business as a single segment could be vulnerable to the competition. Multiple segments help a company to spread costs across the various segments. The company might also be in a position to use the competency of one segment in other segments. Some firms might abandon certain segments because of lack of profitability. The competitive advantage of each segment may be identified in terms of low cost or product differentiation.

Competitive Advantage and Customer Value

In order to survive and prosper in an industry, firms must meet two criteria viz., they must supply what customers want to buy, and they must survive competition. A firm's overall competitive advantage derives from the difference between the value it offers to customers and the cost it incurs for creating such value.

Competitive advantage with regard to products and services take two possible forms. The first one is an offering or differentiation advantage. If customers perceive a product or service as superior, they are willing to pay a premium price in relation to the price they will have to pay for competing products. The second is a relative low-cost advantage, under which customers gain when a company's total costs undercut those of its average competitors.

Differentiation Advantage (Known as Product Differentiation) :
It occurs when customers perceive that a business unit's product offering (defined to include all attributes relevant to the buying decision) is of higher quality, involves less risk and/or outperforms competing product offerings. For example, differentiation may include a firm's ability to deliver goods and services in a timely manner, to produce better quality, to offer the customer a wider range of goods and services, and other factors that provide unique customer value.

Once a company has successfully differentiated its offering, management may exploit the advantage in one of the two ways viz., either increase the price until it just offsets the improvement in customer benefits, thus maintaining current market share; or price below the "full premium" level in order to build market share.

Low-Cost Advantage (Known as Cost Leadership) :
A firm enjoys a relative cost advantage if its total costs are lower than the market average. This relative cost advantage enables a business to do one of the two things; price its product or services lower than its competitors in order to gain market share and still maintain current profitability; or match with the price of competing products or services and increase its profitability.

Some Examples of VCA

Example 1 :

IKEA is a leading global brand of home furnishing products. The company sells stylish home furnishing products that appeal to the taste of the modern people at affordable costs. The main factors behind the popularity of the IKEA brand are its low costs but good quality products. The company has managed its supply chain and production processes efficiently to keep product prices low while also remaining innovative in terms of style and design. Over time, the company has built a strong competitive advantage through its cost-efficient operating model and sales and marketing best practices.

IKEA is the favorite of the millennial generation not just because of its affordable pricing strategy but also because the company offers superior quality products in a very large range. An optimized value chain has helped the company achieve higher cost efficiency as well as grow its international presence faster through a franchise system. IKEA's value chain and the best practices it has adopted makes it more efficient than its competitors.

Example 2 :

Tetra Pak is another popular brand in the food packaging segment. It uses 75% paper and the rest of the package contains aluminum and polyethylene. It allows their customer to pack their food products in their own factory like eatables, food, milk, juices etc.

This packaging is low cost, requires lesser handling and storage cost, no refrigeration is needed to store the products, lesser space and it is more environment friendly as compared to 100% plastic packaging.

Tetra pack preserves the quality of goods packed in it and ensures longer shelf life at lower storage cost which is also environment friendly. These qualities have made Tetra Pak a world leader in food packaging segment.

The Role of Management Accountant

- The management accountant is traditionally considered as an expert on cost analysis; cost estimation; cost behaviour; standard costing; profitability analysis of products or customers or distribution channels; profit variance analysis; and financial analysis.
- Today, management accountants must also bring skills in activity-based costing, benchmarking, business process re-engineering, target costing, life-cycle costing, total quality management and value chain analysis.
- Value chain analysis is a team effort. Management accountants need to collaborate with engineering, production, marketing, distribution and service professionals to focus on the strengths, weaknesses, opportunities and threats identified in the value chain analysis results.
- By championing the use of value chain analysis, the management accountant enhances the firm's value and demonstrates the value of the finance staff to the firm's growth and survival.

Value Shop Model OR Service Value Chain

- The concept of value shop came in to lime light holding the hand of Mr. James D. Thompson in the year of 1967. However, it took more than thirty years to name the concept as 'Value shop'.
- In 1998 Mr. Charles B. Stabell and Mr. Oystein D. Fieldstad in their research work properly defined the concept of 'Value Shop'. This concept aims to serve companies from service sector.
- In value shop principle, no value addition takes place. It only deals with the problem, figure out the main area which requires its service and finally comes with the solution.
- This approach is designed to solve customer problems rather than creating value by producing output from an input of raw materials.
- Value shops mobilizes resources (say people, knowledge or money) to solve specific problems such as curing an illness or delivering a solution to a business problem.
- For example - in case of sale of video lectures through pen drive, the probable problem areas which a student faces could be : (a) unable to install the software, (b) audio quality is not good, (c) video quality is not good, (d) buffering while playing the videos, (e) difficulty related to subject matter etc. To solve these problems, one has to create a back office team (i.e. support team), who can understand and resolve the issues faced by the students. This support team is known as Value Shop or Value Chain.
- The shop process is iterative (means repetitive), involving repeatedly performing a generic set of activities until a solution is reached. This model applies best to telecommunication companies, but also to insurance companies and banks, whose business essentially is mediating between customers with different financial needs.
- The model has the same support activities as Porter's Value Chain but the primary activities are described differently. In value shop the Primary Activities are :
  (a) Problem finding and acquisition
  (b) Problem solving (i.e. developing solutions)
  (c) Choosing among solutions
  (d) Implementation of solution and
  (e) Control / evaluation.

Q. 5 : Case Study – Value Chain Analysis

S-Mart was founded in 1990 as a departmental store catering to the entire household requirements (from grocery to clothing) of middle income groups. The company since has grown leaps and bounds and inaugurated its 100th store in 2017. S-Mart is known for high quality products which are available at discount to the market price at its store. The company claims to give at least 5% discount on listed price across product segments. The sales of company have grown 30% on Y-o-Y basis. The company has highest net profit margin and highest return on equity in the industry.

S-Mart has tie-ups with more than 500 vendors across India who provide high quality products on demand. S-Mart pays all its suppliers in advance and hence enjoys preferential pricing as compared to its competitors. The company procures products using the Just-In-Time (JIT) philosophy which helps it to keep low level of inventories and thereby freeing up significant amount of working capital. The products are directly delivered to the stores by company owned trucks and mini-vans and hence, there is no requirement of warehouses to store products.

The company sells products which are required by households on a day to day basis and is not keen to sell premium products which have higher margin but lower demand. This ensures that inventory is moved out of the stores faster and increases the inventory turnover ratio. The company owns all the stores which it operates under its brand name.

There is no third-party franchisee appointed to operate the stores. Since the products are directly procured from he manufactures and sold to customers, there are no intermediaries in between.

S-Mart invests in superior quality products and high level of customer services than aggressive marketing. The company believes that it can attract more customers by offering quality products at reasonable prices rather than spend huge amount on marketing. However, need based marketing activities are carried out by the company. S-Mart aims to build customer loyalty through high level of customer service at its store.

S-Mart is one of the few companies which has witnessed a low employee turnover in the industry in which it operates. The motivation level of employees is very high which results in excellent performance across all levels. Company rewards its employees generously through employee stock options plan. The company conducts training sessions for its employees periodically to equip them with latest techniques in areas of procurement, sales, marketing and customer service. The result of these efforts is clearly visible in the company's growth.

The company has a solid Information Technology infrastructure for all its activities. The company has leveraged technology across all departments - be it procurement, logistics or sales. It has implemented SAP/R3 which is one of the leading Enterprise Resource Planning system globally. Various reports relating to inventory levels, sales, liquidity position etc. are available on a real time basis to the senior management.

Required :

Map the various activities performed at S-mart to the Porter's Value Chain model.

Solution 5 :

Introduction : Value chain is defined as "a chain of value added activities; products pass through the activities in a chain, gaining value at each stage". Value chain focuses on systems, and how business inputs are changed into business outputs purchased by customers. The entire set of activities that a business undertakes to convert inputs to outputs are interlinked to each other. A business carries out these activities to earn a profit margin.

A business should undertake only those activities which add value to the end product being delivered to the customer. A value chain analysis helps business identify those activities which are not adding value (in other words wasteful activities). An example of a wasteful activity could be unnecessary storage of products which increases the inventory and working capital requirement. Such activities must be removed to ensure that the margin of business improves. Value Chain Analysis is one way of identifying which activities are best undertaken by a business and which are best outsourced.

Porter's value chain classifies activities into primary activity and secondary activity :

Primary Activities

Primary activities are those activities that are directly related with creating and delivering a product to the end customers. The following activities are considered as primary activities :

1. Inbound Logistics

Inbound logistics involves arranging inbound movement of materials or finished goods from suppliers to the manufacturing plants or retail stores. Since S-Mart is not involved in manufacturing, all the activities that it undertakes to deliver the products to its retail stores would form part of Inbound Logistics. The company has its own transport fleet to ensure timely delivery of products to the retail stores. The company also has a JIT system in place which ensures minimum inventory level. A reason why the company uses its own fleet of trucks is to ensure that there are no failures on the supply side. In JIT systems and especially in retail business, it is very important that stock outs are avoided.

2. Operations

Operations involve those activities which are concerned with conversion of input into outputs in case of manufacturing companies. In retail business, it comprises of those activities which are concerned with running of stores, planning of inventory levels of various products, deciding the layout of various stores etc. The company operates through 100 stores which are owned by itself. The company does not have franchisee or agent model for operation of its stores. The ownership of the stores ensure that the quality standards are maintained across various stores and customer get the best value. Since the stores are owned, the company does not face any risk of closing the stores due to expiry of lease arrangements. The company can also invest to build the best layout for the stores.

3. Outbound Logistics

These include planning and dispatch, distribution management, transportation, warehousing, and order fulfillment. In case of a retail business, this includes activities carried out to deliver the product to the customer. S-Mart operates through its own stores and there are no outsourcing or franchisee arrangements. The company does not have any warehousing requirement as the products are directly delivered to the retail stores. The customers directly pick up the products from the stores and there is no transport requirement in this case. The company must however ensure that the customer waiting time is low at the time of invoicing and checkout from the store.

4. Marketing & Sales

Marketing and sales are the means whereby consumers and customers are made aware of the product which is ultimately sold to them. The activities include selling products to the end customers covering activities like product management, price management, promotion and marketing management. S-Mart builds customer loyalty by offering high quality products at affordable pricing. The company does not spend a huge amount on marketing.

5. Service

In case of manufacturing industry, service generally refers to the after sales service which is required to maintain the value of product and includes activities like installation, repair etc. In case of retail stores, service would encompass a superior experience at the stores and managing return of products by the customers. S-Mart aims to build customer loyalty through high level of customer service at its store.

Secondary Activities

Secondary activities are those activities which support the primary activities in their function. The following are the broad classification of secondary activities:

1. Procurement

Procurement refers to the processes of acquiring various products and includes activities like identifying sources of these products, vendor selection, placing an order, purchase of products etc.

The company deals with over 500 vendors across India on advance payment terms to procure high quality products at preferential pricing. This helps the company get better discounts which it can pass it onto the customers. This ensures that the company does not carry the burden of discounts being offered to the customers.

2. Technology Development

Technology spans across all the primary activities of an organisation. It includes activities like process automation, an Enterprise Resource Planning (ERP) system, inventory management systems etc. The company has implemented SAP R/3 - an ERP package which helps in the management of various functions of procurement, logistics and sales. A robust system is always necessary to ensure that the JIT system works effectively. Such systems assist in real-time monitoring of inventory levels and triggering purchase orders when inventory levels are low. The entire flow of products from an order placement till the delivery to customer can be tracked seamlessly.

3. Human Resource Management

This involves areas of recruiting, managing, training, developing and rewarding people within an organisation. S-Mart has a very low employee turnover and a very high level of employee motivation. The company rewards all its employees generously and conducts periodic training and development programmes for its employees. This ensures that the employees are highly motivated which translates into a consistently high performance.

4. Infrastructure

This includes not only the physical infrastructure but also all departments of management, finance, legal which are required to keep the company's store operational. All these are important for organisation's performance in primary activities.

Q. 6 : Case Study : Porter's Value Chain Analysis V/s Value Shop Model

Westwood Solar Solutions (WSS) has mastered the art of developing Solar Domestic Water Heater that fulfill customer's needs. WSS's designers and product developers focus on solutions to get rid of everyday hassles and transform these into a pleasant experience. WSS also has a wide service network that spans the length and breadth of India to ensure good care of customers and products, by providing a prompt and pleasant service experience. In the past, WSS had a dominant position in the Indian market. However, over the past four years, it has been found that its profits and its share in the market have come down.

WSS has business Model comprising of following steps:

- Firstly, WSS's highly qualified and skilled experts visit customer's locations to identify and design the appropriate heater as per customer's requirements. WSS's experts are recognized as the best in the industry, and customers agree that they produce the most effective solutions to their complaints.

- At WSS, in the laboratories, the heater design goes through intricate, complex, and dynamic process. Prototypes are developed on the basis of discussions in previous step. Thereafter, these prototypes are tested. Once a final design is decided, such design is passed to the manufacturing division for production.

- Then, WSS manufactures appropriate Solar Water Heater to the desired specification and installs at the customer's location.

- After the heater's installation, WSS renders annual maintenance services for which it is well known in the industry.

WSS's customers pay a total price for design, manufacture and initial installation of the Solar Water Heater and an annual maintenance charge after that. Total prices are quoted before design work begins.

Although customers appreciate the high quality of the solutions provided by WSS's team, however, they are complaining that the overall prices are too high. Customers have said that although other suppliers do not solve their problems as WSS does, they do charge less. Consequently, WSS has lower down its prices to compete in the market. There is a doubt that the manufacturing and installation stages of the business model are not contributing sufficiently to the firm since costs at both stages are going high.

Partners of WSS have considered that this situation should no longer continue and have recommended that a value chain analysis to be conducted as to identify the way forward for WSS. Although majority of partners are in the agreement with the proposed value chain analysis, however senior partner 'W' has stated that value chain analysis is inappropriate idea. She says that she has heard a number of criticisms of the value chain model.

Assuming yourself as management accountant of WSS, answer the following questions:

Required :

(i) DISCUSS the benefits that may accrue to WSS from conducting a value chain analysis.

(ii) DISCUSS the criticisms of Porter's value chain model in the context of WSS.

(iii) EXPLAIN other form of Value Chain Analysis that may be more suitable for WSS.

Solution 6 :

(i) There are following benefits accruing to WSS through a value chain analysis:

- Value chain analysis is a process by which a firm identifies and analyses various activities that add value to the final product. The idea is to identify those activities which do not add value to the final product/service thereafter eliminating such non-value adding activities. The analysis of value chain help a firm in obtaining cost leadership and improve product differentiation. For WSS, value chain can provide with a clear picture of the value of the manufacturing function as perceived by customers.
- This model also helps in analyzing other firms within the same industry. As WSS observed that other firms in the industry are considered to be more cost effective in terms of manufacturing, it may plan to use the value chain model to examine the reason for the same.
- The value chain will assist WSS to determine ways to get best approach towards developing higher level competitive performance. This model assists firms in finding ways to develop higher level of performance either by cost leadership or product differentiation. Right now, WSS is in a situation wherein it is being defeated on price by some of its competitors, however is recognized as the best solutions provider to customer's problems. Through detailed value chain analysis, WSS may be able to ascertain the reason for fall in market share and profits. Partners may be able to take decision regarding the future course of action for the firm.
- Through this analysis, WSS may apply other relevant management techniques as well. Post value chain analysis, WSS will be in a position to decide whether it is worthwhile to continue the technique of benchmark (processes and performance) against its rivals, to develop an information systems strategy, to carry out a business process reengineering or to adopt activity-based management.
- Further, WSS may decide to outsource manufacturing and keep focus on design and services by following value chain analysis model. This technique may be appropriate for WSS as by outsourcing manufacturing, WSS may be able to focus on its core area for which it is well-known in the industry.
- Value Chain analysis will also facilitate the development of performance metrics for WSS. By developing such metrics, WSS may be able to identify which aspects of its business model are not contributing to the overall value and profits of the firm. Although currently WSS has suspicion that manufacturing and installation are the weak parts of its operation, development of transparent and appropriate metrics would enable WSS to recognize where value and profit are being added in the business model.

(ii) Number of criticisms of the value chain developed by Michael Porter have been:

- This value chain analysis cannot easily be applied to firms belonging to service industries. This criticism is particularly imperative in the context of WSS which has upward profits from rendering solutions and services rather than that from manufacturing tangibles products. Many people appreciate that the model is more suitable to manufacturing based industries, rather than service based industries.
- Often this model is seen as complicated and perhaps could be a source of frustration for the management of a firm. Although the staff of WSS includes bright and intelligent experts, they may not see the value in-depth analyses of business which is required for a full value chain analysis.
- The USP of WSS is it's highly qualified and skilled experts, who visit customer's locations to identify and design the appropriate heater as per customer's requirements. WSS's experts are recognized as the best in the industry, and customers agree that they produce the most effective solutions to their complaints. However, if WSS decides to outsource manufacturing and focus only on design and service, then it may break the value chain of WSS. It is even more relevant where relationships are of utmost important.

- Often value chain analysis is perceived as time consuming and expensive as a whole. However, if the analysis is to be completed timely, there will be requirement of reliable data such as cost of each component in the business model. However, in the absence of good cost accounting system, this model may fail.

(iii) Other Form of Value Chain Analysis :

- WSS requires to acknowledge that the nature of its business is turning from manufacturing zone to a solution provider or professional services firm.
- From this point of view, it would be better for WSS to analyze its business using the Professional Services Value Chain / Value Shop Model. The concept of Value Shop came in to lime light holding the hand of Charles B. Stabell and Oystein D. Fjeldstad in 1998.This concept aims to serve firms from service sector. It only deals with problems, figure out the main area requiring service and finally come with the solution. This approach is designed to solve customer's problems rather than creating value by producing output from an input of raw materials.
- A Value Shop mobilizes resources (say: people, knowledge or money) to solve specific problems such as delivering a solution to business problem. This value shop model is iterative, involving repeatedly performing a generic set of activities until a solution is reached.
- Secondary activities in the Professional Service Value Chain have same support activities as those in the porter's value chain. However, the primary activities are described differently to recognize the different nature of a service-oriented business. In value shop, primary activities are performed in a circle within a firm to perform generic set of activities iteratively before reaching a conclusion. Since WSS team communicates with customers to find a solution before developing a prototype, so they will find the vale shop, compatible and effective model to use.

Question 7 : [RTP - Nov. 2020]

Topic : Competitive Advantage

The following are the income statements of two firms in the same industry:

Particulars	Firm WD (₹)	Firm WG (₹)
Revenues	20,00,000	40,00,000
Less: Variable costs	9,00,000	24,00,000
Contribution margin	11,00,000	16,00,000
Less: Fixed costs	7,00,000	12,00,000
Profit before taxes	4,00,000	4,00,000

Required :

IDENTIFY the strategy (cost leadership v/s differentiation) followed by two firms. JUSTIFY your classification.

Answer 7 :

Key Calculations :

Particulars	Firm WD	Firm WG
Contribution margin / Sales	0.55	0.40
Fixed costs / Sales	0.35	0.30
Profit margin / Sales	0.20	0.10
Variable Cost to Sales Ratio	45%	60%
Total Fixed Cost (₹)	7,00,000	12,00,000

ICAI Answer :

Higher contribution margin ratio exhibited by firm WD indicates that firm WD is following a **differentiate strategy** while firm WG appears to be more focused on **cost leadership**. This is also substantiated by higher fixed costs i.e. R&D, innovation for each sale ₹ in firm WD.

Innovation allows a firm to command premium prices and earn more contribution per sales ₹. However, innovation is expensive.

Note : My views are completely contradictory with ICAI views and hence it is given below.

My Views & Answer :

- Variable cost to sales ratio is lower for WD. It indicates that this firm is able to produce at a lower cost and thus has a cost advantage.
- Fixed cost remains constant irrespective of sales and hence it is to be seen on total basis, instead of viewing it as a % to sales. Firm WD has a substantially lower fixed cost than WG. It again is an indication of cost advantage.
- However, Firm WG is able to generate much higher sales revenue (i.e. double) as compared to WD. It indicates that WG is able to attract more customers than WD. It is an indication of product differentiation strategy. Product of WG seems to be superior to WD.
- Firm WG has spend more on fixed cost. It might be due to higher R&D and innovation expenditure incurred to create a product differentiation advantage over the competitor. In order to create a superior product, one has to spend more amount of money on research.
- Hence, my conclusion is that : Firm WD is following Cost Leadership strategy and Firm WG is following Product Differentiation strategy.

* * * * *

2 MODERN BUSINESS ENVIRONMENT

"It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change." – Charles Darwin.

Introduction :

Each business organisation operates in its unique environment. Environment influence businesses and also gets influenced by it. Each business has an internal and external environment i.e. an environment within the organisation and the environment outside the organisation. Both these environments have a significant impact on the way we do the business. A business needs to adjust itself with the changing environment to stay profitable. Today we see an explosion of information technology and use of internet and mobile phones. Customer needs everything at doorstep and that too very quickly. This change in the customer psychology must be considered while designing a business strategy.

Modern Business Environment

- During the past two decades, the business environment in many sectors has been characterized by rapid changes. The environment is ever changing and dynamic in nature.
- The modern business environment has changed drastically and shaped entirely, in a very different manner. Now, it has become a challenge for business managers to understand their business environment and formulate business plans and policies accordingly.
- Business technology has advanced business functions and operations to new levels. The role of accounting is one of the most reliable functions in business.
- The main revolution has been the transition from a seller's market to a buyer's market. Earlier the supplier or service provider dictated the dimensions of a transaction but now it is dictated by the customer.
- In the seller's market, seller used to decide the sales price using "cost plus" approach. The seller used to decide the response time and the quality of product or service. Now, these are dictated or demanded by the customer.

From a Sellers' Market to Buyers' Market

Today's business environment is that of a buyer's market. This trend is the result of international transitions and macroeconomic, technological, political, and social changes. This environment is characterized by:

- Globalization of the world economy.
- Fierce competition among organizations within and across countries.
- Global excess capacities in production, services, and in some areas of development.
- Using new managerial methods.
- Availability and accessibility of data and knowledge.
- Timely availability of materials and services.
- Ease of global travel and transportation.

The challenge for businesses today is to satisfy their customers through the exceptional performance of their processes. Therefore, in this chapter, we will first address, Total Quality Management, the Cost of Quality, and then focus on Supply Chain Management along with other modern concepts.

Total Quality Management (TQM)

In late 1950s, Japanese products were defamed in the West for their poor quality and unreliability. The transformation in the reputation of Japanese goods started around the year 1990. It started in the field of electronics and car sectors by the application of latest management principles like - Just in Time (JIT), Value Added Management (VAM) and Total Quality Management (TQM) etc.

Mr. W. Edwards Deming, the Guru of TQM from USA mentioned that the inflexible attitude and union resistance to change prevented his ideas from being adopted in his home country but were used by Japanese concerns. The considerable competitive advantage that Japanese companies were able to establish in quality and timeliness as compared to their counterparts in the USA and European countries is mainly attributable to their readiness in recognising and implementing the techniques of TQM.

Total Quality Management (TQM) :

It is too often viewed as a technique whose usefulness is confined to manufacturing processes. This chapter argues that TQM assumes potentially greater importance as a tool for improved efficiency in overall management functioning. By focusing on the management accounting function, we will devise a process through which quality improvement methods might be used to highlight problem areas and facilitate their solution. An initial understanding of the difference between the three major terms "Quality Control", "Quality Assurance", and "Quality Management" is essential to the understanding of TQM.

Quality Control (QC) : It is concerned with the past and deals with data obtained from previous production which allow action to be taken to stop the production of defective units. The focus area is the quality of product and the objective is to make sure that the bad quality product doesn't reach the customers.

Quality Assurance (QA) : It deals with the present and concerns with the putting in place a systems to prevent defects from occurring. Again the focus area is the quality of product and the objective is to ensure that we don't manufacture a bad quality product at all.

Quality Management (QM) : It is concerned with the future and manages people in a process of continuous improvement in the products and services offered by the organisation. The focus area is not just the quality of product but the entire managerial process. It tries to ensure quality in everything i.e. total quality management.

Stages of TQM : The following stages would provide an operational view of implementing the TQM process in the organisation.

Stage 1 : Who is the Customer ?

It deals with the identification of the customer and it includes internal as well as external customers. It means, not only the outside buyers of our goods and services are important, but also the internal managers, engineers and other leading hands are equally important. Every person who receives data, material or any other form of input from the other is considered to be the customer. It is felt by TQM experts that in order to satisfy the external customers, we must satisfy the internal customers first. Therefore, much of the stress is laid on the internal quality of management.

Stage 2 : What does the customer expect from us ?

Once the customers are identified, then the next step is to know their expectations from the accounting or management function.

Stage 3 : What are the customer's decision making requirements ?

The customers require certain information in order to make the correct decisions. This requirement should be ascertained and fulfilled. In order to do this properly, we need to know (a) the nature of the decision being made; (b) the nature of the decision making process and (c) the degree to which information requirements are being presently met.

Stage 4 : What problem areas do we perceive in the decision making process ?

This is an effort to identify the problems faced in the decision making process. Such as the information provided for decision making is not relevant, not understandable or not received on time etc.

Stage 5 : How do we compare with other organisations ?

It is a SWOT Analysis in comparison with the others in the same industry. How the other companies are coping with the similar problems and opportunities. It is also called as benchmarking exercise. It means, to observe others how they tackle a particular problem, select the best way of doing it and then implement it.

Stage 6 : What do the Customers think ?

It is a Feedback process, wherein we want to know, whether our customers are satisfied or not? What do they think about our process? Their suggestions are invited for further improvement and fulfillment of their needs.

Stage 7 : Identification of Improvement Opportunities.

The above mentioned feedback process will help us to identify the areas for improvement. These must be considered as the improvement opportunities.

Stage 8 : Quality Improvement Process.

One must make the use of improvement opportunities to initiate a quality improvement process. This stage is of vital importance and with continuous improvement only, one can deliver the best quality. One must therefore understand and accept that there is always a scope for improvement. It can be achieved by way of a six-step analysis called by the acronym "**PRAISE**".

These six letters stand for -

(i) **P**roblem identification.

(ii) **R**anking - i.e. ranking of problems according to their importance and urgency.

(iii) **A**nalysis - it involves analysis of problems, to know why they occur, what are their causes, etc.

(iv) **I**nnovation - it involves a creative thinking to generate potential solutions.

(v) **S**olution - it involves implementation of a feasible solution to bring about the required change.

(vi) **E**valuation - it involves monitoring the progress to evaluate the impact of our solution and to identify the further improvement opportunities.

Thus, it is a continuous process.

SIX C's OF TQM : For the successful implementation of TQM in the organisation, the following essential requirements must be considered, which are popularly called as six C's of TQM. These are:

1. **Commitment :** If a TQM culture is to be developed, so that quality improvement becomes a normal part of everyone's job, a clear commitment, from the top must be provided. Without this all else fails. It is not sufficient to delegate quality issues to a single person, since this will not provide an environment for changing attitudes. Such expectations must be made clear, together with the support and training necessary to their achievement.

2. **Culture :** Training lies at the centre of effecting a change in culture and attitudes. Management accountants, too often associate creativity with negative perceptions. This must be changed to encourage individual contributions and to make "quality" a normal part of everyone's job.

3. **Continuous Improvement :** Recognition that TQM is a process not a program, necessitates that we are committed in the long term to the never ending search for ways to do the job better. There will always be room for improvement, however small.

4. **Co-operation :** The principle of Total Employee Involvement (TEI) is of paramount importance. The on the job experience of all employees must be fully utilised and their involvement and co-operation must be sought in the development of improvement strategies and associated performance measures.

5. **Customer Focus :** The needs of the customer are the major driving thrust. Not just the external customers (in receipt of the final product or services) but the internal customers (i.e. colleagues who receive and supply goods, services or information). Perfect service with zero defects in all that is acceptable at either internal or external levels. Too frequently, in practice, TQM implementations focus entirely on the external customers to the exclusion of internal relationships, they will not survive in the long run, unless they foster the mutual respect necessary to preserve morale and employee participation.

6. **Control :** Documentation, procedures and awareness of current best practice are essential if TQM implementation are to function appropriately. The need for control mechanism is frequently overlooked in practice. Unless procedures are in place, improvements cannot be monitored and measured nor deficiencies corrected.

Overcoming the Difficulties : Difficulties will undoubtedly be experienced in the implementation of quality improvement and policies might be adopted to minimise them in detail. Ideally, the quality improvement process should be a vehicle for positive and constructive movement within an organisation. We must, however, be aware of the destructive potential of the process. Specially the "Four P's" of quality improvement may so severely damage motivation that the organisation is unable to recover fully. Those four Ps are :

1. **People :** It will quickly become apparent that some individuals are not ideally suited to the participatory process. Lack of enthusiasm will be apparent from a generally negative approach and a tendency to have pre-arranged meeting which coincide with the meetings of TQM teams. Where these individuals are charged with the responsibility for driving group success then progress will be slow or negligible.

2. **Process :** The complicated and inflexible TQM approach will often have a demotivating effect on group activity. It is essential to approach problem solving practically and to regard the formal process as a system designed to prevent participants from jumping to conclusions. As such it will provide a means to facilitate the generation of alternatives while ensuring that important discussion stages are not omitted.

3. **Problem :** Experience suggest that the problems that are too large to provide solutions within a finite time period, leads to demotivation. Hence, problems need to be approached in bite sized chunks, with teams tackling solvable problems with a direct economic impact, allowing for immediate feedback together with a recognition of the contribution made by individual participants. For example, communication and morale are frequently cited as key problem areas, however, they are too broad to provide successful solutions. One must therefore pinpoint the smaller aspects of these issues, so that they can be tackled easily and its impact can be judged immediately.

4. **Preparation :** Adequate training for the successful implementation of TQM process is a must. Additional courses on creative thinking and statistical processes are needed in order to give participants a greater appreciation of the diversity of the process. This training must quickly be extended beyond the immediate accounting circle to include employees at supervisory levels and below who are involved at the data input stage.

Deming's 14 Points Methodology :

Deming outlined his philosophy on quality in his famous "14 Points." These points are principles that help guide companies in achieving quality improvement. The principles are founded on the idea that upper management must develop a commitment to quality and provide a system to support this commitment that involves all employees and suppliers. Deming stressed that quality improvements cannot happen without organizational change that comes from upper management. His 14 points philosophy is enumerated below -

1. Create constancy of purpose towards improvement. Replace short term reaction with long term planning.
2. Adopt the new philosophy. The implication is that management should actually adopt his philosophy, rather than merely expect the workforce to do so.
3. Cease dependence on inspection. If variation is reduced, there is no need to inspect manufactured items for defects, because there won't be any.
4. Move towards a single supplier for any one item. Multiple suppliers mean variation between input qualities.
5. Improve constantly and forever. Constantly strive to reduce variations.
6. Institute training on the job. If people are inadequately trained, they will not work the same way and this will lead to variation.

7. Institute leadership. Deming makes a distinction between leadership and mere supervision. The latter is quota and target based.
8. Drive out fear. Deming sees management by fear as counter productive in the long term. Because, it prevents workers from acting in the organisation's best interests.
9. Break down barriers between departments. Another idea central to TQM is the concept of the internal customer. It means, each department serves not the management, but the other department which uses its outputs or services.
10. Eliminate slogans. Another TQM idea is that it is not the people who make most mistakes but it is the process they are working within. Harassing the workforce without improving the processes they use is counter productive.
11. Eliminate management by objectives. Deming saw production targets as encouraging the delivery of poor quality goods.
12. Remove barriers to pride of workmanship. Many of the other problems outlined reduce worker satisfaction.
13. Institute education and self improvement.
14. The transformation is everyone's job.

The Plan–Do–Check–Act (PDCA) Cycle

Dr. Deming developed the Plan – Do – Check – Act cycle. PDCA Cycle describes the activities a company needs to perform in order to incorporate continuous improvement in its operation. This cycle, is also referred to as the Deming wheel. The circular nature of this cycle shows that continuous improvement is a never-ending process. Let's look at the specific steps in the cycle.

1. Plan – Establish objectives and develop action plans
2. Do – Implement the process planned
3. Check – Measure the effectiveness of new process
4. Act – Take corrective action

It is a continuous process i.e. repeat Plan – Do – Check – Act.

TQM in Practice at Tata Steel - Practical Insight

Tata Steel has maintained the confidence to improve performance globally even in the face of a challenging economic climate in which the steel industry happens to be severely affected. One factor that contributes to this confidence is the Company's adherence to Total Quality Management (TQM) to achieve its goals. Since the formal incorporation of TQM for Business Excellence in the late 1980's Tata Steel has adopted a number of improvement initiatives popular around the world. At Tata Steel's European operations, Continuous Improvement (CI) activities are focused on providing Business Units with the ability to drive business through Lean Management, a common strategy deployment process, training and knowledge sharing through operations.

NatSteel maintains a systematic approach towards improving productivity and enhancing quality while reducing cost at the same time. The Singapore operations concentrated on yield improvement, reduction in power consumption and a significant bottom line benefit. The Xiamen operations have also adopted measures to reduce vulnerability caused by price fluctuations. [NatSteel, Singapore and Xiamen are the subsidiaries of Tata Steel.]

With the Company's better understanding of TQM and the Theory of Constraints (TOC) on the Deming Application Prize journey, its customer focus and market orientation have undergone a sea-change. Tata Steel has initiated a culture of value creation with customers and suppliers. Specific approaches focus on the 'needs' of the customer as opposed to 'wants'. Programmes include those on Customer Value Management, Retail Value Management, and Solution for Sales

and Supplier Value Management. The Company emphasizes effective daily work management practices, a clean and safe work environment and consistency and stability of processes as important factors in sustaining development and growth.

In the face of high raw-material price volatility and an overall trend of rapidly increasing prices, in 2009-2010 the procurement Division of Tata Steel India focused its efforts on keeping these trends in check by leveraging long-term contracts and relationships, and on minimizing risk by hedging and through various other strategic sourcing tools, including innovations and improvement initiatives using Total Quality Management precepts.

Tata Steel is the first integrated steel company in the world, outside of Japan, to win the Deming Application Prize. The steel giant won the 2008 prize for achieving distinctive performance improvements through the application of total quality management (TQM).

Cost of Quality (COQ)

The concept of cost of quality has been around for many years. Dr. Joseph M. Juran in 1951 in his Quality Control Handbook included a section on COQ. Mr. Philip B. Crosby in his book Quality Is Free has popularized the COQ concept.

Quality is concerned with conformance to specification; ability to satisfy customer expectations and value for money. Recognising the importance of cost of quality is important in terms of continuous improvement process. The cost of control/conformance and the cost of failure of control/nonconformance is the quantitative measure of COQ. It is the sum of the costs related to prevention and detection of defects and the costs incurred due to occurrences of defects.

Different views regarding Cost of Quality :

Today view of quality cost among practitioners seems fall into three categories:

1. Higher quality means higher cost

   Quality attributes such as performance and features cost more in terms of labour, material, design, and other costly resources. The additional benefits which are gained from improved quality do not compensate for the additional expenses.

2. The resultant savings are greater than the cost of improving quality

   Deming promoted this view, which is still widely accepted in Japan. The savings result from less rework, scrap, and other direct expenses related to defects. Japanese firms made continuous improvements using this philosophy.

3. Quality costs are those incurred in excess of those that would have been incurred if product was built or service performed exactly right the first time

   This view is held by adherents of the TQM philosophy. Here not only direct cost are included, but also those resulting from loss of customers, loss in market share, and many hidden costs and foregone opportunities not identified by modern cost accounting systems.

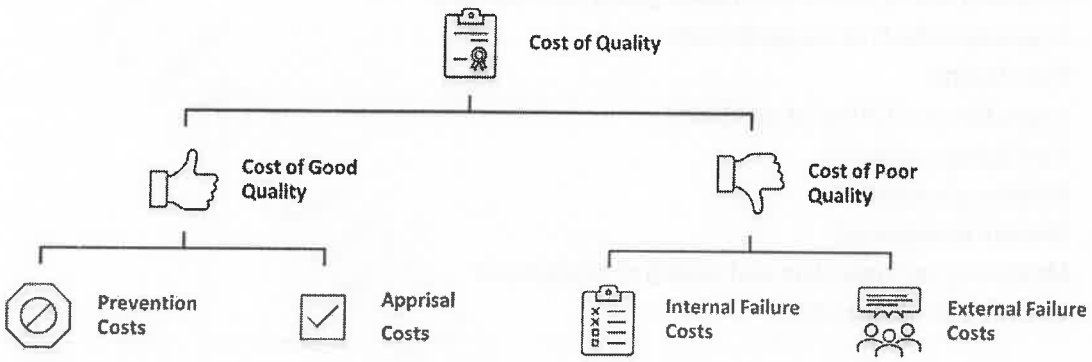
Components of COQ

Mr. Philip B. Crosby in his book Quality is Free referred to the COQ costs in two broad categories namely 'Price of Conformance' and 'Price of Non-conformance'. These two can be bifurcated further in to prevention & appraisal costs and internal & external failure costs. Hence, COQ is often referred as PAF (Prevention, appraisal & failure) model. In other words, 'Price of Conformance' is known as 'Cost of Good quality' and 'Price of Non-conformance' is often termed as 'Cost of Poor Quality'. It can be summed up as follows :

Total Cost of Quality = Cost of Control + Cost of Failure of Control

Total Cost of Quality = Cost of Good Quality + Cost of Poor Quality

Cost of Quality = (Prevention cost + Appraisal Cost) + (Internal + External Failure Cost)



Prevention Costs :

The costs incurred for preventing the poor quality of products and services may be termed as Prevention Cost. These costs are incurred to avoid quality problems. They are planned and incurred before actual operation and are associated with the design, implementation, and maintenance of the quality management system. Prevention costs try to keep failure and appraisal cost to a minimum.

Examples include the costs for :

- Quality engineering
- Quality training programs
- Quality planning
- Quality reporting
- Quality circles
- Design reviews
- Process engineering
- Supplier's evaluation & selection
- Preventive equipment maintenance
- Testing of new materials
- Education of suppliers etc.

Appraisal Costs :

The need of control in product and services to ensure high quality level in all stages, conformance to quality standards and performance requirements is Appraisal Costs. These are costs associated with measuring and monitoring activities related to quality. Appraisal Cost incurred to determine the degree of conformance to quality requirements (measuring, evaluating or auditing). They are associated with the supplier's and customer's evaluation of purchased materials, processes, products and services to ensure that they are as per the specifications.

Examples include the costs for :

- Verification (checking of incoming material, process setup, and products against agreed specifications)
- Quality audits (confirmation that the quality system is functioning correctly)
- Checking and testing of purchased goods and services
- In-process and final inspection/test
- Field testing
- Inspection and testing of materials
- Packaging inspection
- Process acceptance
- Product acceptance
- Measuring i.e. inspection and testing of equipments
- Outside certification etc.

Internal Failure Costs :

Internal Failure Cost associated with defects found **before** the customer receives the product or service. Internal failure costs are incurred to remedy defects discovered before the product or service is delivered to the customer. These costs occur when the product is not as per design, quality standards and they are detected before they are transferred to the customer. These are costs that are caused by products or services not conforming to requirements or customer/user needs and are found before delivery of products and services to external customers. Deficiencies are caused both by errors in products and inefficiencies in processes.

Examples include the costs for :

- Waste - waste occurs when unnecessary work is done or holding of stock as a result of errors, poor organization, or communication
- Scrap - defective product or material that cannot be repaired, used or sold
- Rework or rectification - when the work needs to be rectified for defective material or errors
- Failure analysis -activity required to establish the causes of internal product or service failure
- Re-designing
- Re-testing
- Downgrading
- Downtime

External Failure Costs :

External failure costs are incurred to rectify the defects discovered by customers. These costs occur when products or services that fail to reach design quality standards are not detected until after transfer to the customer. After the product or service is delivered and then the defect is found then it is an external failure. Further external failure costs are costs that are caused by deficiencies found after delivery of products and services to external customers, which lead to customer dissatisfaction.

Examples include the costs for :

- Repairs and servicing (of both products that have been returned by the customer and which are serviced at the customer's place)
- Warranty claims (failed products that are replaced or services that are re-performed under a guarantee)
- Complaints (all work and costs associated with handling and servicing customer's complaints)
- Returns (handling and investigation of rejected or recalled products, including transport costs)
- Handling of complaints
- Repairing goods and redoing services
- Warranty claims and Product liability
- Lost sales due to poor product performance
- Customer dissatisfaction and reduction in market share
- Cost of customer support
- Cost of product recalls, returns and allowances, refunds etc.

Dimensions of Quality

Dimension	Description
1. Performance	Performance refers to a product's primary operating characteristics. This dimension of quality involves measurable attributes of product.
2. Features	Features are additional characteristics that enhance the appeal of the product or service to the User.
3. Reliability	Reliability is the likelihood that a product will not fail within a specific time period. This is a key element for Users who need the product to work without fail.
4. Conformance	Conformance is the precision with which the product or service meets the specified standards.
5. Durability	Durability measures the length of a product's life. When the product can be repaired, estimating durability is more complicated. The item will be used until it is no longer economical to operate it. This happens when the repair rate and the associated costs increase significantly.
6. Serviceability	Serviceability is the speed with which the product can be put into service when it breaks down, as well as the competence and the behaviour of the service person.
7. Aesthetics	Aesthetics is the subjective dimension indicating the kind of response a user has to a product. It represents the individual's personal preference regarding look and feel of the product.
8. Response	This involves aspects like Human–to–Human Interface, e.g. Courtesy of the Dealer.

Practical Questions based on TQM & Cost of Quality

Q. 1 : [Old Syllabus]

Classify the following items under appropriate categories of quality costs viz. Prevention Costs, Appraisal Costs, Internal Failure Costs and External Failure Costs :

(i) Rework
(ii) Disposal of scrap
(iii) Warranty Repairs
(iv) Revenue loss
(v) Repair to manufacturing equipment
(vi) Discount on defective sale
(vii) Raw material inspection
(viii) Finished product inspection
(ix) Establishment of quality circles
(x) Packing inspection

Q. 2 : [Old Syllabus]

A Ltd. is going to introduce Total Quality Management (TQM) in its company. State whether and why the following are valid or not for the successful implementation of TQM.

(i) Some departments serve both the external and internal customers. These departments have been advised to focus on satisfying the needs of the external customers.
(ii) Hold a training program at the beginning of the production cycle to ensure the implementation of TQM.
(iii) Implement Management by Objectives for faster achievement of TQM.
(iv) Appoint the Head of each department as the person responsible to develop improvement strategies and performance measures.
(v) Eliminate wastage of time by avoiding documentation and procedures.

Q. 3 : [Old Syllabus]

Quality Products can be determined by using a few of the dimensions of quality. Identify the following under the appropriate dimension:

i) Consistency of performance over time
ii) Primary Product Characteristics
iii) Exterior Finish of a Product
iv) Useful Life of a Product

Q. 4 : [May 2018 Exam - 10 Marks]

JK Ltd. produces and sells a single product. Presently the company is having its quality control system in a small way at an annual external failure and internal failure costs of ₹ 4,40,000 and ₹ 8,50,000 respectively. As the company is not able to ensure supply of good quality products up to the expectations of its customers and wants to manage competition to retain market share considers an alternative quality control system. It is expected that the implementation of the system annually will lead to a prevention cost of ₹ 5,60,000 and an appraisal cost of ₹ 70,000. The external and internal failure costs will reduce by ₹ 1,00,000 and ₹ 4,10,000 respectively in the new system.

All other activities and costs will remain unchanged.

Required :

(i) Examine the new quality control proposal and recommend the acceptance or otherwise of the proposal both from financial and non-financial perspectives. **(6 Marks)**

(ii) What is your advice to the company, if the company wants to achieve zero defect through a continuous quality improvement programme? **(2 Marks)**

(iii) Suggest a suitable quality control level at a minimum cost. **(2 Marks)**

Solution 4 :

(i) Evaluation of the new proposal :

Particulars	₹
Saving in internal failure cost	1,00,000
Saving in external failure cost	4,10,000
Less : Prevention cost	(5,60,000)
Less : Appraisal cost	(70,000)
Net incremental profit / (loss)	(1,20,000)

Recommendation : As the above proposal leads to an incremental loss of ₹ 1,20,000; the proposal should be rejected based on financial perspective.

However, considering various non-financial benefits due to improvement in quality, one should go ahead with this proposal. In long run, it will help the company to build its Goodwill in the market, increase market share and ultimately increase its revenue.

(ii) Six Sigma policy is often termed as zero defect policy. Similarly, there are other concepts like Total Quality Management (TQM) and Kaizen Costing etc., which talks about a continuous improvement programme.

Through Value Engineering (VE), Value Analysis (VA), Just in Time (JIT) and Total Productive Maintenance (TPM) techniques, the company can achieve zero defect. All these techniques talk about gradual and continuous improvement in the way the work is performed. Thereby identifying and reducing the wastage of any kind of resources in the working system.

(iii) Cost of Quality is broadly divided into two categories i.e. 'Cost of Conformance' and 'Cost of Non-Conformance'. Prevention Cost and Appraisal Cost fall in the category of Cost of Conformance. Whereas, Internal Failure Cost and External Failure Cost fall in the category of Cost of Non-Conformance.

There is an inverse relationship between these two costs. When the Cost of Conformance goes up, the Cost of Non-Conformance goes down and when the Cost of Conformance goes down, the Cost of Non-Conformance goes up. Our objective is to minimise the Total Cost of Quality. Hence, the level at which total cost of quality is minimum should be selected as the optimum level.

Q. 5 : [Old syllabus]

Jai Textiles Ltd., has been having low profits. A special task force is appointed for reviewing performance and implementing total quality management programme.

The present situation is as follows :

The company has 1,200 looms working 2 shifts per day. There are 25 sections of 48 looms each. Each section has 24 weavers and a jobber. Thus there are 1,250 direct labours, other than indirect labours and service hands. The working time is between 7 a.m. and 12 mid-night, comprising 2 shifts of 8 hours each, with half hour interval between shifts. The production is 18 lakhs metres per month and the realisation is Rs. 3 per metre. The average wage of the direct labour is Rs. 800 per month and the fixed costs amount to Rs. 1,75,000 per month. The product cost is Rs. 2.25 per metre in addition to direct wages.

The TQM team has submitted following proposal to the management :-

i. Labour productivity can be improved by changing the layout of the machines.

ii. Given the space available, with the proposed change in layout, only 1,008 looms can be installed, with 48 looms in each section.

iii. Technically, a section of 48 looms can be run with 12 weavers, a helper and a jobber. It will be necessary to increase the wage of direct labour, for such section, by Rs. 110 per head per month. The company is not for retrenchment of labour.

iv. The company can run a third shift between 12 mid-night and 7 a.m., with a half hour interval. However, for the six and half hours' work, eight hours' wage will have to be paid.

v. Only 18 lakh metres can be sold at the present price of Rs.3 per metre. There is an export offer for 4.5 lakh metres at Rs.2.70 per metre.

vi. As an initial step, the company can switch to 3 shift working, with 12 sections having 25 direct labours each and 9 sections having 14 direct labours each. Progressive conversion to 14 hands per section, for all sections, can be planned, as direct labours retire or voluntarily leave the job. The production, with three shift working will be 22.5 lakh metres. Additions to fixed costs will amount to Rs. 50,000 per month.

Examine the implications of the proposal for the company's profit and give your advice.

Q. 6 : [ICAI Module]

A company produces and sells a single product. The cost data per unit for the year 2017 is predicted as below:

Particulars	₹ per unit
Direct Material	35
Direct Labour	25
Variable Overheads	15
Selling Price	90

The company has forecast that demand for the product during the year 2017 will be 28,000 units. However, to satisfy this level of demand, production quantity will be increased.

There are no opening stock and closing stock of the product.

The stock level of material remains unchanged throughout the period.

The following additional information regarding costs and revenue are given:

— 12.5% of the items delivered to customers will be rejected due to specification failure and will require free replacement. The cost of delivering the replacement item is Rs. 5 per unit.

— 20% of the items produced will be discovered faulty at the inspection stage before they are delivered to customers.

— 10% of the direct material will be scrapped due to damage while in storage.

Due to above, total quality costs for the year is expected to be Rs. 10,75,556.

The company is now considering the following proposal :

1. To introduce training programme for the workers which, the management of the company believes, will reduce the level of faulty production to 10%. This training programme will cost Rs. 4,50,000 per annum.
2. To avail the services of quality control consultant at an annual charges of Rs. 50,000 which would reduce the percentage of faulty items delivered to customers to 9.5%.

Required :

(i) PREPARE a statement of expected quality costs the company would incur if it accepts the proposal. Costs are to be calculated using the four recognised quality costs heads.

(ii) Would you RECOMMEND the proposal? Give financial and non-financial reasons.

Q. 7 : [ICAI Exam - Old Syllabus]

Carlon Ltd. makes and sells a single product; the unit specifications are as follows :

- Direct Materials X : 8 sq. metre at Rs. 40 per square metre
- Machine Time : 0.6 Running hours
- Machine cost per gross hour : Rs. 400
- Selling price : Rs. 1,000

Carlon Ltd. requires to fulfill orders for 5,000 product units per period. There are no stock of product units at the beginning or end of the period under review. The stock level of material X remains unchanged throughout the period.

Carlon Ltd. is planning to implement a Quality Management Programme (QMP). The following additional information regarding costs and revenues are given as of now and after implementation of Quality Management Programme.

Before the implementation of QMP	After the implementation of QMP
1. 5% of incoming material from suppliers scrapped due to poor receipt and storage organisation.	1. Reduced to 3%
2. 4% of material X input to the machine process is wasted due to processing problems.	2. Reduced to 2.5%
3. Inspection and storage of material X costs. Re. 1 per square meter purchased.	3. No change in the unit rate
4. Inspection during the production cycle, calibration checks on inspection equipment vendor rating and other checks cost Rs. 2,50,000 per period	4. Reduction of 40% of the existing cost
5. Production Qty. is increased to allow for the downgrading of 12.5% of the production units at the final inspection stage. Downgraded units are sold as seconds at a discount of 30% of the standard selling price.	5. Reduction to 7.5%
6. Production Quantity is increased to allow for return from customers (these are replaced free of charge) due to specification failure and account for 5% of units actually delivered to customer.	6. Reduction to 2.5%
7. Product liability and other claims by customers is estimated at 3% of sales revenue from standard product sale.	7. Reduction to 1%
8. Machine idle time is 20% of Gross machine hrs. used (i.e. running hour = 80% of gross hrs.).	8. Reduction to 12.5%.
9. Sundry costs of Administration, Selling and Distribution total — Rs. 6,00,000 per period	9. Reduction by 10% of the existing.
10. Prevention programme costs Rs. 2,00,000	10. Increase to Rs. 6,00,000.

The Total Quality Management Programme will have a reduction in Machine Run Time required per product unit to 0.5 hr.

Required :

(a) Prepare summaries showing the calculation of :

(i) Total production units (pre inspection),

(ii) Purchase of Materials X (square metres), and

(iii) Gross Machine Hours.

In each case, the figures are required for the situation both before and after the implementation of the Quality Management Programme so that orders for 5,000 product units can be fulfilled.

(b) Prepare Profit and Loss Statement for Carlon Ltd. for the period showing the profit earned both before and after the implementation of the Total Quality Programme.

Q. 8 : [Nov. 2018 Exam]

A company manufactures a single product, which requires three components. The company purchases one of the components from three supplier. DJ Ltd., PJ Ltd. and ZJ Ltd. The following informations are available :

Particulars	DJ Ltd.	PJ Ltd.	ZJ Ltd.
Price quoted by supplier (per hundred units)	₹ 240	₹ 234	₹ 260
Percentage of defective of total receipts	3%	5%	2%

If the defectives are not detected, they are utilised in production causing a damage of ₹ 200 per 100 units of the component. Total requirements is 12,000 units of the components.

The company intends to introduce a system of inspection for the components on receipt. The inspection cost is estimated at ₹ 26 per 100 units of the components. Such an inspection will be able to detect only 90% of the defective components received. No payment will be made for components found to be defective in inspection.

Required :

(i) Advice whether inspection at the point of receipt is justified. [8 Marks]

(ii) Which of the three supplier should be asked to supply? [2 Marks]

Solution 8 :

Approach :

You need to calculate Total Cost of Purchase including cost of defectives and inspection cost, at present i.e. if no inspection is done and if inspection is done.

Compare the two costs i.e. without inspection and with inspection for all the three suppliers. You can select the supplier with lowest cost per good unit.

(i) Analysis of the three suppliers without inspection :

Particulars	DJ Ltd.	PJ Ltd.	ZJ Ltd.
(a) Total requirement of components (units)	12,000	12,000	12,000
(b) Percentage of defective items	3%	5%	2%
(c) No. of defective items [a x b]	360	600	240
(d) No. of good units received [a - c]	11,640	11,400	11,760
	(₹)	(₹)	(₹)
(e) Purchase price per unit (Price / 100)	2.40	2.34	2.60
(f) Total cost of purchase at present [a x e]	28,800	28,080	31,200
(g) Cost of damage [c x 200/100]	720	1,200	480
(h) Total cost [f + g]	29,520	29,280	31,680
(i) Cost per good unit [h / d]	2.5361	2.5684	2.6939

Analysis of the three suppliers with inspection :

Particulars	DJ Ltd.	PJ Ltd.	ZJ Ltd.
(a) Total requirement of components (units)	12,000	12,000	12,000
(b) Percentage of total defective items	3%	5%	2%
(c) Total No. of defective items [a x b]	360	600	240
(d) No. of defective items not detected and hence accepted after introducing the system of inspection [c x 10%]	36	60	24
(e) No. of defective items detected & rejected on inspection [c x 90%]	324	540	216
(f) Payment to be made for [a - e]	11,676	11,460	11,784
	(₹)	(₹)	(₹)
(g) Purchase price per unit [Price/100]	2.40	2.34	2.60
(h) Total cost of purchase [f x g]	28,022.40	26,816.40	30,638.40
(i) Cost of damage [d x 200/100]	72	120	48
(j) Inspection cost [a x 26/100]	3,120	3,120	3,120
(k) Total cost with inspection [h + i + j]	31,214.4	30,056.4	33,806.4
(l) Good units received [a - c] (in units)	11,640	11,400	11,760
(m) Cost per good unit [k / l]	2.6816	2.6365	2.8747

Advice : As can be observed from the above two tables, cost per good unit without inspection is lower than the cost after inspection is carried out. Hence, we can conclude that inspection at the point of receipt is not justified.

(ii) Decision About Supplier :

The lowest cost per good unit is ₹ 2.5361. Hence, we should prefer supplier DJ Ltd.

Q. 9 : [RTP - May 2019]

Cool Air Private Ltd. manufactures electronic components for cars. Car manufacturers are the primary customers of these products. Raw material components are bought, assembled and the electronic car components are sold to the customers.

The market demand for these components is 500,000 units per annum. Cool Air has a market share of 100,000 units per annum (20% market share) for its products. Below are some of the details relating to the product:

Selling price	₹ 2,500 per unit
Raw material cost	₹ 900 per unit
Assembly & machine cost	₹ 500 per unit
Delivery cost	₹ 100 per unit
Contribution	₹ 1,000 per unit

The customers due to defects in the product return 5,000 units each year. They are replaced free of charge by Cool Air. The replaced components cannot be repaired and do not have any scrap value. If these defective components had not been supplied, that is had the sale returns due to defective units been nil, customers' perception about the quality of the product would improve. This could yield 10% increase in market share for Cool Air, that is demand for its products could increase to 150,000 units per annum.

Required :

(i) ANALYZE, the cost of poor quality per annum due to supply of defective items to the customers.

(ii) The company management is considering a proposal to implement an inspection process immediately before delivery of products to the customers. This would ensure nil sales returns. The cost of having such a facility would be ₹ 2 crores per annum, this would include materials and equipment for quality check, overheads and utilities, salaries to quality control inspectors etc. ANALYZE the net benefit, if any, to the company if it implements this proposal.

(iii) Quality control investigations reveal that defective production is entirely on account of inferior quality raw material components procured from a large base of 30 suppliers. Currently there is no inspection at the procurement stage to check the quality of these materials. The management has a proposal to have inspectors to check the quality at the procurement stage itself. Any defective raw material component will be replaced free of cost by the supplier. This will ensure that no product produced by Cool Air is defective. The cost of inspection for quality control (materials, equipment, salaries of inspectors etc.) would be ₹ 4 crore per annum. ANALYZE the net benefit to the company if it implements this proposal? Please note that scenarios in questions (ii) and (iii) are independent and not related to each other.

(iv) Between inspection at the end of the process and inspection at the raw material procurement stage, ADVISE a better proposal to implement (a) in terms of profitability and (b) in terms of long term business strategy?

Solution 9 :

(i) Customer demand for Cool Air's products is 100,000 units per annum. However, 5,000 defective units supplied are to be replaced free of charge by the company.

Therefore, the total number of items supplied to customers per annum = 100,000 + 5,000 units = 105,000 units. The cost of replacement would include raw material cost, assembly & machining cost and delivery cost of 5,000 units = 5,000 units × (900+500+100) per unit = 5,000 units × ₹ 1,500 per unit = ₹ 75,00,000 per annum.

Further, had the sale returns not happened, market share would have increased by 50,000 units. Contribution is ₹ 1,000 per unit, for 50,000 units contribution would be ₹ 5,00,00,000. Therefore, the cost of poor quality per annum = cost of replacement + contribution from lost sales = ₹ 75,00,000 + ₹ 5,00,00,000 = ₹ 5,75,00,000 per annum.

(ii) Inspection at the end of the process would detect defects before delivery to the customers. This would ensure that the sale returns would be nil. Given in the problem that 5,000 units are defective and would need to be replaced. In other words, inspection after production but before delivery to customers would not prevent production of defective units. However, compared to the current scenario, since these defective units have not yet been delivered to the customer, the cost for additional delivery of replaced products would be saved. This savings in the extra delivery cost = 5,000 units × ₹ 100 per unit = ₹ 5,00,000 per annum. Further, had the sale returns not happened, market share would have increased by 50,000 units. Contribution is ₹ 1,000 per unit, for 50,000 units it would be ₹ 5,00,00,000 per annum.

Therefore, the total benefit from the inspection process before delivery to customers = savings on delivery costs + contribution from incremental sales = ₹ 5,00,000 + ₹ 5,00,00,000 = ₹ 5,05,00,000 per annum. The cost to the company to maintain good quality of its products through inspection = ₹ 2,00,00,000 per annum. Therefore, the net benefit to the company would be ₹ 3,05,00,000.

(iii) Inspection of raw material at the procurement stage could entirely eliminate defective production. The benefit would be two fold, the current replacement cost for 5,000 units will no longer be incurred. Secondly, due to better customer perception, market share would increase, resulting in an increased contribution to the company. In other words, the cost of poor quality will be nil.

As explained in solution (i), the cost of poor quality per annum = cost of replacement + contribution from lost sales = ₹ 5,75,00,000 per annum. This would be saved by implementing the proposal.

Cool Air has to incur an inspection cost to ensure this highest standard of quality (0% defects) which would cost ₹ 4,00,00,000 per annum. Therefore, the net benefit to the company would be ₹ 1,75,00,000 per annum.

(iv) (a) The proposal to implement inspection immediately before delivering goods to the customers results in a net benefit of ₹ 3,05,00,000 per annum. Alternately, the proposal to implement inspection at the raw material procurement stage results in a net benefit of ₹ 1,75,00,000 per annum. Therefore, from a profitability point of view, inspection immediately before delivery of goods to the customer would the preferred option.

(b) The drawback of inspection at the end of the production process is that (1) it cannot prevent production of defective goods and (2) information regarding the root cause of defective production, in this case, supply of defective raw materials will not get tracked. Therefore, inspection at the end of production does not contribute to resolving the root cause of defective production. On the other hand, inspection at the procurement stage can eliminate production of defective goods. This will ensure a much higher quality of production, better utilization of resources and production capacity. Therefore, from a long term strategy point of view, inspection at the raw material procurement stage will be very beneficial. Currently the cost of ensuring this highest quality of production (0% defects) is ₹ 4 crore per annum. The cost of ensuring 100% quality is quite high, such that the net benefit to the company is lesser than the other proposal. However, due to its long term benefit, Cool Air may consider some minimum essential quality control checks at the procurement stage. Although selective quality check might not ensure complete elimination of defective production, it can contribute towards reducing it. At the same time cost of selective quality check would not be so high as to override its benefits. To determine the extent of quality control inspection, Cool Air should determine its tolerance limit for defective production and do an analysis of the quality / cost tradeoff.

Alternatively, Cool Air may also think of changing its suppliers. It can identify the suppliers who can supply defect free items. Such suppliers may charge a slightly higher price, but it is worth paying it in the long run. Cool Air may carry out an evaluation process of suppliers by ensuring that the suppliers are TQM compliant.

Q. 10 : [ICAI Module]

[Also appeared in Nov. 2020 exam with name changed as TCS Box Ltd.]

Livewell Ltd. is a manufacturing company that produces a wide range of consumer products for home consumption. Among the popular products are its energy efficient and environment friendly LED lamps. The company has a quality control department that monitors the quality of production.

As per the recent cost of poor quality report, the current rejection rate for LED lamps is 5% of units input. 5,000 units of input go through the process each day. Each unit that is rejected results in a ₹ 200 loss to the company. The quality control department has proposed few changes to the inspection process that would enable early detection of defects. This would reduce the overall rejection rate from 5% to 3% of units input. The improved inspection process would cost the company ₹ 15,000 each day.

Required :

(i) Analyse the proposal and suggest if it would be beneficial for the company to implement it.

(ii) After implementation, Analyse the maximum rejection rate beyond which the proposal ceases to be beneficial?

Solution 10 :

(i) Analysis of the new proposal :

Particulars	₹ / day
Savings in the loss due to reduction in rejection rate [₹ 200 per unit x (5% - 3%) x 5,000 units]	20,000
Less : Cost of inspection process improvement	15,000
∴ Net benefit to the company	5,000

Conclusion : Considering net benefit of ₹ 5,000 per day to the company, it is advisable to implement the proposal.

(ii) Calculation of maximum rejection rate :

Particulars	₹
(a) Cost of implementing proposal	15,000
(b) Savings in loss per unit	200
(c) Reduction in rejection of minimum no. of units to recover the above cost [a / b]	75 units
(d) Reduction in rejection in % of input [75 / 5,000 x 100]	1.5%
(e) Maximum allowable rejection in % of input [5% - 1.5%]	3.5%

The Business Excellence (BE) Model

Business Excellence (BE) is a philosophy for developing and strengthening the management systems and processes of an organization to improve performance and create value for stakeholders. The essence of this approach is to develop quality management principles that increase the overall efficiency of the operation, minimize waste in the production of goods and services, and help to increase employee loyalty as a means of maintaining high standards throughout the business by achieving excellence in everything that an organization does (including leadership, strategy, customer focus, information management, people and processes).

Business excellence principles emerged because of development of quality drive into traditional business management. Business excellence considers various management thoughts as core concepts and structures quality management in a manner that can be adapted by any enterprise. Several business excellence models exist world-wide. While variations exist, these models are all remarkably similar. The most common include :

- European Foundation Quality Management (EFQM) Excellence Model
- Baldrige Criteria for Performance Excellence
- Singapore BE Framework
- Japan Quality Award Model
- Australian Business Excellence Framework

Two most important models are discussed below :

EFQM Excellence Model :

EFQM Excellence Model meets the fundamental concepts of excellence well. It is European model but is closely related to other model such as the US Baldrige Model. The Baldrige Model has the same aims and very similar framework.

The EFQM Excellence Model provides an all round view of the organisation and it can be used to determine how different methods fit together and complement each other. Based on the needs of the organisation, this model can be used with other tools of improvement to attain sustainable excellence.

The EFQM model is a practical, non-prescriptive tool that enables organisations to understand the cause and effect relationships between what their organisation does and the results it achieves. The EFQM model presents set of three integrated components :

(1) The Fundamental, concept of excellence

(2) The Criteria, conceptual framework

(3) The RADAR, logic assessment framework

The fundamental concepts for excellence are the basic principles that describe the essential foundation for any organization to achieve sustainable excellence. These concepts are detailed as below :

(a) Adding value to customers: Companies need to understand their customers, their needs, anticipate their needs and make use of opportunities to fulfill their expectations.

(b) Creating a sustainable future: Society and environment (People and Planet of Triple Bottomline concept) play a major role in ensuring the sustainability of business. A company should have as much positive impact on its surroundings and try to minimize any negative

impact on the same. Here, the company should assess the environmental impact of its operations, it should take measures to minimize adverse impacts on the society etc.

(c) **Developing Organizational Capability:** Companies need to manage change within the organization and beyond. The company should identify "what it is capable of being great at?" in order to differentiate it from its competitors. The company should identify and develop unique capabilities to have a competitive edge in the market.

(d) **Harnessing creativity and innovation:** Continuous improvement and innovation brings value to the company. The company should promote a working environment that enables and appreciates creativity and innovation.

(e) **Leading with vision, inspiration, and integrity:** The tone at the top defines the rest of the company. The leaders and management of the company should have a clear vision of what the company wants to achieve, develop strategy to achieve it, work with integrity and ethics. Leaders shape the future of the organization.

(f) **Managing with agility:** Agility would be the capability to identify and effectively respond to opportunities and threats. For example, live coaching classes are facing serious threat from the virtual direct to home coaching. However, it can also be treated as an opportunity of using e-commerce as a platform to reach out to customers directly.

(g) **Succeeding through the talent of people:** An organization is only as good as the people who work in it. There should be an atmosphere of teamwork that enable achievement of organizational and personal goals. Performance evaluation, reward and recognition programs, training and talent network are ways to cultivate talent within the organization.

(h) **Sustaining outstanding results:** Use of EFQM model is not a onetime exercise. Constant and periodic evaluation is required to keep up and sustain excellence.

EFQM model helps organisations to realise in practice the fundamental concepts and to understand the cause and effect relationships between what the organisation does and the results it achieves. The EFQM model is also a self assessment model for an organisation that wants to assess its level of excellence.

The criteria of the model are comprised of 5 enablers and 4 results. The **'Enabler'** criteria cover what an organisation does. The **'Results'** criteria cover what an organisation achieves. 'Results' are caused by 'Enablers'.

Enablers covers what an organization does (its objective) and how it does it (strategy, use of resources to achieve it).

(a) **Leadership:** A leader defines the organization's culture. They enable the organization to achieve its goals by taking the correct decisions at the correct time. To do this they should have sufficient skill, work as per the company's code of conduct and should be ethical in their dealings.

(b) **Strategy:** Operations should be planned and directed as per a clearly defined strategy. The company's vision and mission statement with respect to its various stakeholders are the goals that the organization wishes to achieve. Strategy (plan) enables the company to achieve these goals.

(c) **People:** Excellence is possible only if the people working in the company wish to achieve it. They must be motivated, recognized, and managed to enable them to work towards the company's vision and mission. The work culture should be that this opens up opportunities for personal development as well. This would cultivate a bond with the organization, which enables people working within to strive for excellence.

(d) **Partnerships and resources:** Effective management of partnerships that the company has with other organizations is critical to success. Partners could be external vendors, suppliers, and service providers. The services of partners enable business to operate smoothly. Resources, both tangible and intangible should be managed optimally. Tangible resources can be financial (cash, bank accounts) and physical assets (machinery, building, land etc.). Intangible resources would be intellectual property rights, information technology, licenses etc. Proper management of resources enables optimal results.

(e) **Processes, Products, and Services:** A company exists because of its processes, products, and services. They should be managed and continuously improved to create value to the stakeholders.

Results are what the organization achieves following its operations and decisions. As explained before, the stakeholders of the company are investors (business), people (employees), customers and society. In order to track performance, the company has to develop Key Performance Indicators (KPI)s for each of the stakeholder groups. Results should be tracked periodically. Changes to targets and benchmarks should be continuously made to reflect the current objectives that the company wants to achieve. Some of the results that the company can look at are:

(a) **Customer results:** Are the customers of the company satisfied with the products and service? How does the company fare in terms of brand loyalty? Is the customer base growing to indicate increasing market share?

(b) **People results:** Does the company have skilled and motivated employees? What is the employee turnover with reasons for the same? Does the company have proper access to hire required talent? Are the employees motivated, trained, recognized, and rewarded for their performance? What is performance measurement system, is it robust and accurate to measure performance?

(c) **Society results:** Is the company a good corporate citizen. Are the objectives of corporate social responsibility being met? If the organization is a not for profit organization, is it meeting its objectives and goals?

(d) **Business results:** Is a for profit organization achieving the required return on investment, profitability that the shareholders and other investor demand? Has the company been able to manage financial and other risks properly?

The last component is the **RADAR** (Results - Approaches - Deploy - Assess - Refine) logic, which is the management and evaluation tool for analysing the performance of an organisation.

Enablers enable achievement of results. EFQM model documents this flow in a structured way. It highlights the strength and weakness of the enablers. With this information, the company can alter its operations and strategy to achieve desired results. On assessment, there is a flow from results to enablers. If the results have been achieved, enablers continue to operate status quo. If the results fall short of targets, changes have to be made to enablers to improve performance.

Therefore, it can be concluded that the EFQM model encourages constant self assessment to achieve excellence. When a company wins an excellence award based on a business excellence model, it gains in stature within the industry. This recognition could work to its advantage financially and otherwise.

Baldrige Criteria for Performance Excellence :

This model provides the foundation for most of the business excellence models adopted around the world. The framework is build around the seven categories :

- Leadership
- Strategic planning
- Customer and market focus
- Measurement analysis and knowledge management
- Workforce
- Process management and
- Business results

Business Excellence Model and Organisational Culture :

Business excellence approach focuses on strengthening the internal function and communication, looks towards the cultivation of strong ties with consumers and can be incorporated into the culture.

Excellence cannot be attained if the staffs are forced to conform to certain norms. They have to be critically managed and motivated. A wisdom is required to be developed among employees that by pursuing the goal of their organisation they are meeting their own objectives. Employees feel accredited when they are considered important elements in pursuit of excellence as they learn new skills.

A feeling of association is developed and employees start believing in the management philosophies, when the organisation tries to achieve excellence. For achieving business excellence effective leadership is equally important to manage all the resources efficiently.

A strong and empathetic leader, effective communication system, employee empowerment, employee motivation, innovative and creative culture are some of the strategies to make the employees feel connected to the management philosophy of the organisation.

A robust culture arises as a result of implementation of business excellence model, which can make the organisation a world class performer.

Business Excellence in Practice

The Tata Business Excellence Model (TBEM) which has been adapted on the pattern of Malcolm Balridge Criteria in the business excellence movement. The model has provided Tata companies with a framework for assessing their businesses holistically, and adopting measures to improve their competitive strength, financial performance and operational efficiencies. The TBEM assesses seven core aspects of business operations i.e., leadership, strategic planning, customer and market focus, measurement, analysis and knowledge management, human resource focus, process management and business results. The essence of this framework is a proactive attitude rather than a reactive one. It talks about keeping the business flexible and running it effectively and efficiently.

Introduction :

Throughput Accounting (TA) is a method of performance measurement which relates production and other costs to throughput. Throughput accounting product costs relate to usage of key resources by various products.

It assumes that a manager has a given set of resources available. These comprise the existing buildings, capital equipment and labour force. Using these resources, purchased materials and components must be processed to generate sales revenue. To achieve this, maximum amount of throughput is required with the financial definition as :

Throughput Contribution = Sales Revenue – Direct Material Cost

The objective of management is always to generate maximum throughput. It is similar to contribution in marginal costing. In marginal costing we deduct all variable costs from the sales revenue to get contribution. In throughput accounting, only material cost is deducted from sales revenue to calculate throughput. Throughput is influenced by (a) Selling price, (b) Direct Material purchase price, (c) Usage of direct materials or (d) Volume of throughput etc.

Constraints on throughput might include :

- the existence of an uncompetitive selling price
- the need to deliver on time to particular customers
- the lack of product quality and reliability
- the lack of reliable materials suppliers
- the existence of shortage of production resources.

It becomes management's task to eliminate these constraints. Shortage of resources are usually termed as bottlenecks, and their elimination often only moves a problem from one location to another. Thus the careful planning to minimize and eliminate all bottlenecks becomes very important. In marginal costing we used to call these bottlenecks as key factor. Thus, **Bottleneck** is a key factor i.e. something in short supply, which is **internal** to the organisation and **Constraint** is a limitation which is **external** to the organisation.

In throughput accounting all costs other than material cost is treated as fixed cost. In maximum organizations, now a days, labour is not a unit variable cost. Therefore only variable cost of production is material. Throughput contribution = Sales – Material Cost.

Theory of Constraints (TOC) - USA

Introduction:

During the 1980s Goldratt and Cox (1989) advocated a new approach to production management called optimized production technology (OPT). OPT is based on the principle that profits are expanded by increasing the throughput of the plant. The OPT approach determines what prevents throughput being higher by distinguishing between bottleneck and non-bottleneck resources. This approach advocates that bottleneck resources/activities should be fully utilized while non bottleneck resources/activities should not be utilized to 100% of their capacity since it would result in increase in inventory.

OPT is based on the principle that profits are expanded by increasing throughput of the plant i.e. rate at which raw material are turned into sales. The most widely recognized management accounting system developed for this purpose is known as throughput accounting (TA). The concept behind the system was first formulated and developed by Goldratt and Cox in USA. Goldratt developed the concept and eventually gave it the name the Theory of Constraints (TOC). The theory was picked up and inducted into an accounting system in the UK where it is known as Throughput Accounting (TA).

Concept and aim of theory of constraints:

The theory of constraint focuses its attention on constraints and bottlenecks within the organisation which hinder speedy production. The main concept is to maximize the rate of manufacturing output i.e. the throughput of the organisation. This requires a close examination of the bottlenecks and constraints which are defined as: A bottleneck is an activity within the organisation where the demand for that resource is more than its capacity to supply. A constraint is a situational factor which makes the achievement of objectives / throughput more difficult then it would otherwise be. Constraints may take several forms such as lack of skilled employees, lack of customer orders or the need to achieve a high level of quality product output. Using above definition, therefore, a bottleneck is always a constraint but a constraints need not be a bottleneck. For example, the due date of delivery of goods to customer i.e. meeting the delivery schedule for customers orders is the major constraint in the organisation. The bottleneck in such a case may be certain machine capacity in the factory. Thus focus on throughput forced management to examine both the constraints and the bottleneck in order to increase throughput.

Operational Measures of Theory of Constraints (TOC)

The idea behind TOC is that raw materials is the only variable cost. Labour & variable overhead are considered as fixed cost. The theory of constraints (TOC) describes methods to maximize operating income under bottleneck situation as follows. For this purpose TOC has classified all the items under the following three measures :

1. Throughput contribution (T) = Sale - Direct materials cost of the goods sold.
2. Investments (I) = Sum of materials costs in direct materials, work in process, and finished goods inventories; R & D costs; and costs of equipment and buildings.
3. Operating Expenses (OE) = All costs of operations (other than direct materials) incurred to earn throughput contribution. Operating costs include salaries and wages, rent, utilities, and depreciation.

The objective of TOC is to increase throughput contribution while decreasing investments and operating costs. TOC considers a short run time and assumes that operating costs are fixed costs. Thus it can maximize Return on Investment (ROI).

The important concept behind TOC is that the production rate of the entire factory is set at the pace of the bottleneck resource. Hence, in order to achieve the best result. TOC emphasizes the importance of removing bottlenecks or limiting factor.

Q. 11 :

Classify the following items appropriately under the three measures used in the theory of constraints :

Sr. No.	Item
(i)	Research and development cost
(ii)	Rent / Utilities
(iii)	Finished goods inventory
(iv)	Depreciation
(v)	Labour cost
(vi)	Stock of Raw Materials
(vii)	Sales
(viii)	Cost of equipments and buildings

Goldratt's Five Step Method for Improving Performance

The theory of constraints describes the process of identifying and taking steps to remove the bottlenecks that restrict output. The theory of constraints considers short-run time horizons and assumes other current operating costs to be fixed costs. The key steps in managing bottleneck resources are as follows:

1. Identifying the System Bottlenecks : This step involves identification of constraints which restrict output from being expanded.
2. Describe How to Exploit the Bottlenecks : Having identified the bottlenecks it becomes the focus of attention since only the bottleneck can restrict or enhance the flow of products. It is therefore essential to ensure that the bottleneck activity is fully utilised. Decision regarding the optimum-mix of products to be produced by the bottleneck activity must be made.
3. Subordinate Everything Else to the Decision in Step-2 : This step requires that the optimum production of bottleneck activity should determine the production schedule of the non bottleneck activities.

   Let us consider an organisation dealing with a product which requires multiple parts and processed on different machines. With multiple parts in a product, dependencies arise among operations; some operations cannot be started until parts from previous operations are available. Waiting time appear for two reasons:

   - Parts that require processing at a bottleneck machine must wait in line until the bottleneck machine is free, and
   - Parts made on non-bottleneck machines must wait until parts coming off the bottleneck machines arrive.

   Therefore, the workers of non-bottleneck machines should not be motivated to improve their productivity if the additional output cannot be processed by bottleneck machine. Producing more non-bottleneck output results in increase in WIP inventories and no increase in sales volume. Therefore, the preferred course of action is that bottleneck machine should setup pace for non-bottleneck machine.
4. Elevate the System Bottlenecks or Increase Bottleneck Efficiency and Capacity : This step involves taking action to remove (that is elevate) the constraint. This might involve replacing a bottleneck machine with a faster one or providing additional training for a slow worker or changing of the design of the product to reduce the processing time required by a bottleneck activity.
5. Repeat the Process as a New Constraint Emerges: If the bottleneck activity has been elevated and replaced by a new bottleneck activity it is necessary to return to step 1 and repeat the process.

Procedure of TOC :

Step-1 : Find the total requirement of resources i.e. [No. of units x resources required per unit] Compute it for each department separately.

Step-2 : Calculate, Throughput accounting Ratio (TA ratio) = [(capacity required / capacity available) x 100] for each department.

Step-3 : The highest among the TA ratio will be considered as the bottleneck factor. So the problem is now converted into many product one limiting factor situation. Now, we have to follow the same procedure as followed in marginal costing for solving the problems of key factor. In TOC, the objective will be to maximize throughput contribution.

Q. 12 : [Old Syllabus]

A company produces 3 products A, B and C. The following information is available for a period.

Particulars	Product A	Product B	Product C
Contribution (Sales – Direct Materials)	Rs. 24	Rs.20	Rs. 12
Machine hours required per unit:			
Machine 1	12	4	2
Machine 2	18	6	3
Machine 3	6	2	1
Estimated sales demand	200	200	200

It is given that machine capacity is limited to 3,200 hours for each machine.

You are required to analyze the above information and apply TOC process to make the optimum use of bottleneck resource time.

Q. 13 : [Old Syllabus]

Gupta Ltd. produces 4 products P, Q, R and S by using three different machines X, Y and Z. Each machine capacity is limited to 6000 hours per month. The details given below are for July, 2013 :

Particulars	P	Q	R	S
Selling price p. u. (₹)	10,000	8,000	6,000	4,000
Variable cost p. u. (₹)	7,000	5,600	4,000	2,800
Machine hours required p. u.				
Machine X	20	12	4	2
Machine Y	20	18	6	3
Machine Z	20	6	2	1
Expected Demand (units)	200	200	200	200

Required :

(i) Find out the bottleneck activity.

(ii) Allocate the machine hours on the basis of the bottleneck.

(iii) Ascertain the profit expected in the month if the monthly fixed cost amounts to ₹ 9,50,000.

(iv) Calculate the unused spare hours of each machine.

Variations in Calculation of Throughput Accounting Ratios :

Different people have recommended different TA Ratios for measuring the operational efficiency of production process. Some variations in TA ratios are as follows. Please note that these TA Ratios are used for **Ranking the product** and not for deciding the bottleneck operation.

1. Throughput contribution per rupee of factory cost -

$$\frac{\text{Throughput Contribution per Bottleneck Minute}}{\text{Factory Cost per Bottleneck Minute}}$$

2. Throughput contribution per rupee of labour cost -

$$\frac{\text{Throughput Contribution per unit}}{\text{Labour Cost per unit}}$$

3. Throughput contribution per rupee of material cost -

$$\frac{\text{Throughput Contribution per unit}}{\text{Material Cost per unit}}$$

Q. 14 : [ICAI Module]

H. Ltd. manufactures three products. The material cost, selling price and bottleneck resource details per unit are as follows:

Particulars	X	Y	Z
Selling Price per unit (₹)	66	75	90
Material and other Variable Cost per unit (₹)	24	30	40
Bottleneck Resource Time (Minutes per unit)	15	15	20

Budgeted factory costs for the period are ₹ 2,21,600. The bottleneck resources time available is 75,120 minutes per period.

Required :

(i) Company adopted throughput accounting and products are ranked according to 'product return per minute'. Select the highest rank product.

(ii) Calculate throughput accounting ratio and comment on it.

Q. 15 : [Old Syllabus]

HG Plc. manufactures four products. The unit cost, selling price and bottleneck resource details per unit are given below. Using the data, answer questions (1), (2) and (3).

Particulars	Product W	Product X	Product Y	Product Z
	Rs.	Rs.	Rs.	Rs.
Selling price	56	67	89	96
Materials	22	31	38	46
Labour	15	20	18	24
Variable overhead	12	15	18	15
Fixed overhead	4	2	8	7
	Minutes	Minutes	Minutes	Minutes
Bottleneck resource time	10	10	15	15

(1) Assuming material, labour and variable overheads as a unit variable cost, if the products are ranked according to their contribution, the most profitable product is :

(a) W (b) X (c) Y (d) Z

(2) Assuming material, labour and variable overheads as a unit variable cost, if budgeted number of units to be sold are in the ratio W : 2; X : 3; Y: 3; Z : 4 and monthly fixed costs are budgeted to be Rs. 15,000, the number of units of W that would be sold at the budgeted breakeven point shall be nearest to :

(a) 106 units (b) 142 units. (c) 212 units (d) 283 units

(3) If the company adopted throughput accounting and the products were ranked according to 'product return per minute', the highest ranked product would be

(a) W (b) X (c) Y (d) Z

Q. 16 : [RTP - May 2018]

Z Plus Security (ZPS) manufactures surveillance camera equipment that are sold to various office establishments. The firm also installs the equipment at the client's place to ensure that it works properly. Each camera is sold for ₹2,500. Direct material cost of ₹1,000 for each camera is the only variable cost. All other costs are fixed. Below is the information for manufacturing and installation of this equipment:

Particulars	Manufacture	Installation
Annual Capacity (camera units)	750	500
Actual Yearly Production and Installation (camera units)	500	500

Required

The questions below are separate scenarios and are not related to each other.

(i) IDENTIFY the bottleneck in the operation cycle that ZPS should focus on improving. Give reasoning for your answer.

(ii) An improvement in the installation technique could increase the number of installations to 550 camera units. This would involve total additional expenditure of ₹40,000. ADVISE ZPS whether they should implement this technique?

(iii) Engineers have identified ways to improve manufacturing technique that would increase production by 150 camera units. This would involve a cost of ₹100 per camera unit due to necessary changes to be made in direct materials. ADVISE ZPS whether they should implement this new technique.

Solution 16 :

(i) Identification of Bottleneck: Installation of cameras is the bottleneck in the operation cycle. The annual capacity for manufacturing and installation are given to be 750 camera units and 500 camera units respectively. Actual capacity utilization is 500 camera units, which is the maximum capacity for the installation process. Although, ZPS can additionally manufacture 250 camera units, it is constrained by the maximum units that can be installed. Therefore, the number of units manufactured is limited to 500 camera units, which is restricted by the bottleneck installation operation. Therefore, ZPS should focus on improving the installation process.

(ii) Improving Capacity of Installation Technique: Every camera sold increases the throughput contribution by ₹1,500 per camera unit (i.e. sales price ₹2,500 less direct material cost ₹1,000 per camera unit). By improving the current installation technique an additional 50 camera units can be sold and installed. This will generate an additional throughput contribution of ₹75,000 (i.e. 50 units x ₹1,500 per camera unit). However, it would involve total additional expenditure of ₹40,000. The net incremental contribution would be ₹35,000.

Hence, it is advisable for ZPS to implement this technique.

(iii) Improving Manufacturing Capacity: We already have a manufacturing capacity to produce 750 camera units. This capacity is not utilised fully at present. It is not a bottleneck activity. Hence, spending an additional amount of ₹100 per camera unit is unnecessary to increase the manufacturing capacity.

Unless the installation capacity (i.e. bottleneck) is increased, there is no use of increasing manufacturing capacity. Therefore, ZPS should not go ahead with the proposal to improve the manufacturing technique.

Q. No. 17 : [May 2018 Exam]

Rohni Steel Company produces three grades of steel — super, good and normal grade. Each of these products (Grades) has high demand in the market and company is able to sell as much as it can produce these products.

The furnace operation is a bottleneck in the process. The company is running at 100% capacity. The company wants to improve its profitability. The variable conversion cost is ₹ 100 per process hour. The fixed cost is ₹ 48,00,000. In addition, the cost accountant was able to determine the following information about the three products :

Particulars	Super	Good	Normal
Budgeted units produced	6,000	6,000	6,000
Total process hours per unit	12	12	10
Furnace hours per unit	6	5	4
Unit selling price (₹)	3,600	3,400	3,000
Direct material cost per unit (₹)	2,100	1,900	1,720

The furnace operation is part of the total process for each of these three products. Thus furnace hours are the part of process hours.

Required :

(i) Determine the unit contribution margin for each product. **(5 Marks)**

(ii) Give an analysis to determine the relative product profitability, assuming that the furnace is a bottleneck. **(5 Marks)**

(iii) Management wishes to improve profitability by increasing prices on selected products. At what price would super and good grades need to be offered in order to produce the same relative profitability as normal grade steel? **(10 Marks)**

Solution 17 :

(i) Statement of Contribution :

Particulars	Super	Good	Normal
(a) Unit selling price (₹)	3,600	3,400	3,000
(b) Direct material cost per unit (₹)	2,100	1,900	1,720
(c) Total process hours per unit [given]	12	12	10
(d) Variable conversion cost [c x 100]	1,200	1,200	1,000
(e) Total variable cost per unit [b + d]	3,300	3,100	2,720
(f) Contribution per unit [a - e]	300	300	280
(g) Furnace hours per unit [given]	6	5	4
(h) Contribution per furnace hour [f / g]	50	60	70
(i) Ranking based on (h) above	III	II	I

(ii) If furnace is a bottleneck, then the ranking based on contribution per furnace hour is relevant to decide relative profitability. We can conclude that, Normal Grade Steel is the most profitable product, Good Grade Steel is moderately profitable product and Super Grade Steel is the lowest profitable product.

(iii) Contribution per furnace hour of Normal Grade Steel is ₹ 70. If we want the same relative profitability for Super Grade and Good Grade, then we should match this contribution per hour. We will have to change the sales price of Super Grade and Good Grade as follows :

Particulars	Super	Good
(a) Desired contribution per furnace hour	70	70
(b) Furnace hours per unit [given]	6	5
(c) Desired contribution per unit [a x b]	420	350
(d) Total variable cost per unit [WN(i) e]	3,300	3,100
(e) Revised Sales Price per unit [c + d]	3,720	3,450

SUPPLY CHAIN MANAGEMENT (SCM)

A complete chain of serving the customers or consumer is the composition of supply chain. It comprises of vendors that supply raw material, producers who convert the material into finished products, warehouses that store the goods, distribution centers that deliver to the retailers and retailers who sell the product to the ultimate user.

Supply chains encourage value-chains because, without them, no producer has the ability to give customers what they want, when and where they want, at the price they want. Deficiencies in supply chain reduce the ability of the producers to compete with each other.

The term supply chain can be referred to as the management of flow of goods and services, involves the movement and storage of raw materials, of work in process inventory and of finished goods from point of origin to point of consumption.

The Global Supply Chain Forum (GSCF) defines Supply chain management as the "integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders".

The following eight supply chain management processes are included in the GSCF framework:

- Customer Relationship Management, to manage and analyse customer's interaction and data throughout the life cycle with the main motive of improving business relations.
- Supplier Relationship Management, provides the structure for how relationships with suppliers are developed and maintained.
- Customer Service Management, provides the key points of contract for administering product and service agreements.
- Demand Management, provides the structure for optimising the customer's requirements with supply chain capabilities.
- Order Fulfillment, includes all activities necessary to define customer requirements, design the logistics network, and fulfill customer orders.
- Manufacturing Flow Management, includes all activities necessary to move products through the plants and to obtain, implement and manage manufacturing flexibility in the supply chain.
- Product Development and Commercialization, provides the structure for developing and bringing to market new products jointly with customers and suppliers.
- Returns Management, includes all activities related to sales returns or return of goods from customers for repairs during warranty or exchange of goods etc. It is a reverse logistics management.

Types of Supply Chain - Push and Pull Models :

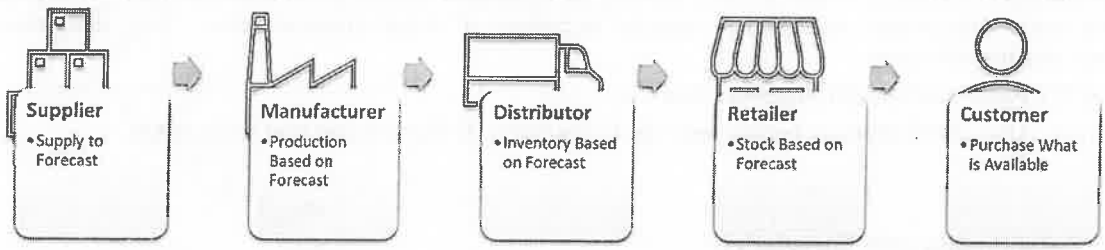
Under Push model goods are produced on the basis of anticipated customer demand. Distributor and retailers store the goods based on estimated demand. In this case, demand is forecasted using variety of sophisticated techniques. It is a product centric model. For example – manufacture of mobile handsets, vehicles etc. It is a traditionally used model.

Under Pull model goods are produced as per the requirement of customers. Here the focus is not on products but on customers. It is more customer centric model. It is a new business model. For example – Restaurants, Colour banks for Asian Paints, Domino's Pizza etc.

Activity Flow of Push Model :

1. Supplier will supply the raw material as per the estimated requirement of manufacturer.
2. Manufacturer will produce the goods based on anticipated demand.
3. Distributor will store the goods based on anticipated demand.
4. Retailer will also store the goods based on anticipated demand.
5. Customer will purchase whatever is available for sale with the retailer.

Note : In Push model, there is an overstocking of inventory and thus the inventory management cost is higher. Chances of obsolescence are higher.



Activity Flow of Pull Model :

1. Customer will order for the goods or services which he needs.
2. Retailer will supply the goods and will automatically replenish the stock.
3. Distributor will supply to retailer and will automatically replenish the stock in warehouse.
4. Manufacturer will produce as per the demand.
5. Supplier of inputs will order as per the requirement of manufacturer.

Note : In Pull model, there is no overstocking of inventory and thus the inventory management cost is much lower. Chances of obsolescence are greatly reduced.

This model uses a computerized system of handling customer orders on real time basis. For example – orders placed through Flipkart and Amazon or a cab booked through Ola & Uber etc.

Upstream and Downstream Flow of SCM

A supply chain begins right from the supplier and finally ends with delivery of goods or services to the end customer or consumer. In the total chain there are flows of material, information and capital or finance. When the flow relates to supplier of resources, it is termed as upstream flow. If the flow of goods or money is related with consumers or customers, then it is named as downstream flow.

Upstream Supply Chain Management

Management of transactions with suppliers of resources is termed as upstream supply chain management. Let's understand who these suppliers are. (1) Suppliers of raw material, components and spare parts (2) Labour contractors who supply workers (3) Suppliers of money i.e. shareholders, debenture holders, banks and financial institutions (4) Suppliers of services like AMC contracts, Auditors, Consultants, Telephone & Internet service providers (5) Suppliers of Plant & Machinery i.e. capital goods etc.

If we are able to obtain good quality of material and services at reasonable prices, then the quality of our output will also be good and cost efficient. Hence, we need to pay proper attention to the input suppliers, which is often termed as upstream supply chain management. However, the major discussion will revolve around suppliers of input material only. This discussion includes the following :

(1) Relationship with Suppliers and

(2) Use of Information Technology i.e. E-Sourcing, E-Purchasing and E-Payment.

1. Relationship with Suppliers :

Supplier Relationship Management (SRM) is undergoing a major transition. In today's global economy there are so many factors to consider when choosing and managing a supplier. Supplier capabilities of innovation, quality, reliability and costs/price reductions and agility to reduce risk factors all have witnessed significant changes when aligned with key suppliers. Let's imagine a company called Tata Motors and think about how many suppliers it might be managing.

Supplier Strategy:

To possess a commendable influence on the whole upstream flow, organization has to build up a set of strategies which in turn results in control over suppliers. This strategy is likely to take account of matters such as the following:

(a) Sources : Location and availability of source.

(b) Bargaining Power : The bargaining power of buying organization depends on that whether the suppliers' businesses is larger or smaller than the buying organization. In the era of globalization, companies may choose suppliers from different parts of world also.

(c) Number of Suppliers : In the event the buying company wants to avail huge discount, then bulk purchase from single supplier is advisable. However, if requirement is to avoid the risk of failed deliveries, then the buying company may prefer several or multiple suppliers.

(d) Cost, Quality, and Speed of Delivery : These factors are closely interrelated and the strategy will probably need to make compromises to achieve the right balance.

(e) Make or Buy and Outsourcing : Depending upon the application of various strategic cost management techniques, decision is required to be taken on to produce or to outsource.

2. Use of Information Technology :

The main activities of upstream supply chain are procurement and logistics. In modern business environment upstream supply chain management use **E-Procurement process**. E-Procurement is the electronic methods beginning from identification of the organization's requirements and end on payment. E-Procurement includes E-Sourcing, E-Purchasing and E-Payment.

(a) E-Sourcing : In E-Sourcing organization provide electronic invitation to tenders and request them to submit their quotations. Especially organization which may opt to choose tenders from different countries. E-Sourcing is the best possible way to find out the best supplier among others. This process reduces the cost, time and efforts associated with the selection of supplier than it is required in traditional method.

(b) E-Purchasing : In recent years, organizations are shifting from centralized purchasing to decentralization. Usage of technology has resulted in lesser time, lower cost & better result in product selection and ordering. Features of an E-Purchasing system include:

- Electronic catalogues for core/standard items.
- Recurring requisitions/shopping lists for regularly purchased items. The standard shopping lists form the basis of regular orders and the lists can have items added or deleted for each specific order.
- Electronic purchase orders dispatched automatically through internet to suppliers.
- Detailed management information reporting capabilities.

(c) E-Payment : After purchasing from the best possible supplier, payment also takes place through electronic mode i.e. invoicing and fund transfer. E-Payment results in faster payment with zero error which is expected in manual form.

E-Procurement is beneficial for organization as it results in lower cost, lesser time, quick ordering, selection of best supplier, control over inventory, better purchase and sales, greater financial transparency etc. However, the drawback is that, even a small problem in technology can crash the whole system in few moments.

Downstream Supply Chain Management

Management of transactions with consumers or customers is termed as downstream supply chain management. Customer is the person who buy your product or service and the Consumer is the person who actually uses (i.e. consumes) your product or service. Downstream SCM consists of the following activities :

1. Relationship Marketing
2. Customer Relationship Management – It consists of (a) Analysis of customers and their behaviour; (b) Customer Account Profitability (CAP); (c) Customers Lifetime Value (CLV) and (d) Customer selection, Acquisition, Retention and Extension.
3. Use of Information Technology
4. Brand Strategy

1. Relationship Marketing :

Marketing plays a vital role to successfully handle the downstream supply chain management. The Relationship marketing helps the organization to keep existing customers and to attract new customers through motivated staff, quality service / product, appropriate prices and proper customer care etc.

Six Markets Model identifies the six key "market domain" where organizations may consider directing their marketing activities.

(a) Internal Markets : Internal Markets are the crucial requirement for the success of relationship marketing. Internal markets include internal departments and staff. It is like selling the goods and services internally to our employees, staff, other departments and branches of the same company. For example – bank provides housing and vehicle loans to their staff.

(b) Referral Markets : Referral Markets include two main categories i.e. existing customers who recommend to others and referral sources such as a tax consultancy firm may refer work to a law firm.

(c) Influence Markets : Influence Markets represent entities and individuals, which have the ability to influence the marketing environment of a firm. It may include financial analysts, shareholders, press reporters, the government, and consumer groups. A good relationship needs to be developed by the firms with critical sources of influencers relevant to their markets.

(d) Recruitment Markets : Recruitment Markets are focal point for relationship marketing. Firms have to manage its relationships with recruitment markets such as commercial recruitment agencies, universities and institutes in order to have access to potential employees who possess the required skills for the job position.

[**Note** : In my opinion, it should be included in the Upstream SCM and not Downstream SCM.]

(e) Supplier's Markets : Supplier Markets refer to traditional suppliers as well as organizations with which the firm has some form of strategic alliance to gain benefits such as better quality, faster reach-to-market, original and creative products, and lower levels of inventory. For example – Hosing construction companies have tie-ups with banks for housing loans, Vehicle dealers have tie-ups with finance and insurance companies, Book stores have a tie-up with schools and colleges, Coaching institutes have tie-ups with hostels etc.

(f) Customer's Markets : Customer Markets represent all existing and prospective customers as well as intermediaries. They can be either consumers or intermediaries. It is an open market for all. In today's environment, the way firms provide services affects the market and helps in gaining more and more customers. Intermediaries are those who buy your product for re-sell or they buy your product and use it in their finished products. For example – Vehicle manufacturers buy tyres from tyre manufacturing companies, Computer & Laptop manufacturers buy Microprocessor chips & Operating System, Mobile manufacturers buy batteries etc.

The six markets model suggests that a firm must regulate its actions towards developing appropriate relationships with each of the market areas as the management of relationships in each of the six markets is critical for the attainment of customer retention objective.

2. Customers Relationship Management :

To manage and analyse customer's interaction and data throughout the life cycle with the main motive of improving business relations, the strategies and technologies used is known as Customer Relationship Management (CRM). Now a days, a CRM software is available, which provides all the necessary data to manage and handle the customers.

- Relation includes relations with customers, assisting in customer retention and driving sales growth. Customers under different channels are compiled through CRM.
- The staff dealing with customers get a detailed information about customer's personal information, purchase history, buying preferences etc.
- Organizations must ensure customers are satisfied with their products and services for higher customer retention. Remember one satisfied customer brings ten new customers with him where as one dissatisfied customer takes away ten customers along with him.
- In simpler words, CRM is knowing the needs of the customers and providing them with best possible solution.

(a) Analysis of Customers and their Behaviour

Analysis of customers is necessary based on geographical location or purchasing characteristics. For industrial customers, their expectations about - quality, discount, serviceability, quick delivery etc. should be taken into consideration. During such analysing process, management should keep in mind the physiological need, safety need, social need, status / ego need of existing and future customers.

(b) Customers Account Profitability (CAP)

Most firms today understand the source of their revenues, but unfortunately do not understand the source of their profits. Many organisations try to measure profitability of their products, or profitability of their branches and divisions, or profitability of their various business units etc. However, these attempts to judge the profitability can be severely misleading. What firms fail to do is to measure profit at the most meaningful and controllable level, the customer level. Understanding the components of cost and addressing specific causes of poor profitability associated with specific customers will significantly improve bottom-line performance.

Undertaking a customer account profitability improvement initiative is a five-step process: (i) Analyse your customer base and split them into different segments or groups; (ii) Calculate the annual revenue earned from each customer or each segment; (iii) Calculate the annual cost of serving each customer or a segment; (iv) Identify and retain the quality customers and (v) Eliminate or re-negotiate with the unprofitable customers or segments.

Customer Profitability Analysis is best conducted with a technique known as Activity Based Costing or ABC analysis. The net profit coming from each customer which can be calculated by revenue less costs can be done by this tool. These costs are not only manufacturing and distribution costs but also after sales costs, marketing costs, and any other related costs which have to be undertaken to service the customer.

After CAP analysis, customers are divided into different profit tiers. This principle is best observed in the banking industry with credit card as a product. Customers are basically classified into four types

- Platinum Customers – Most Profitable
- Gold Customers – Profitable
- Iron Customers – Low Profit but Desirable
- Lead Customers – Unprofitable and Undesirable

A credit card company would always give the best service as well financial and other benefits to the top two customers. It will at the same time try to attract iron customers and try to convert these iron customers to platinum or gold customers. Finally, these companies will have systems in place so as to avoid lead customers completely.

It is found that with customer profitability analysis, the firm can correctly classify customers and also find out which of the customers it needs to hold on to and acquire more of the same type, and which customers it needs to let go of. Several times, firms find out that there are customers which they should have left altogether as the profitability from these customers is minimum and expenses are more.

Cost calculation is one of the major problem in CPA. Calculating cost per customer becomes difficult especially in a service environment where manpower as well as time also has a cost factor associated with it. Time spent with each customer is different and therefore the cost is different. Furthermore, there are several non-quantifiable costs too. We popularly call it as cost of headache. If these costs are ignored, then right figures would be difficult to check. The customers will be shown more profitable than they are.

(c) Customers Lifetime Value (CLV)

Customer Life time value is the present value of net profit that we derive from a customer over the entire lifetime of relationship with that particular customer. It is the net present value of the projected future cash flows from a lifetime of customer relationship. It is an essential tool used in marketing to focus on more profitable customers and stop servicing non-profitable customers.

First of all, we need to ascertain the profits generated from each customer. ABC model helps in associating direct costs and indirect cost to a particular customer over a period of time to ascertain the profit margins from that particular customer. To ascertain the lifetime value, judgement with regards to the duration of relationships have to be made. These require detailed analysis of the strength of relationships, the likelihood, frequency and amount of repeated or additional sales, competitive products, customer loyalty etc. Thus, profit margins are then discounted at the firm's cost of capital or any other rate that may be determined by the organisation to arrive at the CLV.

(d) Customer's Selection, Acquisition, Retention and Extension

Customer Selection – Type of customer which the company needs to target has to be selected.

Customer Acquisition – A relationship needs to be developed with new customers.

Customer Retention – Keeping existing customers satisfied to retain them.

Customer Extension – To sell more products or other related products to the same customer.

3. The use of Information Technology in Downstream Supply Chain Management :

In managing downstream supply chain, one should link their sales system with the purchasing system through Electronic Data Exchange. Lot of organisations are now a days using E-Commerce platform to sale their products. Customer's buying habits, preferences, spending capacity etc. is closely monitored using the historical data. This helps in pushing another products to the same customers. It is called as Data Analytics.

E-mail is the modern way through which organization keeps touch with customers. Use of IT results in quick action, reduction in associated cost and saving in time.

4. Brand Strategy :

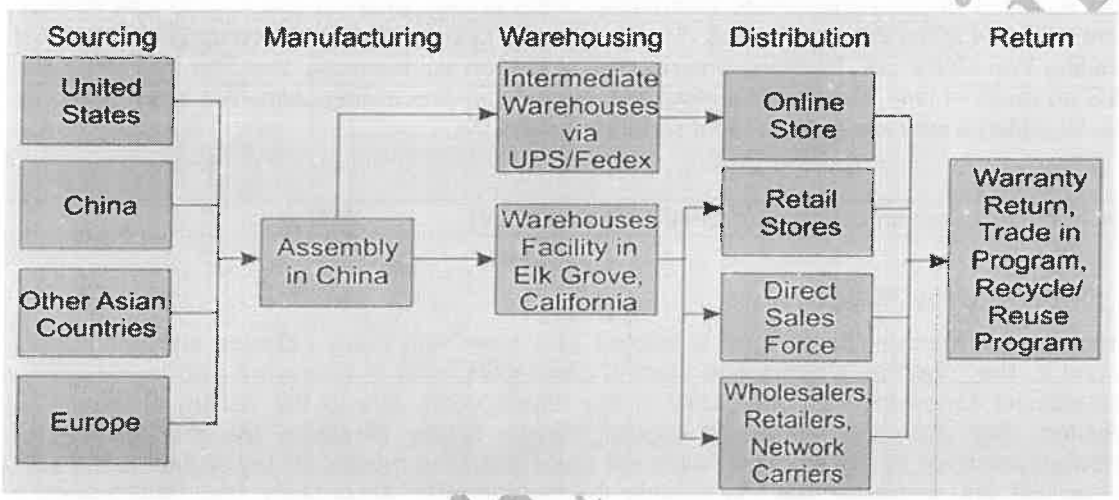
Specially branding of product makes a huge difference in its appeal to customers. Branding can be usage of logo or specific colour or any other means which makes the product or service distinctively visible among others. Branding helps the customer to recall the product quickly and helps in maintaining customer loyalty. For example – Parachute Coconut Oil is a Brand which belongs to Marico Ltd., Dettol is a Brand owned by an MNC called Reckitt Benckiser, Aashirvaad Atta is a Brand owned by ITC Ltd. and so on.

Benefits of Supply Chain :

Benefits of supply chain are enormous to any business. Highly controlled supply chain fetches tangible benefits such as inventory reduction, personnel reduction, productivity improvement, order management improvement, financial cycle improvement etc. Further it results in information visibility, new / improved processes, customer responsiveness, standardization-flexibility & globalization of business performance.

Apple's Supply Chain Model – Practical Insight

Apple Inc purchases raw materials from various sources, then get them shipped to an assembling plant in China. From there, assembler will ship products directly to consumers (via UPS/ Fedex), for those who buy from the Apple's Online Store. For other distribution channels, such as retail stores, direct sales from Apple Stores and other distributors, Apple Inc will keep products at warehouse facility at Elk Grove, California. At this place, a central warehouse and call center facility is located, which will inturn supply products from here. At the end of product's life, customer can send products back to the nearest Apple Stores or dedicated recycling facilities. It can be diagrammatically shown as follows :



Apple's Supply Chain has certain drawbacks as enumerated below:

- Some re-sellers may also distribute products from the competing manufacturers.
- Inventories can become obsolete or exceed the anticipated demand.
- Some components are currently obtained from the single or limited sources.
- Some custom components are not common to the rest of the industries.
- Ability to obtain components in sufficient quantities is important.

Apple being a marketing company is now-a- days having an inventory turnover ratio [cost of goods sold of digital content/ downloadable products are excluded] of 59 which is quite impressive. Apple has about 156 key vendors across the globe. In effective supply chain management, Apple synchronizes data between the central warehouse in California and its own 246 stores + customers. The success of its supply chain operations depends on how well they manage the supplier relationship. This includes early supplier involvement in new product development, close communication, and supplier performance improvement/evaluation.

Supply Chain Collaboration Between Wal-Mart and Procter & Gamble

Before Wal-Mart and Procter & Gamble started collaborating back in the '80s, retailers shared very little information with manufacturers. But then the two giants built a software system that hooked P&G up to Wal-Mart's distribution centers. When P&G's products run low at the distribution centers, the system sends an automatic alert to P&G to ship more. In some cases, the system communicates down to the individual Wal-Mart store, allowing P&G monitor the shelves through real-time satellite link-ups that send messages to the factory whenever a P&G item swoops past a scanner at the register. Within the last couple of years, the relationship has expanded to include radio-frequency identification (RFID) technologies to gain even more insight into the inefficiencies in the supply chain.

With this kind of minute-to-minute information, P&G knows when to make, ship and display more products at the Wal-Mart stores. There's no need to keep products piled up in warehouses awaiting Wal-Mart's call. Invoicing and payments happen automatically too. The system saves P&G so much in time, reduced inventory and lower order-processing costs that it can afford to give Wal-Mart a very low price, without suffering losses.

Practical Question on Customers Lifetime Value (CLV)

Q. 18 : [RTP - May 2019]

Cineworld is a movie theater and is located in a town with many colleges and universities around it. The town has a substantial student population, most of whom are avid movie goers. Business for Cineworld has been slow in the recent years due to the advent of streaming websites, that show the latest and popular movies online. However, the management of Cineworld continue to feel students would still enjoy watching movies on big-screen, along with the facilities and ambience that only a movie theater can offer. Accordingly, they have framed a plan to attract students by offering discounts on movie tickets.

The average time a student spends at the college or university is 4 years, which is the average duration of any course. For a nominal one-time subscription fee, Cineworld plans to offer students a discount on movie tickets for a period of 4 years. By attracting more footfalls, Cineworld targets to cross sell it food & beverages and souvenirs. This would help it sustain a reasonable revenue each year.

Cineworld would attract attention to the plan by initially offering free tickets, food and beverage and gift vouchers. This one time initial expense, net of the one-time subscription fee collected, would cost ₹ 5,000 per student. On subscription to the plan, the viewership and purchases of each student is expected to be as follows:

Particulars	Years 1 and 2	Years 3 and 4
Spend on movie tickets per year	2,000	1,500
Spend on food and beverage per year	4,000	3,000
Spend on souvenirs and accessories per year	2,250	750

Assumptions

1. Only 50% of the subscribers are expected to visit the theatres in years 3 and 4.
2. Across all years, only 75% of the subscribers who visit the theatre are expected to buy food and beverage.
3. Only 25% of the subscribers who visit are expected to buy souvenirs in years 1 and 2, and 10% of them in years 3 and 4.

Given that : PVIFA of ₹1 for 4 years at 10% = 3.169 and PVIFA of ₹1 for 2 years at 10% = 1.735

Required :

CALCULATE the customer lifetime value per subscriber for the above plan.

Solution 18 :

Customer lifetime value per subscriber can be found by calculating the present value of the revenue that is generated over the period of 4 years. This netted out with the cost incurred to attract subscribers, would give the customer lifetime value per subscriber.

S.N.	Particulars	Revenue (per year)	PVIFA	PV of Revenue	Probability of Usage	Net Revenue
1.	Net cost of attracting a student (one time exp)					(5,000)
2.	Net revenue from movie tickets					
	Years 1 - 2	2,000	1.735	3,470	100%	3,470
	Years 3-4 (refer note 1)	1,500	1.434	2,151	50%	1,076
3.	Sale of food and beverages					
	Years 1 - 2	4,000	1.735	6,940	75%	5,205
	Years 3-4 (refer note 2)	3,000	1.434	4,302	37.5%	1,613
4.	Sale of souvenirs and accessories					
	Years 1 - 2	2,250	1.735	3,904	25%	976
	Years 3-4 (refer note 3)	750	1.434	1,076	5%	54
5.	Total revenue (Steps 2+3+4)					12,394
6.	Net revenue from subscription plan (Step 5 - 1)					7,394

Note 1 : PVIFA (10%, 4 years) = 3.169 and PVIFA (10%, 2 years) is 1.735. Therefore, PVIF for years 3 and 4 = PVIFA (10%, 4 years) - PVIFA (10%, 2 years) = 3.169 - 1.735 = 1.434.

Note 2 : Only 50% of the subscribers are expected to attend in years 3 and 4. Out of those only 75% are expected to buy food and beverage. Therefore, only 37.5% of the subscribers (75% of 50% subscribers who visit) are expected to buy food & beverage in years 3 and 4.

Note 3 : Only 50% of the subscribers are expected to attend in years 3 and 4. Out of those only 10% are expected to buy souvenirs. Therefore, only 5% of the subscribers (10% of 50% subscribers who visit) are expected to buy souvenirs in years 3 and 4

Conclusion : Net present value of a customer (lifetime value) per subscriber is ₹ 7,394. Cineworld has to multiply this with the expected total number of subscribers, to find out if this would be a profitable proposition or not.

GAIN SHARING ARRANGEMENTS

- Gain sharing is an approach to the review and adjustment of an existing contract, or series of contracts, where the adjustment provides benefits to both parties.
- A fundamental form of gain sharing is where a supplier agrees to perform its side of the contract with no guarantee of receiving a payment.
- Instead, any payment received is based upon the benefits that emerge to the customer as a result of the successful completion of the supplier's side of the bargain.
- This is clearly a risky stance for the supplier, because it could spend a fortune and walk away with nothing.
- Alternatively, if the benefits to the customer are substantial, the supplier could find itself rewarded with a large return.
- In this situation, the supplier could almost be described as taking an equity stake in the customer rather than entering into a contract with it.
- Gain-sharing deals are, on the face of it, a win-win situation for suppliers and their customers.
- It is similar to Employee Stock Option Schemes (ESOPS). In ESOP, prosperity of an organisation is shared between its employees by making them the shareholders of the company. In a similar manner, here we are offering our suppliers an opportunity to become our business partners.
- In Hindi Film making business, a new trend has started. The lead actors are asking for a certain percentage of revenue sharing from the film producer. Hence, they participate in the promotion activities of the film as well.
- In the business of printing and publishing of books, this practice is prevailing since a long time. Publisher of the book shares a certain percentage of sales revenue with the author of the book as royalty and he also shares a fixed percentage of sales revenue with the retailers as their sales commission.

Another imaginary example of cost saving with gain sharing arrangement at X Ltd. :

- Supplier will deliver 3% minimum cost savings on *controllable portion* of costs.
- Cost savings generated in first year as a result of Supplier idea will be retained by Supplier.
- Cost savings generated in year second will be shared between X Ltd. and Supplier at a ratio of 40% : 60%.
- Cost savings generated in year three & onwards will be passed to X Ltd.
- Any cost savings generated by an idea proposed exclusively by X Ltd. that does not require capital investment by Supplier will be immediately passed to X Ltd.

Question 19 : [Jan. 2021 Exam - 8 Marks]

The newly appointed Finance Director Mr. Praveen, in the month of September wants to make the billing pattern simple and proposed to change the price quoting methodology of the organization. The details of his proposal are listed below –

The target cost for each research work is fixed in consultation with the client and the ABC Ltd. receives a bonus for completing the work below target cost.

For particular research conducted for Mr. Mohan, ABC Ltd has agreed upon a target cost of ₹ 20,00,000 and a target fee of ₹ 1,40,000. If the ABC Ltd completes the research at a lower cost than ₹ 20,00,000 then it will receive an additional profit up to a maximum profit of ₹ 1,80,000. If ABC Ltd completes the work for more than the target cost, then it will receive less profit but at least ₹ 40,000.

If the work is performed below the target cost, the client keeps 80% of the savings and leaves 20% of the surplus to ABC Ltd as an extra profit up to a maximum of ₹ 1,80,000. If the cost of research work exceeds the target cost, then client would bear 80% of the excess costs over and above the target cost and ABC Ltd would bear 20%, which is subtracted from the target fees as long as the fees is not less than ₹ 40,000.

If the actual work is performed at a cost of ₹ 19,00,000, CALCULATE the following :

(i) Cost saving for the project.

(ii) ABC Ltd's share in surplus.

(iii) ABC Ltd's total profit.

(iv) Total cost to Mr. Mohan for market research work. **(1 x 4 = 4 Marks)**

Now assume that ABC Ltd. has spent ₹ 24,00,000 for performing the work. Ascertain :

(v) Cost overturn.

(vi) Mohan's burden.

(vii) ABC's burden

(viii) Total Cost to Mr. Mohan for market research work **(1 x 4 = 4 Marks)**

Answer 19 :

Student Note : In the first reading, who is Mr. Praveen and who is Mr. Mohan cannot be captured properly. But, after a careful reading, we will come to the conclusion that - Mr. Praveen is Finance Director of ABC Ltd. i.e. the service provider. Mr. Mohan seems to be the client of ABC Ltd. who wants to get the research work done from ABC Ltd.

Hint : ABC Ltd's Profit = Share in Surplus + Agreed Fees for the work

If the actual cost of work performed amounted to ₹ 19,00,000

(i) Cost Saving for the project = ₹ 20,00,000 – ₹ 19,00,000 = ₹ 1,00,000

(ii) ABC Ltd's Share in Surplus = ₹ 1,00,000 x 20% = ₹ 20,000

(iii) ABC Ltd's Total Profit = ₹ 20,000 + ₹ 1,40,000 = ₹ 1,60,000

(iv) Total Cost to Mr. Mohan for market research work = Actual cost of the project + Amount payable to ABC Ltd. = ₹ 19,00,000 + ₹ 1,60,000 = ₹ 20,60,000.

If the actual cost of work performed amounted to ₹ 24,00,000

(v) Cost overrun = ₹ 24,00,000 – ₹ 20,00,000 = ₹ 4,00,000

(vi) Mohan's burden = ₹ 4,00,000 x 80% = ₹ 3,20,000

(vii) ABC's burden = ₹ 4,00,000 x 20% = ₹ 80,000

(viii) Total Cost to Mr. Mohan for market research work = Actual cost of the project + Fees payable to ABC Ltd. - Burden borne by ABC Ltd.

= ₹ 24,00,000 + ₹ 1,40,000 - ₹ 80,000 = ₹ 24,60,000

OUTSOURCING

- Outsourcing (also sometimes referred to as "contracting out") is a business practice used by companies to reduce costs and improve efficiency by shifting tasks, operations, jobs or processes to another party for a span of time.
- The contract given to third party can be done at the premises of outside party. Outsourcing is a cost saving measure, and practicing this can have a significant impact on manufacturing.
- Outsourcing is not limited to manufacturing. Giving services to customer such as those in a call center, and computer programming jobs are also outsourced by companies seeking ways to reduce costs.
- A part of product may even be purchased from outside this would be within the purview of outsourcing, such as components for computer equipment. The component can be purchased for a lower cost than it would be for the company to manufacture that component themselves, and the component may be of higher quality.
- Outsourcing is often an integral part of downsizing or reengineering.
- **Some Real Life Examples are –**
  (a) All banks have outsourced the ATM machine services and cash refilling to outside agencies.
  (b) Maintenance of Generators, Invertors, Air Conditioners etc. is generally outsourced.
  (c) Management of Receivables i.e. Debtors is outsourced by big companies, which is popularly known as Factoring Service.
  (d) In Multi-Speciality hospitals (i.e. big hospitals), the cleaning and house keeping services are outsourced.
  (e) In Big Malls, Multiplexes, Schools and Colleges, Railway Stations and Airports, the parking service is generally outsourced.
  (f) In the manufacturing sector, vehicle manufacturers and electronic goods manufacturers generally buy majority of the components and parts from outside suppliers. It is also a form of outsourcing.
  (g) India is popularly known as back office of the world. In India, we have lot of BPO companies, who are managing the back office work of Multi National Companies.
  (h) In the modern world, people hire the services of Event Managers for conducting the Business or Family Programmes like Launching a new product, Marriage Function, Birthday Parties etc. This list is unending...

Advantages of Outsourcing

- Outsourcing helps in cost savings. The lower cost of operation and labour, and reduction in overhead costs makes it attractive to outsource.
- It frees an organization from investments in technology, infrastructure and people that make up the bulk of a back-end process capital expenditure.
- It gives businesses flexibility in staffing and manpower management.

Disadvantages of Outsourcing

- One of the biggest disadvantages is the risk of losing sensitive data and the loss of confidentiality.
- Control of operations and of activities goes in the hands of outside agencies.
- Inexperienced workers or improper process can lead to quality problems.
- We become dependent on others.

* * * * *

3 LEAN SYSTEM AND INNOVATION

"Chance Favors the Prepared Mind." – Louis Pasteur

Lean System

- Lean System is an organized method for waste minimization without sacrificing productivity within a manufacturing system.
- Here 'Waste' means wastage of any kind of resources and not just the waste material generated in the manufacturing process.
- The objective of Lean System is to identify and then remove the wastage of any of the resources from the system of the organisation.
- Lean implementation emphasizes the importance of optimizing work flow through strategic operational procedures while minimizing waste and being adaptable.
- Any activity which is not required to complete a process is called as "Non-Value Added Activity." It is identified and removed from the system.
- Any activity which is required to deliver a satisfactory product or service to the customer is known as "Vale Added Activity" and it will remain in the process.
- For example – ECS system of payment of dividend, Single KYC for all financial transactions etc.

There are generally 7 types of wastes :

1. **Overproduction** : Producing ahead of demand.
2. **Inventory** : Having more inventory than is minimally required at any point in the process, including end-product.
3. **Waiting** : Waiting includes products waiting on the next production step.
4. **Motion** : People or equipment moving or walking more than is required to perform the process.
5. **Transportation** : Moving products that is not actually required to perform the process.
6. **Defects** : Rectification of defective items, which are not correctly produced in the first stroke itself.
7. **Over Processing** : Unnecessary work elements (non-value added activities).

Characteristics of lean manufacturing :

- Zero waiting time
- Zero inventory
- Pull processing
- Continuous flow of production
- Continuously finding ways of reducing process time.

Some of the techniques of Lean System are :

- Just-in-Time (JIT)
- Cellular Manufacturing / One-Piece Flow Production Systems
- Kaizen Costing
- 5 S
- Total Productive Maintenance (TPM)
- Six Sigma (SS)

Most of the above techniques are based on following principles :

- Perfect first-time quality
- Waste minimization
- Continuous improvement
- Flexibility

Note : Let's discuss each one of the above techniques in detail.

Just in Time System (JIT)

A just in time approach is a collection of ideas that streamline a company's production process and activities to such an extent that wastage of all kinds viz., of time, material, and labour is systematically driven out of the process. JIT has a decisive, positive impact on product costs.

A complete JIT system begins with production, includes deliveries to a company's production facilities, continues through the manufacturing plant, and even includes the types of transactions processed by the accounting system.

CIMA defines :

"Just-in-time (JIT): System whose objective is to produce or to procure products or components as they are required by a customer or for use, rather than for stock. just-in-time system Pull system, which responds to demand, in contrast to a push system, in which stocks act as buffers between the different elements of the system such as purchasing, production and sales".

"Just-in-time production: Production system which is driven by demand for finished products, whereby each component on a production line is produced only when needed for the next stage".

"Just-in-time purchasing: Purchasing system in which material purchases are contracted so that the receipt and usage of material, to the maximum extent possible, coincide".

Raw Material Inventory Management under JIT : (i.e. JIT Purchasing)

- To begin with, a company must ensure that it receives products/spare parts/materials from its suppliers on the exact date and at the exact time when they are needed. For this reason the purchasing staff must investigate and evaluate every supplier, eliminate those which could not keep up with the delivery dates.
- In addition, deliveries should be sent straight to the production floor for immediate use in manufactured products, so that there is no time to inspect incoming parts for defects.
- Instead, the engineering staff must visit supplier sites and examine their processes, not only to see if they can reliably ship high-quality parts but also to provide them with engineering assistance to bring them up to a higher standard of product.
- As soon as the suppliers are certified for their delivery and quality, the concern must install a system, which may be as simplistic as a fax machine or as advanced as an electronic data interchange system or linked computer systems, that tells suppliers exactly how much of which parts are to be sent to the company.
- Drivers then bring small deliveries of material and parts to the company, possibly going to the extreme of dropping them off at the specific machines that will use them first.

WIP & FG Inventory Management under JIT : (i.e. JIT Production)

- In most of the factories equipment is changed over to new configurations as rarely as possible because the conversion is both lengthy and expensive. When setups take a long time, company management authorizes long production runs, which spreads the cost of the setup over far more units, thereby reducing the setup cost on a per-unit basis. However, with this approach too many products are frequently made at one time, resulting in product obsolescence, inventory carrying costs, and many defective products (because problems may not be discovered until a large number of items have already been completed). 'But under JIT system a different approach to the setup issue is followed which focuses on making a **video tape** of a typical set up, instead of reducing the length of equipments setups and thereby eliminating the need for long production runs to reduce per unit costs. A team of industrial engineers and machine users examines this tape, spotting and gradually eliminating steps that contribute to a lengthy setup. It is observed that, after a number of iterations, we can achieve setup times in minutes whereas the previous setup times were well into hours.
- It is not sufficient to reduce machine setup times because there are still problems with machines not being coordinated properly so that there is a smooth, streamlined flow of parts from machine to machine. In most of the companies there is such a large difference between the operating speeds of different machines that work-in-process inventory builds up in front of the slowest ones. Not only does this create an excessive quantity of work-in-process inventory, but defective parts produced by an upstream machine may not be discovered until the next downstream machine operator works his way through a pile of work-in-process and finds them. By the time this happens the upstream machine may have created more defective parts, all of which must now be destroyed or reworked. There are two ways to resolve both problems.
- The first involves a "**kanban card**," which is a notification card that a downstream machine sends to each machine that feeds it parts, authorizing the production of just enough components to fulfill the production requirements being authorized in turn by the next machine further downstream. This is also known as a "pull" system, since kanbans are initiated at the end of the production process, pulling work authorizations through the production system. With this approach, there is no way for work-in-process inventory to build up in the production system, since it can be created only with a kanban authorization.

- The second way to reduce excessive work-in-process inventory and defective parts, is to, group machines into **working cells**. A working cell is a small cluster of machines which can be run by a single machine operator. This individual machine operator takes each output part from machine to machine within the cell; and thus there is no way for work-in-process to build up between machines. Also, this operator can immediately identify defective output which otherwise is difficult for each machine of the cell. This configuration has the additional benefit of lower maintenance costs since the smaller machines used in a machine cell are generally much simpler than the large, automated machinery they replace. Also, because the new machines are so small, it is much easier to reconfigure the production facility when it is necessary to produce different products, avoiding the large expense of carefully repositioning and aligning equipment.
- Both kanbans and machine cells should be used together—they are not mutually exclusive. By doing so a company can achieve extremely low product defect rates, as well as reducing investments in work-in-process inventory.
- Before the preceding steps are completed, it becomes apparent that a major change must also be made in the work force. The traditional approach is to have one employee maintaining one machine, which is so monotonous that workers quickly lapse into apathy and develop a complete disregard for the quality of their work. Now, with full responsibility for a number of machines, as well as product quality, workers become much more interested in what they are doing. To enhance this situation the human resource development department of organisation must prepare and organise training classes to teach to employees how to operate a multitude of different machines, perform limited maintenance on the machines without having to call in the maintenance staff, spot product errors, understand how the entire system flows, and when to halt the production process to fix problems. In short, the workforce must be completely retrained and focused on a wide range of activities. This usually results in a reconfiguration of the compensation system as well. Now the focus has shifted from high production volumes to high product quality. Workers should be well paid for taking up more responsibility.
- A major result of having an empowered workforce is that employees are allowed to stop their machines when they see a problem, and either fix it on the spot or immediately call in a repair team. In either case the result is immediate resolution of the bulk of performance problems. This one step has a profound impact on much of the manufacturing variance analysis. Historically, management accountants compile all kinds of variance information at the end of each month, investigate problems in detail, and then present a formal problem analysis report to management a few weeks after the end of the month. However, because the production staff resolved the underlying issues within a few minutes of their occurrence, the variance report becomes a complete waste of time. Management no longer cares what happened a month in the past because it is presently dealing with current problems that will not appear on management accountant reports for weeks to come. In short, the quick response capabilities of a JIT system allows the management accountant to omit a large amount of the variance reporting that was previously an important central job function.

JIT Supporting Accounting system :

- Finally, the massive changes caused by a JIT system also requires several alterations in the supporting accounting systems.
- Because of the large number of daily supplier shipments, the accounting staff faces the prospect of going through a large pile of accounts payable paperwork.
- To make the problem worse there is no receiving paperwork, because the suppliers deliver parts directly to the production operation, so there is no way to determine if deliveries have been made.
- To avoid the first problem, accountants can switch to making a single consolidated monthly payment to each supplier.

- The second problem requires a more advanced solution. To prove that a supplier has delivered the part quantities which it claims it has, the accounting system that can determine the amount of finished products created during the period and then multiply these quantities by the parts listed on the bill of materials for each product, obtaining a total quantity for each part used. The accountants then pay suppliers based on this theoretical production quantity, which is also adjusted for scrap during the production process (otherwise suppliers unfairly will not be paid for their parts that are scrapped during the company's production process). This approach also means that there is no need for suppliers to send invoices, since the company relies solely on its internal production records to complete payments.

Positive Impact of JIT System :

- Meeting customer demand in a timely manner
- Providing high quality products and
- Providing products at the lowest possible total cost.

Five Main Features of JIT System (i.e. summary) :

- Organise production in manufacturing cells, a grouping of all the different types of equipment used to make a given product. Materials move from one machine to another where various operations are performed in sequence. Material – handling cost are reduced.
- Hire and retain workers who are multi-skilled so that they are capable of performing a variety of operations, including repairs and maintenance tasks. Thus, labour idle time gets reduced.
- Apply TQM to eliminate defects. As, there are tight link stages in the production line, and minimum inventories at each stage, defect arising in one stage can hamper the other stages. JIT creates urgency for eliminating defects as quickly as possible.
- Place emphasis on reducing set-up time which makes production in smaller batches economical and reducing inventory levels. Thus, company can respond to customer demand faster.
- Carefully selected suppliers capable of delivering high quality materials in a timely manner directly at the shop – floor, reducing the material receipt time.

Essential Pre-requisites of a JIT system :

- Low variety of goods
- Vendor reliability
- Good communication
- Demand stability
- TQM
- Defect free materials
- Preventive maintenance

Impact of JIT System on :

- **Waste Costs:** A characteristic of the JIT system is its continuous focus on eliminating all waste from a system. This can be a waste of assets, excessive inventory. It can also be a waste of time, in the case of assets it may include unused assets for long periods of time (e.g., work-in-process inventory held in a production queue). It can also be a waste of materials, such as unnecessary levels of obsolete inventory, defective products, rework, and

the like. When fully installed, a JIT system vastly reduces all these types of waste. When this happens, there is a sharp drop in several aspects of a product's costs.

- **Overhead Costs:** The costs of material handling, facilities, and quality inspection decline when a JIT system is installed. In addition, the reduction of all types of inventory results in a massive reduction in the amount of space required for the warehouse facility. Since all costs associated with the warehouse are assigned to the overhead cost pool, the amount of overhead is reduced when the costs of staff, equipment, fixed assets, facilities, and rent associated with the warehouse are sharply cut back.
- **Product Prices:** When a company achieves a higher level of product quality, along with ability to deliver products on the dates required, customers may be willing to pay a premium. This is particularly true in industries where quality or delivery reliability is low. If customers are highly sensitive to these two factors, it may be possible to increase prices substantially. Alternatively, if these factors are not of great importance, or if customers place a higher degree of importance on other factors, then there will be no opportunity for a price increase.

Performance Measurements under Traditional and JIT System

Many of the performance measurement measures used under a traditional accounting system are not useful in a JIT environment. Certain new measures can be implemented that take advantage of the unique characteristics of this system.

- One of the key measurements in a traditional system is machine utilization : This is used to ensure that every asset a company purchases is being thoroughly utilized. It is particularly important in cases where there has been a large investment in automation or large high-speed machinery, since these items are quite expensive and should be used to the utmost. However, if we make machine utilization as a key measurement criteria; then production manager will try to manufacture as much as possible in order to show a high level of machine utilization. It can result in large amount of inventory piling up in the warehouse. This is not a desirable end result in a JIT environment, where producing only what is actually needed is the underlying rule. Also, small machine cells in a JIT system tend to be smaller and less costly than the highly automated (and expensive) juggernauts used in more traditional systems. Hence there is no need to justify the investment in these smaller machines by proving that they have been heavily used. In short, machine utilization measurements can be discarded under JIT environment.

- Another inappropriate measurement is any type of piece rate tracking for each employee: This is a common measure in the textile industry, where employees are paid extra if they exceed certain production volume targets. However, a JIT system focuses on producing only what is needed, so an employee who has incentives to create vast piles of parts is producing contrary to the rules of the system. Accordingly, any piece rate system must be eliminated. It should be replaced with measures that focus on the quality of output and the number of employee suggestions for improving the system, which are much more important outcomes in a JIT system.

- Any type of direct labour efficiency tracking is highly inappropriate in a JIT system: It is a key measurement in more traditional systems, where employee time and productivity are closely monitored and measured. However, a JIT system does not focus on how fast an employee works, but if focuses only on the quality of the products manufactured. Also, labour variance measurements require considerable employee time tracking, which forces workers to fill in a time sheet, punch a clock, or use a bar coding system to track what they are doing and what job they are working on. All this labour tracking is a non-value-added activity, which is something a JIT system strive to avoid as an unnecessary activity. Consequently, the management accounting staff should advocate the complete elimination of all labour variance measurements.

- Installing a JIT system does not mean that there should be a complete elimination of operational measures: There are still several measures that are highly relevant to operations. Some of them are :

  - **Inventory turnover Ratio** : Those who have installed JIT systems emphasize the extraordinarily high inventory turnover. The turnover levels of such well-known JIT companies as Toyota have been known to exceed 70 per year, as opposed to the levels of 2 to 10 per year that are more common for companies with other types of manufacturing systems. This measure is best subdivided into smaller parts, so that one can determine the turnover levels for raw materials, work in process, and finished goods.

  - **Setup time reduction**: The average setup time per machine is of great importance as it can be measured periodically and plotted on a trend line. The shortest possible setup intervals are crucial for the success of short production runs, so this is a major JIT measurement. It is best to measure it for each machine, rather than in the aggregate, since an aggregate measure does not reveal enough information about which equipments requires more setup time.

  - **Customer complaints**: A JIT system is partly based on the premise that product quality will be superb. Consequently, any hint from customers that there is product problem should be greeted with the gravest concern and investigated immediately. The accumulation of customer complaints and their prompt reporting to management should be considered a major JIT measure.

  - **Scrap**: Little waste should be generated by a JIT system, which means that materials scrap should be driven down to exceedingly low levels. The cost of scrap (especially when supported by a detailed list of items that were scrapped) is of particular concern as a JIT system is being implemented, since it helps to identify problem areas requiring further management attention.

  - **Cost of quality**: One focus of JIT is on creating high-quality products, so it is reasonable to keep track of the full cost of quality (which comprises defect control costs, failure costs, and the cost of lost sales) on a trend line. Managers want to see the details behind this measure, so that they know where the largest quality costs still reside in the company and can then work to reduce them.

  - **Customer service**: This measure really has several components like - delivering products on the dates required by customers, shipping full orders to customers, not having products returned because of poor quality etc. This measure can be summarized in a variety of ways or reported at the component level, but the main issue is to measure and post the information for all to see, so that the company focuses strongly on providing the highest possible degree of customer service.

  - **Ideas generated**: A JIT system works best when employees pitch in with hundreds of suggestions for improvements that, when taken in total, result in a vastly improved, efficient operation. The amount of idea generation going on can be measured by the number of ideas per worker, the number of ideas suggested in total, the number of ideas implemented, or the proportion of ideas suggested that are implemented.

The common theme that unites all the JIT measures listed above is that they are not financial in nature (with the exception of the cost of quality). They are operational measures that focus attention on the nuts-and-bolts details of creating and running a JIT system. A management accountant involved in the calculation and reporting of these measures may feel that this is quite a departure from the more traditional cost variance measures, but the end result will be a much more efficient JIT process that churns out and delivers high-quality products.

Back-flushing in a JIT System

Back-flushing requires no data entry of any kind until a finished product is completed. At that time the total amount of finished goods are entered into the computer system, which multiplies it by all the components listed in the bill of materials for each item produced. This yields a lengthy list of components that should have been used in the production process. This consumption is further adjusted for defective production, scrap and waste generated in the production process. Thereafter this consumption if added with the closing stock (if any) and opening stock is subtracted to arrive at the amount of inventory purchased during the period. Given the large transaction volumes associated with JIT, this is an ideal solution to the problem.

However, there are some serious problems with back-flushing that must be corrected before it will work properly. They are:

- Production reporting: The total production figure entered into the system must be absolutely correct, or else the wrong component types and quantities will be subtracted from stock. This is a particular problem when there is high turnover or a low level of training to the production staff that records this information, which leads to errors.
- Scrap reporting: All abnormal scrap must be diligently tracked and recorded; otherwise these materials will fall outside the black-flushing system and will not be charged to inventory. Since scrap can occur anywhere in a production process, a lack of attention by any of the production staff can result in an inaccurate inventory. Once again, high production turnover or a low level of employee training increases this problem.
- Lot tracing: Lot tracing is impossible under the back-flushing system. It is required when a manufacturer need to keep records of each production lots, which are used to recall the products in case of customer complains.
- Inventory accuracy: As the inventory turnover ratio is very high, there is a constant movement of inventory. Counting the stock in such case becomes difficult at any point of time. Without correct stock adjustment, we will not get the correct figures of purchases.

Of all the issues noted here, the worst is a situation where the production staff is clearly incapable of providing sufficiently accurate scrap or production reporting for the back-flushing system. If there is an easily traceable cause, such as less capable workers on a particular shift, moving a few reliable employees into these positions can provide immediate relief from the problem. It may even be possible to have an experienced shift supervisor to collect this information. However, where this is not possible for whatever reason, computer system users experience back-flushing garbage in, garbage out (GIGO). Entering inaccurate information rapidly eliminates any degree of accuracy in the inventory records, requiring many physical inventory counts to correct the problem. Consequently, the success of a back-flushing system is directly related to a company's willingness to invest in a well-paid, experienced well-educated production staff that undergoes little turnover.

Concept of Takt Time in a JIT System

Takt Time is the maximum available time to meet the demands of the customer; this will help to decide the speed of / at manufacturing facility.

Takt time is the average time between the start of production of one unit and the start of production of the next unit, when these production starts are set to match the rate of customer demand.

$$\text{Takt Time} = \frac{\text{Available Production Time}}{\text{Total Quantity Required}}$$

For example,

Available Production Time is 'total available time for production' – 'planned downtime i.e. spent in shutdown and cleaning' = (480 minutes – 30 minutes) = 450 minutes per day. Total Quantity required is 10 units per day.

$$\text{Takt Time} = \frac{450\,\text{minutes}}{10\,\text{units}} = 45\,\text{Minutes}$$

Further explanation about 'Takt Time' :

First of all, this concept is missing in the ICAI module. However, it appeared first time in RTP of May 2020. 'Takt' is derived from a German word. It is the time available to fulfill customer demand. Few more examples are –

If a Chartered Accountant is devoting 8 hours of his effective time (excluding time losses) for his office work and he has to meet 20 clients in a day; then the average time available per client is

(8 hours x 60 minutes) / 20 clients = 480 minutes / 20 clients = 24 minutes per client

As a student, you have 3 hours to write a 100 marks paper. In such case, the time available per mark is = (3 hours x 60 minutes) / 100 marks = 1.8 minutes per mark i.e. takt time.

Let's assume that a particular student requires a time of 2 minutes per mark, then he will need 200 minutes to solve the entire question paper. He is falling short of 20 minutes. Increasing the time is not in our hands, hence either he will have to increase his speed of writing or leave a question of 10 marks. This adjustment done to match with 'Takt Time' is also known as Heijunka.

Heijunka (it is a Japanese word, which means production levelling and smoothing) can be applied in order to reduce variation between takt time. It means, increase the resources like machine / manpower or re-schedule the production plan.

Practical Insight of Mahindra & Mahindra (M&M)

M&M wanted to implement JIT at their main plant in Nasik as they were aware of the fact that JIT approach will help them to operate with minimal levels of inventory. Their business objective was to make all their suppliers "active participants" in the production process. They wanted that the suppliers should be "enabled" to know of any change in the whole production process and at the same time contribute actively. This was necessary to reduce the time-to-respond to a situation and help "just-in-time" approach in the production process.

Objectives

- Make all the suppliers active participants in the production process.
- Suppliers should be able to know of any change in the whole production process and at the same time contribute actively.
- Update to best practices for supply strategies for 400 vendors, 150 vehicles per day and 1,100 parts.
- Improvement of the replenishment efficiency.
- Reduction of stock at the assembly line favoring a flexible manufacturing.

Benefits of JIT

- By making the suppliers participant in the 'just-in-time" method of production, they could maintain the least inventory level.
- Suppliers could see on real time basis, the status of their supplies, bill settlement and host of other parameters.
- All active participants of a process, for instance, the process from a supplier to the dealer can handle change management with the help of a software solution and a defined process.
- Set up times are significantly reduced in the production process. Cutting down the set-up time, allowed the company to improve their bottom line to look more efficient.
- Having employee focused on specific areas of the system allowed them to process goods faster. Earlier they were doing too many jobs and their responsibilities were not clearly defined.
- Increased emphasis on the supplier customer relationships.

Practical Questions on JIT System

PROBLEM NO. 1 : [Old Syllabus]

The present output details of a manufacturing department are as follows :

Average output per week from 160 employees	48,000 units
Sale value of output	Rs. 6,00,000
Contribution earned towards fixed expenses and profit	Rs. 2,40,000

The Board of Directors plan to introduce the concept of small working cells under JIT system. It requires a worker to shoulder more responsibility and he is also responsible for his efficiency directly. The effect of this will be to reduce the number of employees to 120, and increasing the output per individual employee by 60%. To provide to necessary incentive to achieve the increased output, the Board intends to offer a 1% increase on the piece work rate of Re. 1 per unit for every 2% increase in average individual output achieved. To sell the increased output, it will be necessary to decrease the selling price by 4%.

Calculate the extra weekly contribution resulting from the proposed change and evaluate the desirability of introducing the change.

PROBLEM NO. 2 : [Old Syllabus]

JIT system calls for more innovation to reduce all possible wastes in the working system of an organisation. Sunil Hi-Tech Ltd. is a firm believer of JIT system and has introduced a suggestion box scheme. As per this scheme, the workers working on the shop floor are asked to give their valuable suggestions. This box is opened on every Sunday and an award equivalent to two month's saving in the effective cost p.a. is passed on to the employee whose suggestion is accepted.

One suggestion of an employee to use a Jig for a manufacturing operation of a component is accepted. The cost of the Jig which has a life of only one year is Rs. 2,000 and the use of the Jig will reduce the standard time by 8 minutes.

Compute from the following data the amount of award payable to the employee who has given the suggestion to use a Jig.

- Number of pieces to be produced in the year : 15,000
- Standard time per piece before use of Jig : 80 minutes
- Average wage rate of a workman : Rs. 160 per day of 8 hours
- Average efficiency of workmen : 80%

PROBLEM NO. 3 : [Old Syllabus]

ABC Co. Ltd. has an annual turnover of Rs. 6,00,00,000 from a range of products. Material costs and conversion costs account for 30% and 25% of annual turnover respectively.

Other information relating to the company is as follows :

(i) Stock values are currently at a constant level, being :

(a) Raw Material Stock : 10% of the material element of annual turnover.

(b) Work in Progress : 15% of the material element of annual turnover together with a proportionate element of conversion costs allowing for 60% completion of work-in-progress as to conversion costs and 100% completion as to material cost. The material cost : conversion cost ratio is constant for all products.

(c) Finished Goods Stock : 12% of the material element of annual turnover together with a proportionate element of conversion cost.

(ii) Holding and acquisition costs of materials comprise of fixed costs of Rs. 200,000 plus variable cost of Rs. 0.10 per Re. of stock held.

(iii) Movement and control costs of work-in-progress comprise of fixed costs of Rs. 280,000 per annum plus variable costs of Rs. 0.05 per Re. of material value of work in progress.

(iv) Holding and control costs of finished goods comprise fixed costs of Rs. 360,000 p.a. plus variable costs of Rs. 0.02 per Re. of finished goods (material cost + conversion cost).

(v) Financial charges due to the impact of stock holding on working capital requirement are incurred at 20% p.a. on the value of stocks held.

ABC Co. Ltd., is considering a JIT system, which will cause a number of changes which is estimated to affect stock levels and costs are follows :

1. Raw material stock : Negotiate delivery from suppliers on a just in time basis. Stock levels will be reduced to 20% of the present level. Fixed costs of holding and acquiring stock will be reduced to 20% of the present level and variable costs to Rs. 0.07 per Re. of stock held.
2. Work-in-progress : Convert the layout of the production area into a "dedicated cell" format for each product type, instead of the existing system which comprises groups of similar machines to which each product type must be taken. Work-in-progress volume will be reduced to 20% of the present level with the same stage of completion as at present. Fixed costs of movement and control will be reduced to 40% of the present level and variable costs to Rs. 0.03 per Re. of material value of work in progress.
3. Finished goods stock : Improved control of the flow of each product type from the production area will enable stocks to be reduced to 25% of the present level. Fixed costs of holding and control will be reduced to 40% of the present level and variable cost to Rs. 0.01 per Re. of finished goods held.

Required :

Calculate the annual estimated financial savings from the proposed changes in each of raw material stock, work-in-progress and finished goods stock.

PROBLEM NO. 4 : [Old Syllabus]

X Video Company sells package of blank video tapes to its customer. It purchases video tapes from Y Tape company @ Rs. 140 a packet. Y Tape company pays all freight to X video company. No incoming inspection is necessary because Y tape company has a superb reputation for delivery of quality merchandise.

Annual demand of X Video Co. is 13,000 packages. X Video Co. has 15% annual carrying cost on investment in average inventory. The purchase order lead time is two weeks. The purchase order is passed through Internet and it costs Rs. 20 per order. The relevant insurance, material handling etc. Rs. 3.10 per package per year.

X Video Co. has to decide whether or not to shift to JIT purchasing. Y tape company agrees to deliver 100 packages of video tapes 130 times per year instead of existing delivery system of 1,000 packages 13 times a year with additional amount of Rs. 2 per package. X Video Co. incurs no stockout under its current purchasing policy. It is estimated that X Video Co. incurs stockout cost on 50 video tape packages under a JIT purchasing policy. In the event of a stockout, X Video Co. has to rush order tape packages which costs Rs. 4 per package. Comment whether X Video Company should implement JIT purchasing system.

Z Co. also supply video tapes. It agrees to supply same tapes @ Rs. 136 per package under JIT delivery system. If video tape are purchased from Z Co., relevant insurance, material handling etc. would cost Rs. 3 per package against Rs. 3.10 in case of purchasing from Y tape Co. However, Z Co. doesn't enjoy so sterling reputation for quality.

X Video Co. anticipates following negative aspects of purchasing tapes from Z Co.

- To incur additional inspection cost of 50 paisa per package.
- Average stockout of 360 tape packages per year would occur, largely resulting from late deliveries. Z Co. cannot rush order at short notice. X Video Co. anticipates lost contribution margin per package of Rs. 8 from stockout.
- Customer are likely to return 2% of all packages sold due to poor quality of the tape and to handle this return an additional cost of Rs. 25 per package will be incurred.

Comment whether X Video Co. should place an order to Z Co.

Discuss financial as well as non-financial considerations involved in the decision.

PROBLEM NO. 5 : [ICAI Module]

KP Ltd. (KPL) manufactures and sells one product called "KEIA". Managing Director is not happy with its current purchasing and production system. There has been considerable discussion at the corporate level as to use of JIT system for "KEIA". As per the opinion of managing director of KPL Ltd. –

"Just-in-time system is a pull system, which responds to demand, in contrast to a push system, in which stocks act as buffers between the different elements of the system such as purchasing, production and sales. By using Just in Time system, it is possible to reduce carrying cost as well as other overheads".

KPL is dependent on contractual labour which has efficiency of 95%, for its production. The labour has to be paid for minimum of 4,000 hours per month to which they produce 3,800 standard hours.

For availing services of labour above 4,000 hours in a month, KPL has to pay overtime rate which is at 45% premium to the normal hourly rate of ₹ 110 per hour. For avoiding this overtime payment, KPL in its current production and purchase plan utilizes full available normal working hours. The excess production over demand will be used to meet sales of month with higher demand level. KPL has determined that the cost of holding inventory is ₹ 70 per month for each standard hour of output that is held in inventory.

KPL has forecast the demand for its products for the first six months of year 2018 as follows:

Month	Demand (Std. Hrs.)
Jan'18	3,150
Feb'18	3,760
Mar'18	4,060
Apr'18	3,350
May'18	3,650
Jun'18	4,830

Following other information is given:

(i) All other production costs are either fixed or are not driven by labour hours worked.

(ii) Production and sales occur evenly during each month and at present there is no stock at the end of Dec'17.

(iii) The labour is to be paid for their minimum contracted hours in each month irrespective of any purchase and production system.

Required :

As a chief accountant you are requested to COMMENT on managing director's view.

Solution 5 :

1. Statement Showing 'Inventory Holding Cost' under Current System:

Particulars	Jan	Feb	Mar	Apr	May	Jun
Opening Inventory (Std. Hours)	---	650	690	430	880	1,030
Add : Production (Std. Hours)	3,800	3,800	3,800	3,800	3,800	3,800
Less : Demand (Std. Hours)	3,150	3,760	4,060	3,350	3,650	4,830
∴ Closing Inventory (Std. Hrs.)	650	690	430	880	1,030	---
Average Inventory (Std. hrs.) (Op. + Clo. Inventory) / 2	325	670	560	655	955	515
Inventory Holding Cost @ ₹ 70/hr. based on average inventory (₹)	22,750	46,900	39,200	45,850	66,850	36,050
Total Inventory holding cost for 6 months (₹)						₹ 2,57,600

2. Statement Showing 'Overtime Cost' under JIT System:

Particulars	Jan	Feb	Mar	Apr	May	Jun
(a) Demand (Std. Hours)	3,150	3,760	4,060	3,350	3,650	4,830
(b) Production = Demand (Std. Hrs.)	3,150	3,760	4,060	3,350	3,650	4,830
(c) Normal Availability (Std. Hours)	3,800	3,800	3,800	3,800	3,800	3,800
(d) Overtime [b – c] (Std. Hrs.)	---	---	260	---	---	1,030

(e) Actual labour hours @ 95% efficiency [(d) / 0.95]	---	---	274	---	---	1,085
(f) Overtime wages @ 159.50/hr (₹)	---	---	43,703	---	---	1,73,057
(g) Total overtime wages for 6 months (₹)						₹ 2,16,760
(h) Effective saving under JIT [2,57,600 – 2,16,760]						₹ 40,840

Comments :

(i) Considering a saving in cost of ₹ 40,840, it is advisable to implement JIT system. But the following factors to be kept in mind before adopting JIT system.

(ii) KPL has to ensure that it receives materials from its suppliers on the exact date and at the exact time when they are needed. Credentials and reliability of supplier must be thoroughly checked.

(iii) To remove any quality issues, the engineering staff must visit supplier's sites and examine their processes, not only to see if they can reliably ship high-quality parts but also to provide them with engineering assistance to bring them up to a higher standard of product.

(iv) The workforce must be completely retrained and focused on a wide range of activities. So that they are capable of performing a variety of operations at effective and efficient manner.

Notes / Assumptions :

(i) It is mentioned in the question that the labour is to be paid for their minimum contracted hours in each month irrespective of any purchase and production system. Hence, payment of normal wages will remain same under both the situations, and therefore it is irrelevant for decision making.

(ii) Under JIT system, we produce only as per demand and hence there is no inventory and therefore no inventory holding cost.

(iii) Under JIT system, we will have to work overtime to meet the increased demand and hence overtime wages are relevant for decision making.

Question 6 : [RTP May 2018 + Case Study Digest of ICAI]

Revolution Ltd. has entered into a contract to supply a component to a company which manufactures electronic equipments.

Expected demand for the component will be 70,000 units totally for all the periods.

Expected sales and production cost will be -

Period	1	2	3	4
Sales (units)	9,500	17,000	18,500	25,000
Variable cost per unit	30	30	32.50	35

Total fixed overheads are expected to be ₹14 lakhs for all the periods.

The production manager has to decide about the production plan.

The choices are:

Plan 1 : Produce at a constant rate of 17,500 units per period. Inventory holding costs will be ₹ 6.50 per unit of average inventory per period.

Plan 2 : Use a just-in-Time (JIT) system

Maximum capacity per period normally.....18,000 units

It can produce further up to 10,000 units per period in overtime.

Each unit produced in overtime would incur additional cost equal to 30% of the expected variable cost per unit of that period.

Assume zero opening inventory.

Required :

(i) CALCULATE the incremental production cost and the savings in inventory holding cost by JIT production system.

(ii) ADVISE the company on the choice of a plan.

(iii) DISCUSS any other factors involved in the decision.

Solution 6 :

1. Statement showing relevant costs under Plan 1 :

Period	1	2	3	4	Total
(a) Opening stock (units)	0	8,000	8,500	7,500	
(b) Production units	17,500	17,500	17,500	17,500	70,000
(c) Sales (units)	9,500	17,000	18,500	25,000	70,000
(d) Closing stock (units) [a + b – c]	8,000	8,500	7,500	0	
(e) Average stock (units) [(a + d) / 2]	4,000	8,250	8,000	3,750	
(f) Inventory holding cost (₹) [e x ₹ 6.50]	26,000	53,625	52,000	24,375	1,56,000
(g) Variable cost per unit (₹)	30	30	32.50	35	
(h) Total variable cost (₹) [b x g]	5,25,000	5,25,000	5,68,750	6,12,500	22,31,250

2. Statement showing relevant costs under Plan 2 :

Period	1	2	3	4	Total
(a) Sales (units)	9,500	17,000	18,500	25,000	70,000
(b) Production units = (a)	9,500	17,000	18,500	25,000	70,000
(c) Production in normal time	9,500	17,000	18,000	18,000	62,500
(d) Production in overtime [b – c]	0	0	500	7,000	7,500
(e) Variable cost per unit (₹) [for normal time is given]	30	30	32.50	35	
(f) Variable cost per unit (₹) [for overtime = e + 30%]	39	39	42.25	45.50	
(g) Total variable cost (₹) [(c x e) + (d x f)]	2,85,000	5,10,000	6,06,125	9,48,500	23,49,625

3. **Evaluation of Plan 2 (i.e. JIT system) :**

Particulars	₹
(a) Total variable production cost under Plan 1 [WN 1(h)]	22,31,250
(b) Total variable production cost under Plan 2 [WN 1(h)]	23,49,625
(c) Incremental cost under JIT system [b – a]	1,18,375
(d) Saving in inventory holding cost [WN 1 (f)]	1,56,000
(e) Net saving under JIT system [d – c]	37,625

Advice : Considering net saving of Rs. 37,625 it is advisable to implement Plan 2.

4. Other considerations :

Though Revolution Ltd is saving ₹37,625 by changing its production system to Just-in-time but it has to consider other factors as well before taking any final call which are as follows:-

— Revolution Ltd. has to ensure that it receives materials from its suppliers on the exact date and at the exact time when they are needed. Credentials and reliability of supplier must be thoroughly checked.

— To remove any quality issues, the engineering staff must visit supplier's sites and examine their processes, not only to see if they can reliably ship high-quality parts but also to provide them with engineering assistance to bring them up to a higher standard of product.

— Revolution Ltd. should also aim to improve quality at its process and design levels with the purpose of achieving "Zero Defects" in the production process.

— Revolution Ltd. should also keep in mind the efficiency of its work force. Revolution Ltd. must ensure that labour's learning curve has reached at steady rate so that they are capable of performing a variety of operations at effective and efficient manner. The workforce must be completely retrained and focused on a wide range of activities.

CELLULAR MANUFACTURING / ONE PIECE FLOW PRODUCTION SYSTEM

A Subsystem of JIT and Lean System is Cellular Manufacturing. It encompasses a group technology. It is the same system which we discussed above under JIT system i.e. small working cells. The goals of cellular manufacturing are:

- To move as quickly as possible,
- Make a wide variety of similar products,
- Making as little waste as possible.

In the assembly line production system, multiple cells are used. Each cell comprises of one or more machines which accomplish a certain task. The product moves from one cell to the next, each station completing part of the manufacturing process. U-shaped design is given to these cells because this allows for the supervisor to move less and have the ability to more readily watch over the entire process.

One cell is designed to manufacture a particular type of component or part, which will be used in the final product. Similar type of parts and components can be produced on large scale by making small alterations in the machine cell.

Flexibility in operations is its biggest advantage. Changes are easy to make as the machines are automatic. Minor changes to the overall design are made possible.

A cell is created by consolidating the processes required to create a specific output. It facilitates quick identification of problems and encourages communication of employees within the cell in order to resolve issues quickly. It increases productivity and quality while simultaneously reducing the amount of inventory, space and lead time required to create a product. It is for this reason that the one-piece-flow cell has been called "the ultimate in lean production".

Implementation Process

In order to implement cellular manufacturing, a number of steps must be performed.

First, the parts to be made must be grouped by similarity (in design or manufacturing requirements) into families.

Then a systematic analysis of each family must be performed; typically in the form of production flow analysis (PFA) for manufacturing facilities. This analysis can be time consuming and costly, but is important because a cell needs to be created for each family of parts.

Each cell is designed to minimize factors such as, "total cost of holding, inter-cell material handling, external transportation, fixed cost for producing each part in each plant, machine and labour salaries."

Difficulties in Creating Flow

Following difficulties need to be considered and addressed to create efficient flow in cellular manufacturing:

- Exceptional Elements
- Machine Distances
- Bottleneck Machines and Parts
- Machine Location and Relocation
- Part Routing
- Cell Load Variation
- Inter and Intracellular Material Transferring
- Cell Reconfiguring
- Dynamic Part Demands and
- Operation and Completion Times

Benefits and Costs

Scattered processes are merged to form short focused paths in concentrated places. So constructed, by logic a cell reduces flow time, flow distance, floor space, inventory, handling, scheduling transactions, and scrap and rework (the latter because of quick discovery of non conformities). Moreover, cells lead to simplified, higher validity costing, since the costs of producing items are contained within the cell rather scattered in distance and the passage of reporting time.

Production and quality controls are facilitated. Cells that are underperforming in either volume or quality can be easily isolated and targeted for improvement. The segmentation of the production process allows problems to be easily located and it is more clear which parts are affected by the problem.

There are also a number of benefits for employees working in cellular manufacturing. The small cell structure improves group cohesiveness and scales the manufacturing process down to a more manageable level for the workers.

Workers can more easily see problems or possible improvements within their own cells and tend to be more self-motivated to propose changes. Additionally, these improvements that are instigated by the workers themselves cause less and less need for management, so over time overhead costs can be reduced.

Question 7 : [RTP May 2021]

It has been resolved that cellular manufacturing shall be adopted in order to improve productivity, in the recent board meeting of **Raptor Bearing and Shaft Limited.** In favour of the resolution, Mr. Nayak (the executive director) who is responsible for production and operation function gave a briefing over different layouts of cells. The Managing Director, Mr. Syal believes that each possible cell formation and layout need to be studied in advance by a cross functional team.

Chief HR officer Mr. Mishra shows his concern over the utility of cellular manufacturing to enhance productivity. In response to him, Mr. Nayak mentioned 'Although scientific management is quite an old theory of management pronounced by Frederick Winslow Taylor, which analyses and synthesizes workflows with the objective of improving economic efficiency, especially labour productivity; but still has relevance. This relevance multi-folds when Time and Motion studies are considered in nexus with cellular manufacturing'.

Mr. Nayak constituted a cross-functional team with the term of reference stated in said board resolution. You are also a part of team as a representative of Management Accounting Division. The team started with the study of different possible layouts and machine cell designs. While analysing the production flow, it is observed that 5 different parts / components (P101, P104, P105, P107, and P108) are complexly involved in processing at 5 different machines (M2, M7, M13, M13A, and M15).

Part-Machine Incident Matrix for Production Flow Analysis for the said product is given below -

	P101	P104	P105	P107	P108
M2	1*				
M7		1#			1
M13	1*			1	
M13A		1#	1		
M15				1	

Interpretation :

(*) P101 requires processing at M2 and M13, whereas

(#) P104 requires processing at M7 and M13A and so on for the remaining parts also.

Required :

(i) DISCUSS the concern expressed by Mr. Mishra over the utility of cellular manufacturing.

(ii) EXPLAIN on utility of at-least three machine cell design, which can be used.

(iii) FIND logical part families and machine groups based upon Part-Machine Incident Matrix to showcase Machine-Part grouping using Rank Order Clustering Algorithm.

Answer 7 :

Student Note : The above question is more a **technical** in nature and seems to be picked up from the Engineering syllabus. ICAI wants a future CA to be expert in Production Planning & Engineering as well. Moreover, the concept of **'Rank Order Clustering'** is not available in ICAI module anywhere. It is first time used in this RTP only. In students language, it is out of the syllabus question.

ICAI answer is given below -

(i) Cellular manufacturing is a lean way to enhance productivity by improving (i.e. reducing) the performance in the context of time and motion involved in the production.

Cellular manufacturing is an application of group technology in manufacturing, in which all or a portion of a firm's manufacturing system has been converted into manufacturing cells.

Here it is important to note that a manufacturing cell is a cluster of machines or processes located in close proximity and dedicated to the manufacturing of a family of parts.

Cellular Manufacturing results in the following benefits to improve productivity –

(a) Reduce setup time by using part family tooling and sequencing.

(b) Reduce flow time by reducing material handling and transit time and using smaller batch sizes (even single piece flow – this also results in the requirement of less floor space).

(c) Reduce lead time.

(d) Reduced work-in-process inventory.

(e) Better use of human resources. Hence, reduced direct labour but heightened sense of employee participation.

(f) Better scheduling, easier to control, and automate.

(g) Increased use of equipment & machinery, hence reduced investment on machinery & equipment.

Hence, concern expressed by Mr. Mishra, regarding the utility of cellular manufacturing to enhance productivity is not tenable.

(ii) The Machine Cell Design can be classified based on the number of machines and the degree to which the material flow is mechanized between the machines. The most common designs are -

(a) **Single Machine Cell** consists of a machine plus supporting fixtures and tooling to make one or more part families. This can be applied **(useful)** to work parts that are made by one type of process such as turning or milling.

(b) **Group Machine Cell with manual handling** consists of more than one machine used collectively to one or more part families and no provision for mechanical part movement between machines. In this, human operators run the cell and perform material handling.

Note - If the size of the part is huge or there is a large number of machines in the cell, then regular handling crew may be required.

Preferable cell shape is **U-shaped** (single/few workers). U shape is useful in the movement of multi-functional workers.

Since the design simply includes certain machines in the group and restrict their use for specified part family, hence often achieved without rearranging the process type

layout. So, it brings the cost-saving (on rearranging) but lock-in material handling benefits of group technology.

(c) **Group Machine Cell with Semi-integrated handling** consists of more than one machine used collectively to one or more-part families and uses a mechanical handling system, such as conveyor, to move parts between machines in the cell.

Note – There may be **in-line layout** (identical or similar routing – machines are laid along a conveyor to match the processing sequence) and **loop layout** (allows parts to circulate in the handling system and permits different processing steps on the different parts in the system).

(d) **Flexible Manufacturing System** is a highly automated machine cell in group technology that combines automated processing stations with a fully integrated material handling system.

(iii) Rank Order Clustering Algorithm to form machine-part groups –

Assign **Binary Weight** (BW = 2^{n-1}) to each column j of the matrix, when n = 5 (the number types of components). Calculate the **Decimal Equivalent** (DE) of the binary values of each row using the formula :

$$DE = \sum_{j=1}^{n} (BW_j)\,(a_{ij})$$

Rank the rows in decreasing order of their DE values (i.e. the largest value is ranked as 1).

i \ j	P101	P104	P105	P107	P108	DE_i	Rank
M2	1					16	2
M7		1			1	9	4
M13	1			1		18	1
M13A		1	1			12	3
M15				1		2	5
BW_j	2^{5-1}	2^{5-2}	2^{5-3}	2^{5-4}	2^{5-5}		
	16	8	4	2	1		

Now, **Re-arrange** the rows in the running order of the rankings.

Since further rearrangement is necessary, assign **Binary Weight** (BW = 2^{m-1}) to each row i of the matrix, where m = 5 (the number of machines). Calculate the **Decimal Equivalent** (DE) of the binary values of each column j using the formula -

$$DE_j = \sum_{i=1}^{m} (BW_i)\,(a_{ij})$$

Rank the columns in decreasing order of their DE values i.e. the largest value is ranked 1.

i \ j	P101	P104	P105	P107	P108	BW_i	
M13	1			1		2^{5-1} =	16
M2	1					2^{5-2} =	8
M13A		1	1			2^{5-3} =	4
M7		1			1	2^{5-4} =	2
M15				1		2^{5-5} =	1
DE_j	24	6	4	17	2		
Rank	1	3	4	2	5		

Now, **Re-arrange** the columns in the running order of the rankings.

Since further rearrangement is necessary, assign **Binary Weight** to each column j of the matrix, where n=5. Calculate the **Decimal Equivalent** (DE) of the binary values of each row i using the formula.

$$DE_j = \sum_{j=1}^{n} (BW_j)\,(a_{ij})$$

Rank the rows in decreasing order of their DE_i values

i \ j	P101	P107	P104	P105	P108	DE_i	Rank
M13	1	1				24	1
M2	1					16	2
M13A			1	1		6	4
M7			1		1	5	5
M15		1				8	3
BW_j	2^{5-1}	2^{5-2}	2^{5-3}	2^{5-4}	2^{5-5}		
	16	8	4	2	1		

Now, **Re-arrange** the rows in the running order of the rankings.

Since further rearrangement is necessary, assign **Binary Weight** to each row i of the matrix, where m = 5. Calculate the **Decimal Equivalent** of the binary values of each column j using the formula :

$$DE_j = \sum_{i=1}^{m} (BW_j)\,(a_{ij})$$

Rank the columns in decreasing order of their DE_j values.

i \ j	P101	P107	P104	P105	P108	BW_i	
M13	1	1				2^{5-1}=	16
M2	1					2^{5-2}=	8
M15		1				2^{5-3}=	4
M13A			1	1		2^{5-4}=	2
M7			1		1	2^{5-5}=	1
DE_j	24	20	3	2	1		
Rank	1	2	3	4	5		

Since the ranking is now neatly arranged in order, stop the process. We can now identify the groupings.

Part Families and Machine Groups

Cluster/Cell	Parts	Machines
I	P101 and P107	M13, M2, and M15
II	P104, P105, and P108	M13A and M7

Question 8 :

You are a newly appointed management consultant with experience in Lean System. During discussion at a meeting, managing partner (Mr. Gupta) explain the assembly line workflow process at **RIO** along with the machine part incident matrix. You quoted about your past experience of implementing Cellular Manufacturing system. Mr. Gupta asks you to :

(i) FIND appropriate cells using suitable method.

(ii) COMMENT on the results, if any.

Note - Use "Rank Order Clustering method".

Machine Shop RIO-042
Machine Part Incident Matrix

Machine \ Part	P_1	P_2	P_3	P_4	P_5	P_6
M_b			1		1	
M_c				1	1	1
M_d	1	1				
M_e			1		1	1
M_f	1	1		1		

Answer 8 :

Student Note : It is very similar to the above question, hence only the matrix after every trial is given below. Steps for calculation of BW and DE are not repeated again. You may solve it on your own first and then check it with the answer below.

Just remember that in the above question there are 6 parts (i.e. 6 columns) and 5 machines (i.e. 5 rows). While calculating Binary Weight (BW) for columns, you will start with 2^{6-1} and while calculating BW for rows, you will start with 2^{5-1}.

Step 1 :

i \ j	P_1	P_2	P_3	P_4	P_5	P_6	DE_i	Rank
M_b			1		1		10	4
M_c				1	1	1	7	5
M_d	1	1					48	2
M_e			1		1	1	11	3
M_f	1	1		1			52	1
BW_j	2^{6-1}=	2^{6-2}=	2^{6-3}=	2^{6-4}=	2^{6-5}	2^{6-6}		
	32	16	8	4	2	1		

Now, **Re-arrange** the rows in the running order of the rankings.

Step 2 :

i \ j	P_1	P_2	P_3	P_4	P_5	P_6	BW_i	
M_f	1	1		1			2^{5-1}=	16
M_d	1	1					2^{5-2}=	8
M_e			1		1	1	2^{5-3}=	4
M_b			1		1		2^{5-4}=	2
M_c				1	1	1	2^{5-5}=	1
DE_j	24	24	6	17	7	5		
Rank	1	2	5	3	4	6		

Note : In case of a tie at Decimal Equivalent (DE), give the rank arbitrarily.

Now, **Re-arrange** the columns in the running order of the rankings. We have to continue this process, until all the ranks are in a normal sequence.

Step 3 :

i \ j	P_1	P_2	P_4	P_5	P_3	P_6	DE_i	Rank
M_f	1	1	1				56	1
M_d	1	1					48	2
M_e				1	1	1	7	4
M_b				1	1		6	5
M_c			1	1		1	13	3
BW_j	2^{6-1}	2^{6-2}	2^{6-3}	2^{6-4}	2^{6-5}	2^{6-6}		
	32	16	8	4	2	1		

Now, **Re-arrange** the **rows** in the running order of the rankings.

Step 4 :

i \ j	P_1	P_2	P_4	P_5	P_3	P_6	BW_i	
M_f	1	1	1				2^{5-1}	16
M_d	1	1					2^{5-2}	8
M_c			1	1		1	2^{5-3}	4
M_e				1	1	1	2^{5-4}	2
M_b				1	1		2^{5-5}	1
DE_j	24	24	20	7	3	6		
Rank	1	2	3	4	6	5		

Note : In case of a tie at Decimal Equivalent (DE), give the rank arbitrarily.

Now, **Re-arrange** the columns in the running order of the rankings.

Step 5 :

i \ j	P_1	P_2	P_4	P_5	P_6	P_3	DE_i	Rank
M_f	1	1	1				56	1
M_d	1	1					48	2
M_c			1	1	1		14	3
M_e				1	1	1	7	4
M_b				1		1	5	5
BW_j	2^{6-1}	2^{6-2}	2^{6-3}	2^{6-4}	2^{6-5}	2^{6-6}		
	32	16	8	4	2	1		

Since the ranking is now neatly arranged in order, stop the process.

We can now identify the cells.

Cell 1	P_1, P_2, P_4	M_f, M_d
Cell 2	P_5, P_6, P_3	M_c, M_e, M_b

The following cells, as derived from the Rank Order Clustering Algorithm, shall be presented to Mr. Gupta for consideration along with the below comments.

Cell 1		**Cell 2**	
Part Family 1	**Machine Group 1**	**Part Family 2**	**Machine Group 2**
P_1	M_f	P_5	M_c
P_2	M_d	P_6	M_e
P_4		P_3	M_b

Comments :

It is essential to understand that the cells are **not totally independent.** Since part P_4 which is a member of cell 1, needs processing on M_c, which belongs to cell 2. So, some amount of inter cell movement will take place in this situation. Only Part P_4 has to taken from Machine Cell 1 to Machine Cell 2 for processing. Other than this part, all other parts will be processed in their respective machine cells only.

In general, these movements may become unavoidable in real life circumstances. There are various alternative ways of eliminating inter cell moves in a cellular manufacturing system like – redesigning the part so that the machine belonging to other cell is no longer required for processing or subcontracting the part or adding an additional machine M_c in cell 1 etc. The cell designer should evaluate the consequences of each of these ways and take suitable measures to minimise these movements.

KAIZEN COSTING

Lean manufacturing is founded on the idea of kaizen, which means continuous improvement. Continuous improvement is the continual examination and improvement of existing processes and is very different from approaches such as business process re-engineering (BPR), which seeks to make radical one-off changes to improve an organization's operations and processes. This philosophy implies that small, incremental changes routinely applied and sustained over a long period result in significant improvements. The kaizen strategy aims to involve workers from multiple functions and levels in the organization in working together to address a problem or improve a particular process.

Some of the activities in the kaizen costing methodology include the elimination of waste in the production, assembly, and distribution processes, as well as the elimination of work steps in any of these areas. Though these points are also covered in the value engineering phase of target costing, the initial value engineering may not uncover all possible cost savings. Thus, kaizen costing is really designed to repeat many of the value engineering steps for as long as a product is produced, constantly refining the process and thereby stripping out extra costs. The cost reductions resulting from kaizen costing are much smaller than those achieved with value engineering but are still worth the effort since competitive pressures are likely to force down the price of a product over time, and any possible cost savings allow a company to still attain its targeted profit margins while continuing to reduce cost.

Kaizen Costing Principles :

- The system seeks gradual improvements in the existing situation, at an acceptable cost.
- It encourages collective decision making and application of knowledge.
- There are no limits to the level of improvements that can be implemented.
- Kaizen involves setting standards and then continually improving these standards to achieve long-term sustainable improvements.
- The focus is on eliminating waste, improving systems, and improving productivity.
- Involves all employees and all areas of the business.

Kaizen Costing in Practice :

A UK company called Kappa Packaging had a factory in Greater Manchester. It made cartons to hold bottles of drink. In the year 2002, the firm introduced a new approach of cardboard manufacturing by reducing the amount of waste generated in the process. The present waste was at 14.6 per cent of the raw materials consumed. The new approach included the following initiatives:

a) Making employees more aware of how much waste was being produced.

b) Requiring them to monitor the amount of waste for which they were individually responsible.

c) Establishing a Kaizen team to find ways of reducing waste.

As a result, Kappa was able to reduce waste from 14.6 per cent to 13.1 per cent of raw materials used by the end of 2002 and down to 11 per cent in 2003. Each 1% reduction in waste was worth an estimated saving of £110,000 a year.

Question 9 : Case Study on Kaizen Costing

Zen Limited is a leading mobile manufacturing company and sells its mobile phone across the world. In a fast-changing technological environment, Zen has been able to maintain its leadership in smartphone segment for third year in a row now. Though the revenues have grown year on year, the costs have increased at a higher rate in the mobile phone industry as a whole.

"We have been leaders in revenue. We must lead in cost reduction front as well. I believe we can achieve this with improvements over time, however minor they might be!" This is what the CEO of Zen has told its directors in a recently concluded board meeting.

The net profit margins of the company has fallen from 10% in 2016 to 8% in 2017 owing to rise in raw material & repair cost. Another significant rise in the cost was on account of repairs of mobiles which are under warranty. There was an increase in these repair costs by ₹1.5 crores which represent 1% of the total turnover of the company.

The process of repairs / replacement of under warranty product is outlined below:

- The company own 200 repair centres in various cities in India.
- A customer whose phone is under warranty and requires replacement / repair visits any of the 200 centres to deposit the faulty mobile phone.
- The technician at service centres examines the phone and the service centre sends the phone to a centralised repair centre at Mumbai. The phones are sent to Mumbai even for minor repairs which can be done locally if requisite infrastructure is provided to the service centres.
- The phones are sent in batches. Each service centre creates 3-4 batches of mobile phones in a day. (A recent study showed that the batches could be combined into a single batch per day)
- The phones are repaired in Mumbai's centralised centres and sent back to the respective service centres for handing them back to the customer. The phones which are repaired are sent in separate batches and those which are replaced are sent in separate batches.

Required :

You are working as a Finance Manager in Zen. The finance director has approached you to understand whether the minor improvement would be useful given the size of the company. The Finance Director has asked you to examine the process of warranty repairs and replacement and submit a report covering the following aspects:

(i) What is the CEO referring to when he says "minor improvements"?

(ii) What are the benefits of such minor improvements?

(iii) Apply the above process to the warranty claim processing work and explain how the process can be improved.

(iv) Any other matter which you consider relevant.

Solution 9 :

Issue

Zen limited is a leader in manufacturing of mobiles and is concerned about increasing costs. The increase in warranty related costs has been significant in the current year as compared to previous year. This has reduced the net profit of the company by 1% of sales.

(i) The CEO is referring to Kaizen costing when he mentions minor improvements to save costs over time. Kaizen costing takes into consideration various costs such as costs of supply chain, manufacturing costs, marketing, sales, distribution costs etc.

(ii) Benefits of Kaizen Costing

- Kaizen reduces waste in areas such as employees waiting time, transportation, excess inventory etc., which leads to improved efficiency in overall business processes and systems.
- A company applying Kaizen philosophy can achieve cost reduction through small incremental improvements and cost savings.
- Kaizen looks at functions and processes at all levels of organisation and requires participation of all employees and massive as well as open communication system. This participative approach improves teamwork across the organisation.
- Product improvement using Kaizen is likely to result in less number of defective products leading to customer satisfaction and reduction in warranty related costs.
- The reduction in wastage, improved efficiency and cost reduction improves the overall profitability of the company.

(iii) Application of Kaizen at Zen Limited

The current warranty claim process at Zen involves movement of mobile phones from various service centres across the country to a centralised centre in Mumbai. The possible improvements in the claim process is explained below -

- The company needs to analyse whether it requires owning 200 centres by itself across the country. The company can evaluate closing down centres with less customer footfalls or outsource the ones which are not located at the strategic location. This would save some cost to the company.
- The current process requires each service centre to send the faulty mobile phones back to Mumbai for repair or replacement. This is done even in case of minor repairs which can be handled locally. The company can provide necessary infrastructure to the service centres to carry out minor repairs locally. This would save logistics cost of sending the phones to Mumbai and back to service centre.
- The company should analyse the past data to understand the proportion of phones which require minor repair. Repairing the phones locally would also reduce the turnaround time and the customer will get back the phone faster. It will improve customer satisfaction ratio.
- The current process is to send phones in 3-4 batches in a day. This effectively means creating 3-4 consignments, documents for dispatches and incurring extra costs for transportation. Combining the phones in a single batch per day would reduce the cost of transportation and administrative cost as well.
- The phones can be sent back from Mumbai in single batch instead of creating multiple batches to save transportation costs.
- The above improvements must be revisited continuously to derive required benefit from Kaizen process.

(iv) Other Relevant Matters

- Apart from eliminating waste in the warranty claim process, the company must also identify root causes of increase in warranty claims in the current year as compared to previous year. Every phone being sent back for repair/replacement involves avoidable cost.
- Zen can consider producing better quality mobiles at the manufacturing process to reduce the warranty claims. For this purpose the company should revisit the manufacturing process and quality control processes to eliminate wastage in production process and improve quality.
- The pattern of warranty claim must be analysed to understand whether there is certain common problem related to repair claims. If the issue has some relation with parts used in mobile, the issue can be taken up with supplier of such parts.

5S

5S is the name of a workplace organization method that uses a list of five Japanese words : seiri, seiton, seiso, seiketsu, and shitsuke. It explains how a work space should be organized for efficiency and effectiveness by identifying and storing the items used, maintaining the area and items, and sustaining the new order.

There are 5S phases : It can be translated from the Japanese words to simple English with the meaning as "sort", "set in order", "shine", "standardize", and "sustain". These are explained further as below :

Sort (Seiri)

- Make work easier by eliminating obstacles and evaluate necessary items with regard to cost or other factors.
- Reduce chances of being disturbed with unnecessary items.
- Prevent accumulation of unnecessary items.
- In short, we need to sort out the necessary and unnecessary things lying around us. Keep the items necessary to perform our work and remove the unnecessary items, which may distract our attention.

Set In Order (Seiton)

- Arrange all necessary items into their most efficient and accessible arrangements so that they can be easily selected for use and make workflow smooth and easy.
- Ensure first-in-first-out FIFO basis, so that it is easy to find and pick up necessary items.
- Place components according to their uses, with the frequently used components being near to the work.
- In short, decide the sequence and place to keep the necessary items. It should be arranged in such a manner that we get these items easily as and when needed with minimum movement.
- For example – arrangement of medicines in a medical store and arrangement of instruments in an operation theatre.

Shine (Seiso)

- Clean your workplace on daily basis completely or set a cleaning frequency.
- Keep your workplace safe, easy to work, clean and pleasing to work in.
- In an unfamiliar environment, people must be able to detect any problem within 50 feet.
- In short, keep your work place neat and tidy. You can observe any deviation or problem from a long distance also, if your work area is disturbed.

Standardize (Seiketsu)

- Standardize the best practices in the work area.
- Maintain high standards, orderliness, everything in order and according to its standard.
- Every process has a standard.
- In short, find the best way (i.e. standard) of doing any work and adhere to these standards.

Sustain (Shitsuke)

- Sustain your progress with proper training and discipline, to maintain proper order.
- Also translates as "do without being told".
- In short, do the above things on a continuous basis and not once. Meaning, we should sustain what we are doing without being told. It may require proper training and discipline.
- For example – lot of people decide to do regular exercise and set it as a New Year goal. However, after first few days, this determination fades away and we go back to the original position. However, those who are able to do it regularly are sure to get benefited.

Six Sigma Concept

Introduction :

- Engineer Bill Smith introduced Six Sigma while working at Motorola in 1986. Six Sigma became well known after Jack Welch made it a focus of his business strategy at General Electric in 1995, and today it is widely used in many sectors of industry.
- It is quality improvement technique whose objective to eliminate defects in any aspect that affects customer satisfaction. The premise of Six Sigma is that by measuring defects in a process, a company can develop ways to eliminate them and practically achieve "zero defects".
- Six Sigma ensures that the no. of defects or errors are not more than 3.4 per million transaction. It means chances of defective production should be less than 3.4 in every 10,00,000 units manufactured. It means, the accuracy level should be 99.99966%.
- Six Sigma concept was pioneered by Bill Smith at Motorola corporation, USA and it was first implemented in India by Wipro Technologies.

The primary focus of Six Sigma is on:

- Customer satisfaction.
- Decisions based on data-driven facts.
- Management, improvements, and processes.
- Proactive management team.
- Collaboration with in the business
- Goal for perfection.

Numerical Concept of Six Sigma

Level of Sigma	Defects per Million Items Produced	% Defectives	% Accuracy
One Sigma	6,90,000 defects per million	69%	31%
Two Sigma	3,08,537 defect per million	31%	69%
Three Sigma	66,807 defects per million	6.7%	93.3%
Four Sigma	6,120 defects per million	0.62%	99.38%
Five Sigma	233 defect per million	0.023%	99.977%
Six Sigma	3.4 defects per million	0.00034%	99.99966%

Indian Example of Six Sigma :

- Bombay's Dabbewala's got six sigma rating in 2002 with the help of Forbes Magazine.
- According to a recent survey, they make less than one mistake in every 6 million deliveries.
- Their fame skyrocketed when Prince Charles met them in November, 2003 during his visit to India.

Six Sigma Methodology for Implementation :

For implementing six sigma in an organisation, there are **two** approaches or methodologies. One is for existing process and another is for new process. These two methodologies are very similar to each other, with a very minor difference. These are explained below :

1. **DMAIC :** It is an acronym for the five steps involved towards improvement of **existing** product, process or service. These five steps are :

- **Define :** First we need to define the goal to be achieved. The goal should be consistent with the overall strategy of the organisation and customer demand.
- **Measure :** Six Sigma experts will first measure the performance of existing process by collecting the relevant data. It will facilitate a comparison with the redesigned process at a later stage.
- **Analyse :** Analysis means verifying the cause and effect relationship. The experts will try to analyse the factors which are causing the problems in the existing process and its effect on the quality of service to the customer. A comprehensive (i.e. detailed) study has to be done of all the factors which influence the quality of existing process.
- **Improve :** Once the causes are identified, one has to prepare an improvement plan. It is the process of redesigning the existing production process to deliver better performance. One may have to select the best plan out of many choices available to improve the quality of service to the customer.
- **Control :** An organisation always faces problem in the process of implementation. Control means, comparing the expected performance of the redesigned process with the actual performance. The variation in the performance should be carefully studied to make further improvement to achieve the expected performance. It is a continuous process.

2. **DMADV** : It is again an acronym for the five steps involved towards implementation of six sigma. It is a strategy for designing a **new** product, process or service. These five steps are :

- **Define :** First we need to define the goal to be achieved. The goal should be consistent with the overall strategy or the organisation and customer demand. It is same as previous method.
- **Measure :** Six Sigma experts will establish the standards for measuring the performance of new product, process or service. It means, one has to identify the key factors to measure the success of six sigma process and lay down the standards of performance. It will facilitate a comparison with the actual performance at a later stage.
- **Analyse :** Here the meaning of analysis is to analyse the performance of various alternatives designed to achieve the success. It is a process of analysis and evaluation of various alternatives and then to select the best alternative.
- **Design :** Once the best alternative is selected, then one needs to design a detailed plan of action for implementation.
- **Verify :** An organisation need to verify the result of the six sigma process to understand whether it generates the desired outcome or not. Sometimes a quantitative technique called simulation (i.e. trial and error) is used to verify the result. Once the desired results are achieved through the simulation process, then the entire six sigma plan is implemented.

Six Themes of Six Sigma :

Theme 1 – Genuine focus on the Customer : In six sigma, customer focus becomes the top priority. The success of six sigma process is measured by the impact which it creates on customer satisfaction and value. Internal & External, both the customers are equally important.

Theme 2 – Data & Fact Driven Management : In six sigma process, the analysis and decision are based on facts and figures. Not on assumptions and opinions.

Theme 3 – Processes are where the action is : Six sigma positions the process as the key vehicle of success. It believes that mastering processes is a way to build competitive advantage in delivering value to customers.

Theme 4 – Proactive Management : Proactive means acting in advance and Reactive means acting after the things take place. Indirectly proactive means prevention and reactive means cure. Six sigma process makes you to think proactively.

Theme 5 – Boundaryless Collaboration : This concept was pioneered by Jack Welch, Chairman of General Electric (GE) company. He observed that the organisation is divided in to various groups and sub-groups and they create boundaries among themselves. In short, they do not have a close co-ordination among themselves. He recommended a boundary less organisation structure and stressed upon the need of teamwork across the entire organisation.

Theme 6 – Drive for Perfection; Tolerate Failure : These two statements seems to be contradictory to each other. However, they are not contradictory but are complementary to each other. Perfection cannot be achieved without trying and taking the risk of failure. Those who are afraid of failure, will never try. Hence, one must keep on trying new ideas and processes to achieve perfection in the work.

Implementation of DMAIC in Banking Sector :

In banking sector, DMAIC may be used as follows:

Define: Customer satisfaction & loyalty has a significant impact on financial performance of a bank. Six Sigma involves defining objectives and opportunities to improve (based on customer's feedback or complaints) in discussion with staff.

Measure: In this phase, Six Sigma experts deploy quantitative procedures to collect statistical data. Then the statistical data is used for measuring the impact of the various processes on customer satisfaction. Different processes may have different impact on customer satisfaction. The measurement of impact of the individual processes helps the banks to concentrate on improving the processes that have the maximum impact on customer satisfaction. In the banking industry, reduction in waiting time of customer is said to have the maximum impact on customer satisfaction.

Analyse: In this phase, Six Sigma experts analyse the data collected in accordance with the parameters set for improvement. So that, the processes (that directly affects customer's satisfaction) can be improved at minimum cost.

Improve: In this phase, experts take corrective measures to improve processes in consultation with staff based on facts and statistics. Advanced statistical tools can also be used to study the impact of the proposed improvement initiative on business processes.

Control: Control systems should be put in place to monitor the impact of the improvement initiatives through periodical review performance. If still a business process is not performing well in accordance with the desired Six Sigma levels, the process is referred back to the 'define' phase. However, if a small problem is impacting the performance, then corrective measures are taken and the whole process is not referred back.

Limitations of Six Sigma :

- Six Sigma focuses on quality only.
- Six Sigma does not work well with intangible results.
- Substantial infrastructure investment is required.
- Six Sigma is complicated for some tasks.
- Not all products need to meet Six Sigma standards.
- Six Sigma focuses on specific type of process only.
- There are many barriers which needs to be resolved while translating the theoretical concepts into practical applications.

Practical Insight - Six Sigma in Practice at Wipro :

Wipro is the first Indian company to adopt Six Sigma. Today, Wipro has one of the most mature Six Sigma programs in the industry ensuring that 91% of the projects are completed on schedule, much above the industry average of 55%.

Six Sigma at Wipro simply means a measure of quality that strives for near perfection. It is an umbrella initiative covering all business units and divisions so that it could transform itself in a world class organization. At Wipro, it means -

- Have products and services which meet global benchmarks.
- Ensure robust processes within the organization.
- Consistently meet and exceed customer expectations.
- Make Quality a culture within the organisation.
- Six Sigma training.

Question 10 : Case Study [RTP - May 2018]

Six Sigma and Cost of Quality

Absolute Singapore Pte Ltd. (ASPL) manufactures electronic components for washing machines in an assembly line. Recent market survey reports indicate erosion of its clientele. Feedback taken from customers suggest that the company's products were not of good quality. ASPL is concerned because its competitors have been able to achieve zero defect performance in terms of nil sale returns on account of quality and nil subsequent warranty cost. Therefore, the competitors enjoy huge customer loyalty.

To satisfy its customers, the company ASPL wants to improve its product quality. Consequently, it has decided to undertake Six Sigma study of its operations.

Below is the additional information given about ASPL's operations:

Yearly sales of electronic components are 25,000 units at ₹ 20,000 each. Of these, 1% sales are returned due to quality issues. These are scrapped and a replacement is made by the company. In addition, each product is under warranty for one year after sale. If a claim is accepted under warranty, service and replacement of parts is done free of cost. Current yearly warranty claims (these are separate from sales returns), which is also representative of the average yearly warranty claims, amount to ₹ 30,00,000 per annum.

Quality control check and inspection is carried out directly at the assembly line. There is no quality check done at any other point in the entire work flow. Total time spent on inspection is 2,000 hours in a year which costs the company ₹ 10,00,000 per annum. Inspection leads to 10% rejection i.e. 2,525 units. These units require only one cycle of rework, after which they are ready for sale. Rate of rework in the units rejected on inspection at the assembly line is 5 units in 1 hour. Cost of rework is ₹ 6,250 per hour.

The variable cost of electronic component is ₹ 12,500.

The Six Sigma team as part of its study found that rework on products was mainly due to the following reasons:

(1) Assembly line workers, including new hires, learnt on the job as to how to assemble the input material to produce the final electronic component. This lead to many errors due to lack of proper standardized training. Therefore, on account of these errors, the entire electronic component has to be assembled again.

(2) Sub-standard quality of raw material is detected on inspection only at the assembly line. By this time, the defective material is already fitted into the final electronic component. Therefore, entire component has to be reworked upon to replace the defective raw material input.

(3) Machines are outdated and are not entirely suitable for the current production methodology.

Proposed solutions to tackle these issues are as follows:

(1) Provide training to assembly line workers to train them on the production methodology. This training is expected to standardize work flow, thereby reducing errors. Such training programs will be held regularly to update the workers on new methodologies. These programs can also serve as employee feedback sessions about the actual working conditions at the assembly line. This two-way communication can improve and streamline the production process. Brainstorming can help in detecting the potential problems in the production process. Total training hours in a year are expected to be 5,000 hours, costing ₹ 1,000 per hour.

(2) Currently poor quality of raw material input is detected only on inspection at the assembly line. This results in wastage of resources in terms of material, time and capacity. In addition to the existing inspection at the assembly line, a new functional area for quality planning and improvement is proposed to be set up. At the time of procurement, the department will determine the appropriate quality of raw material input, ensure that suppliers supply material as per these requirements as well as suggest alternatives that can help improve

product quality. By ensuring quality of raw materials at the beginning of the production process, wastage of resources is reduced, if not eliminated. Cost of setting up such a facility will be ₹ 1,50,00,000. In addition to this facility, inspection will continue at the assembly line. This ensures complete quality check during the entire production cycle. At the same time, due to the introduction of this new functionality for quality control, the pressure on resources for inspection at the assembly line would reduce.

(3) Current machines should be replaced entirely with new machines. Old machines can be sold for negligible amount as scrap. New machines would cost ₹ 3,60,00,000 having a life of three years.

Implementation of the above three solutions can have the following impact:

- Rework of products can be entirely eliminated.
- Sales return will reduce from 1% to 0% due to better quality of products.
- Yearly warranty claims will reduce from ₹ 30,00,000 to nil per annum.
- With the introduction of the new facility, time required for inspection at the assembly line would reduce from 2,000 hours to 1,200 hours. Cost of inspection to do quality check at the assembly line would reduce from ₹ 10,00,000 per annum to ₹ 6,00,000 per annum.
- Due to better quality, ASPL can build better reputation with the customers which can further yield additional sales of 5,000 units per year.

Required :

You are the management accountant at ASPL. As part of the Six Sigma project implementation team, you are requested to EVALUATE proposals suggested by the Six Sigma team. The team has used the DMAIC technique to assess quality improvements.

Solution 10 :

DMAIC technique analyses operational problems by assessing them in the following phases (1) Define; (2) Measure; (3) Analyze; (4) Improve and (6) Control.

In the given case, we can briefly discuss these points as follows :

(1) Define the problem, project goals and customer requirements: Poor quality leading to erosion of clientele.

(2) Measure current performance: Indicators of poor quality to find out what is the sigma level of the current operations?

(3) Analyze: What is the cause of poor quality? What is the cost of resources focused on quality?

(4) Improve: Reduce errors and improve quality of the product

(5) Control: Maintain quality at 6σ level and keep the production facilities updated.

After implementing the suggestions given by Six Sigma Team, the cost of quality shall be:

Cost of Quality Report

Cost of Quality Component	Before Improvements		After Improvements	
	Current Cost (₹)	% of Sales	Projected Cost (₹)	% of Sales
Preventive Cost :				
Training (5,000 hrs. x ₹1,000/hr.)	×××	×××	50,00,000	0.83%
Quality Planning and Improvement	×××	×××	1,50,00,000	2.50%
Appraisal Cost :				
Inspection Cost	10,00,000	0.20%	6,00,000	0.10%
Internal Failure Cost :				
Rework cost [2,525 units / 5 x ₹ 6,250]	31,56,250	0.631%	×××	0.00%
External Failure Cost :				
Sale Returns [25,000 units x 1% x ₹ 12,500]	31,25,000	0.625%	×××	0.00%
Warranty Claims	30,00,000	0.60%	×××	0.00%
Total Cost of Quality	1,02,81,250	2.056%	2,06,00,000	3.43%
Yearly Sales (Qty. x S.P.)	50,00,00,000 (25,000 units x ₹ 20,000)		60,00,00,000 (30,000 units x ₹ 20,000)	

Evaluation of Six Sigma Team Proposal

Particulars	Amount (₹)
Incremental Contribution [5,000 units x ₹ 7,500]	3,75,00,000
Add : Savings in present cost of Quality (above report)	1,02,81,250
Less : Proposed cost of Quality (above report)	(2,06,00,000)
Less : Additional depreciation on new machines [3,60,00,000 / 3 years]	(1,20,00,000)
∴ Incremental Net Benefit	1,51,81,250

Comments : Cost of quality will increase in terms of % to sales. However, we can avoid internal and external failure cost completely. It will have a positive impact on our internal team as well as on external customers.

The increase in cost of quality proposed to be made would be a preventive cost to avoid failure of quality. The company should focus on preventing the error such that it ensures that product is of good quality when it reaches the customer at the very first instance. This enhances the customer experience and therefore eliminating the scope for external failures like sales returns and warranty claims. Better quality can yield further sales of 5,000 units per year. Therefore, an

increase in spending on quality measures is justified since it not only yields significant improvements to quality but also brings in more sales orders.

Conclusion: Six Sigma team's proposals are focused on preventing the error from occurring. Consequently, quality improves, sale improves and thereby it can yield an additional net benefit of ₹ 1,51,81,250 per year to the company. Hence, the proposal should be implemented.

Question 11 : [Jan. 2021 Exam - 5 Marks]

The Business Digest, a fortnight business magazine, in its recent release has published an article titled "Why you can safely ignore Six Sigma". This was highly critical of Six Sigma. The pointed criticism levelled under five sequentially numbered paras which are listed herein below :

(i) The results often don't have any noticeable impact on company financial statements. Thus, Six Sigma success doesn't assure you the higher stock values. This is true for 90 percent of companies that implement Six Sigma.

(ii) Only early adopters can benefit from the implementation of Six Sigma.

(iii) Six Sigma focuses on defects which are subjective to determine for service business.

(iv) Six Sigma can't assure that your product will have market.

(v) Substantial infrastructure investment is required.

How would you RESPOND to these statements?

Answer 11 :

(i) **Response to first criticism** – Six Sigma is a part of lean system hence require commitment of top-management, implementation with high motivation among employees and continuous efforts with reasonable patience for reasonable duration. In absence of these, despite implementing Six Sigma; many companies do not witness the expected impact on the financial statements of the company.

In short run it may possible that a company who successfully implemented Six Sigma may not be getting directly visible financial advantage, **but in long run it will.**

Moreover, stock value is not the sole feature of the quality of product manufactured; it is impacted by other factors too. **Hence, I disagree with the author.**

(ii) **Response to second criticism** - No doubt early adopter has more benefit from implementation of Six Sigma, on the principle of first mover advantage. But more important is not when organisation started, it is **how long and efficiently it practice** the Six Sigma, longer the duration – larger the benefit. **Hence, I disagree with the author.**

(iii) **Response to third criticism** – Due to inherent nature of service business, subjectivity is high and it is hard to objectively determine the defect. But this problem is not only with Six Sigma, it is with all performance measurement methods for service industry. Further each professional has its own style of working; hence subjectivity also arises in determination and classification among errors and mistakes. But use of certain other tools (value shop model etc.) in association with Six-Sigma may reduce subjectivity to avoid pitfalls. **Hence, partially agree but not completely agree with the author.**

(iv) **Response to fourth criticism** – Product comprises two element **features** and **quality** of such feature. No doubt if customer do not like the product due to features then Six Sigma will not help. But if there is an issue with the quality (be it conformance or reliability) of the feature then Six Sigma can be really game-changer for the organisation; and capable to build the market for product, by attracting the customer (value chain analysis may be great help). Six Sigma or Lean Six Sigma is customer-oriented and intended to deliver value to the customer. If a customer is satisfied, then the product will surely have a place in the market. **Hence, completely disagree with the author.**

(v) **Response to fifth criticism** – No doubt substantial infrastructure investment is required both of monetary and non-monetary in nature. But Six Sigma is capable to yield the corresponding significant benefits. Why one company is able to create value, whereas another could not, is an issue with implementation and not with the technique. Hence, Six Sigma is **capable to pay-off the substantial investment.** An extensive cost benefit analysis can be useful prior to decision of six sigma implementation. **Statement in itself is true, but not a valid argument to safely ignore Six Sigma.**

Student Note :

- Conceptually correct and **brief explanation** is sufficient for each point.
- Alternative reasoning is also possible.

TOTAL PRODUCTIVE MAINTENANCE (TPM)

Total Productive Maintenance (TPM) is a system of maintaining and improving the integrity of production and quality systems. This is done through the machines, equipment, processes, and employees that add to the value in Business Organisation. This concept was first introduced by M/s Nippon Denso Co. Ltd. of Japan, a supplier of M/s Toyota Motor Company.

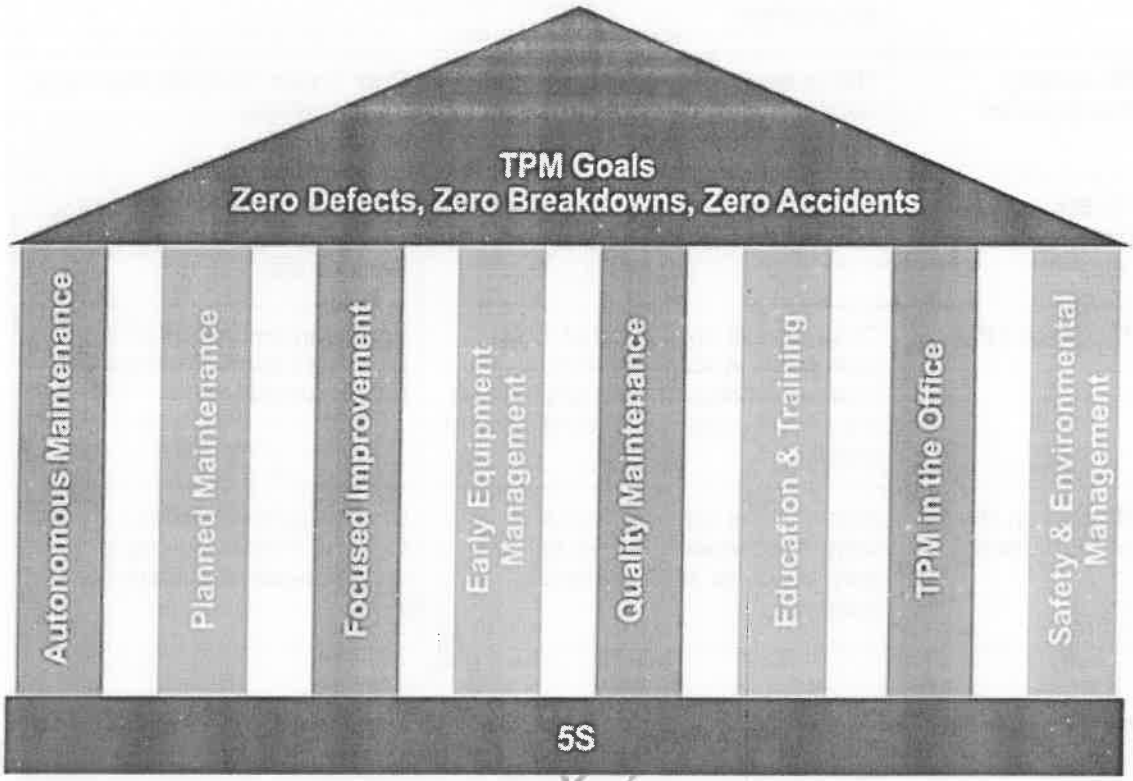
TPM helps in keeping all equipment in top working condition so as to avoid breakdowns and delays in manufacturing processes.

How TPM can be introduced in the organization?

The introduction of TPM follows four main phases:

- Preparation Stage: Establish a suitable environment and conducting programme awareness.
- Introduction Stage: Initialization of TPM, information to suppliers, customers, and other stakeholders.
- Implementation Stage: This is done with the help of eight activities referred as eight pillars of TPM.
- Institutionalizing stage: This is the stage of getting TPM awards.

TPM Strategy focuses on eight pillars of success with 5S strategy as foundation.



Foundation & Pillars	About	Techniques
Foundation : 5S	TPM starts with 5S. It deals with organizing a workplace which helps to recognize and uncover problems.	Seiri (sort), Seiton (set in order) Seiso (shine), Seiketsu (standardize), Shitsuke (sustain).
P1: Autonomous Maintenance	Operation of equipment without breakdown and eliminating the defects at source through active employee participation.	Cleaning, Lubricating, Visual Inspection, Tightening of Loosened Bolts etc.
P2: Focused Improvement (Kaizen)	This pillar is about the minor improvements made on continuous basis. This pillar aims to reduce losses in the workplace that affect efficiencies.	Kaizen Register, Kaizen Summary Sheet, Cause-Effect Analysis, Summary of Losses.
P3: Planned Maintenance	This is proper maintenance system adopted for improvement in reliability and maintainability of equipment. It aims to have zero breakdown and optimum maintenance cost.	Preventive Maintenance, Breakdown Maintenance, Corrective Maintenance.

P4: Early Management	This focuses on shortening the time required for product and equipment development.	Engineering and Re-engineering Processes.
P5: Quality Maintenance	This is towards achieving customer satisfaction through delivery of highest quality product.	Root Cause Analysis, Customer Data Analysis.
P6: Education & Training	It aims to improve knowledge / skills and enhance morale of employees.	Training Calendar, Policies for Education and Training, On-site Training etc.
P7: Office TPM	This refers to application of TPM techniques in administration to improve productivity and efficiency in the office functions with elimination of losses.	Analyzing processes and procedure towards increased Office Automation.
P8: Safety, Health, and Environment	Above all the safety of worker is utmost importance. It aims to have zero accidents and zero health damages.	Drama, Safety Slogans, Quizzes, Poster Making to create awareness related to safety.

Performance Measurement in TPM

The most important approach to the measurement of TPM performance is known as **Overall Equipment Effectiveness (OEE)** measure. The calculation of OEE measure requires the identification of "six big losses" as follows :

1. Equipment Failure / Breakdown
2. Set-up / Adjustments
3. Idling and Minor Stoppages
4. Reduced Speed
5. Reduced Yield and
6. Quality Defects and Rework

The first two losses refer to time losses and are used to calculate the **availability** of equipment. The third and fourth losses are speed losses that determine **performance** efficiency of equipment. The last two losses are regarded as **quality** losses.

Availability × Performance × Quality = OEE

OEE may be applied to any individual assets or to a process. It is impossible that any manufacturing process can run at 100% OEE. The suggested ideal values for the OEE component measures are:

Availability	> 90%
Performance	> 95%
Quality	> 99%

Accordingly, OEE at World Class Performance would be approximately 85%. However, any figure greater than 50% is more realistic and therefore more useful as an acceptable target. One can say that the value of OEE should lie between 50% to 85%.

Formulae for calculation :

(a) Availability Ratio :

$$= \frac{\text{Actual operating time available}}{\text{Planned production time}} \times 100$$

Important Note : The above formula is as per the revised module of ICAI released in Nov. 2020. There is a slight modification in the denominator of the above formula. In the earlier module, the denominator was Gross available time and in the revised module, it is Planned production time.

Planned down time such as preventive maintenance, lunch break, tea break, rest pauses etc. is not regarded as loss of time as per the revised approach. It means, planned down time should be excluded while calculating 'Planned production time'.

(b) Performance Ratio (i.e. Efficiency Ratio) :

$$= \frac{\text{Standard time required for actual output}}{\text{Actual time taken for actual output}} \times 100$$

The same ratio can also be calculated using the data of units produced i.e. output -

$$= \frac{\text{Actual total units produced in actual operating time}}{\text{Standard output expected in actual operating time}} \times 100$$

(c) Quality Ratio :

$$= \frac{\text{Number of units accepted (i.e. good units)}}{\text{Total number of units produced}} \times 100$$

(d) OEE% = Availability Ratio % × Performance Ratio % × Quality Ratio %

Question 12 :

Gold Coast Company Ltd. manufactures automobile spare parts. It works in two shifts of 8 hours for 6 days in a week. Lunch break is 45 minutes and other miscellaneous breaks add up to 25 minutes per shift. The following details are collected for the last 4 weeks by the TPM team for one of their important equipment.

Hours for Planned Preventive Maintenance = 15 minutes per shift

Breakdown Maintenance = 6 hours total

Machine Set up time = 15 hours total

Power Failure = 4 hours total

Standard Time per piece = 3 minutes

No. of Parts Produced per shift = 120

No. of Parts Accepted per shift = 115

Required : Calculate 'OEE'.

Solution 12 :

Student Note : As the production is given per shift, we will convert all the data on per shift basis for ease of calculations.

1. Calculation of total number of shifts in a four week period :

= 2 shifts per day x 6 days per week x 4 weeks

= 48 shifts worked during the given period of 4 weeks

2. Calculation of Available time, Production time and Actual operating time per shift :

Particulars	Minutes/shift
Total available time per shift (8 hours x 60 min.)	480
Less : Planned Downtime :	
Lunch break	45
Other miscellaneous breaks	25
Preventive maintenance	15
∴ Planned production time per shift	395
Less : Unplanned Downtime :	
Breakdown Maintenance (6 hours x 60 min.) / 48 shifts	7.5
Machine set up time (15 hours x 60 min.) / 48 shifts	18.75
Power Failure (4 hours x 60 min.) / 48 shifts	5.0
∴ Actual operating time per shift	363.75

3. Availability Ratio :

= Actual operating time available / Planned production time x 100

= [363.75 min.] / (395 min.) x 100

= 92.09%

4. Performance Ratio (i.e. Efficiency Ratio) :

= Standard time required for actual output / Actual time taken for actual output x 100

= (120 units x 3 minutes) / 363.75 min. (as above) x 100

= 98.97%

5. Quality Ratio :

= Number of units accepted / No. of units produced x 100

= 115 units / 120 units x 100 = 95.83%

6. OEE Ratio :

OEE % = Availability × Performance × Quality

= 92.09% x 98.97% x 95.83%

= 0.9209 x 0.9897 x 0.9583

= 0.8734 = 87.34%

Question 13 : [ICAI Module]

GVK Pharmaceuticals Ltd. is producing medication products i.e. pills, capsules, balms etc. There are several different automated production machines located in the plant, through which production of medicines is accomplished to fulfill the demands. Plant operates in double shift a day each consisting of 8 hours with 25 minutes lunch break and tea break of 10 minutes. Following data pertains to automated machine 'X-78'.

Data of X-78 for a day - 14 February 2020 (for 2 shifts)

Breakdown, repair and start up time (unplanned)	90 minutes
Standard cycle time	2.5 minutes per tablet
Quality loss due to scrap, rework and rejection	40 tablets
Total quantity produced	280 tablets

Required : Calculate & Comment on OEE.

Solution 13 :

Calculation of OEE :

Particulars	**Minutes**
(a) Total available time per day [8 hours x 2 shifts x 60 minutes]	960
(b) Planned downtime - Lunch & Tea break [(25 + 10) min. per shift x 2 shifts]	70
(c) Planned production time for a day of 2 shifts [a - b]	890
(d) Unplanned downtime - Breakdown, repair and start up time	90
(e) Actual operating time for a day of 2 shift [c - d]	800
(f) Availability Ratio [800 / 890 x 100]	89.89%
(g) Standard time for actual output [280 tablets x 2.5 minutes]	700
(h) Performance (Efficiency) Ratio [700 / 800 x 100]	87.50%
(i) Quality loss due to scrap, rework and rejection	40 tablets
(j) Total quantity produced	280 tablets
(k) Good quality produced [j – i]	240 tablets
(l) Quality Ratio [240 / 280 x 100]	85.71%
(m) OEE Ratio = Availability x Performance x Quality [f x h x l]	67.41%

Comments :

Since OEE of GVK Pharmaceuticals Ltd. is lesser than 85% i.e. World Class Performance Level, the company is advised to improve its each ratio i.e. availability ratio, performance ratio and quality ratio. It can be done by collecting information related to all downtime and losses on machines, analyzing such information through graphs and charts, making improvement decisions thereon like autonomous maintenance, preventive maintenance, reduction in set up time etc. and implementing the same.

However, above 50% OEE ratio is acceptable and is considered as good performance.

Question 14 : [May 2018 Exam]

Hindustan Ltd. supplies the following information relating to a vital equipment used in its production activity for April, 2018:

Total time worked during the month	210 hours
Total production during the month	2,800 units
No. of units accepted out of total production	2,520 units
Standard time for actual production of the month	180 hours
Time lost during the month	28 hours

Required :

(i) State an appropriate approach to measure the total productive maintenance performance of an equipment. **(2 Marks)**

(ii) Quantify the total productive maintenance performance of the above mentioned equipment, by using the approach stated in (i) above. **(6 Marks)**

(iii) Comment on the effectiveness of maintenance of the equipment. **(2 Marks)**

Solution 14 :

(i) The most important approach to the measurement of total productive maintenance (TPM) performance is known as **Overall Equipment Effectiveness (OEE)** measure. The calculation of OEE measure requires the identification of "six big losses" as follows :

1. Equipment Failure / Breakdown
2. Set-up / Adjustments
3. Idling and Minor Stoppages
4. Reduced Speed
5. Reduced Yield and
6. Quality Defects and Rework

The first two losses refer to time losses and are used to calculate the **availability** of equipment. The third and fourth losses are speed losses that determine **performance** or efficiency of equipment. The last two losses are regarded as **quality** losses.

OEE % = Availability × Performance × Quality

(ii) Calculation of Overall Equipment Effectiveness (OEE)

$$\text{Availability} = \frac{\text{Actual time worked}}{\text{Total time available}} = \frac{210 \text{ hrs.}}{(210 + 28 \text{ hrs.})} = 88.24\%$$

Note : In absence of specific information, it is assumed that the entire time lost of 28 hours is an unplanned downtime.

$$\text{Performance} = \frac{\text{Standard time}}{\text{Actual time}} = \frac{180 \text{ hrs.}}{210 \text{ hrs.}} = 85.71\%$$

$$\text{Quality} = \frac{\text{Units accepted}}{\text{Total production}} = \frac{2{,}520 \text{ units}}{2{,}800 \text{ units}} = 90.00\%$$

OEE % = Availability × Performance × Quality

= 88.24% x 85.71% x 90% = 68.07% (approx)

(ii) Comments on the effectiveness :

OEE may be applied to any individual assets or to a process. It is impossible that any manufacturing process can run at 100% OEE. The suggested ideal values for the OEE component measures are:

Availability	> 90%
Performance	> 95%
Quality	> 99%

Accordingly, OEE at World Class Performance would be approximately 85%. However, any figure greater than 50% is more realistic and therefore more useful as an acceptable target. One can say that the value of OEE should lie between 50% to 85%.

As our OEE performance is around 68.07%, we can say that, it is an acceptable performance but not the world class performance. There lies a scope for improvement.

Question 15 : [Jan. 2021 Exam - 10 Marks]

(i) Based on the following data CALCULATE 'Overall Equipment Effectiveness :

Particulars	**Data**
Shift length	9 hours
Short breaks	3 of 10 minutes each
Meals break	45 min.
Equipment down time	30 min.
No. of parts produced (Standard)	30 per min.

Total units produced per shift	12,240
Rejected units out of the above	240

(5 Marks)

(ii) (A) Based on the answer derived from the above can you DEMONSTRATE that the machine is working at world class performance as suggested by 'Nakajima' ideal values for the 'OEE'. **(2 Marks)**

(B) 'OEE is an aggregate measure. Its components will compensate for each other or, on the contrary, will aggravate a falling situation and attract further attention to it". EXPLAIN **(3 Marks)**

Answer 15 :

(i) Seiichi Nakajima led the introduction of TPM, OEE and the Six Big Losses in the early 1970s while at the Japanese Institute of Plant Maintenance. OEE is a quantitative metric for measuring productivity of individual equipment in a manufacturing plant. OEE identifies and measures losses of crucial parts in a manufacturing process namely availability rate, performance rate and quality rate.

OEE = Availability x Performance x Quality

OEE Factors are calculated as follows –

Calculation of Available time, Production time and Actual operating time per shift :

Particulars	**Minutes/shift**
Total available time per shift (9 hours x 60 min.)	540
Less : Planned Downtime : Short breaks (3 x 10 min.) Meals break	 30 45
∴ Planned production time per shift	465
Less : Unplanned Downtime : Equipment downtime	 30
∴ Actual operating time available per shift	435
Standard time for actual output (12,240 units / 30 unit per min.)	408

Availability Ratio :

= $\frac{\text{Actual operating time available}}{\text{Planned production time}}$ x 100

= $\frac{435 \text{ min.}}{465 \text{ min.}}$ x 100

= 93.55%

Performance Ratio (i.e. Efficiency Ratio) :

$$= \frac{\text{Standard time required for actual output}}{\text{Actual time taken for actual output}} \times 100$$

$$= \frac{408 \text{ min.}}{435 \text{ min.}} \times 100$$

$$= 93.79\%$$

Quality Ratio :

$$= \frac{\text{Number of units accepted}}{\text{Total No. of units produced}} \times 100$$

$$= \left\{ \frac{12{,}240 \text{ units} - 240 \text{ units}}{12{,}240 \text{ units}} \times 100 \right\}$$

$$= 98.04\%$$

OEE = 93.55% x 93.79% x 98.04% = 86.02%

(ii) (A) The suggested ideal values for the OEE component measures are :

Availability	> 90%
Performance	> 95%
Quality	> 99%

Accordingly, OEE at World Class Performance would be approximately 85%.

In the instant case OEE is **86.02%**, which is beyond the ideal rate of 85% suggested by Seiichi Nakajima. Availability, Performance, and Quality rate is 93.55%, 93.79%, and 98.04% respectively against the ideal rate of 90%, 95% and 99% respectively. Hence, considering OEE only (rather its individual components) it can be said that machine demonstrates the world class performance. Both performance and quality rate are **slightly lower** than the ideal rate (world class performance), whereas availability rate is beyond the ideal rate to help the OEE to stand beyond ideal rate of 85%.

(B) Yes, OEE is an aggregate measure of productivity; comprising the sub-metrics (components) of Availability, Performance and Quality.
When the sub-metrics (components) are multiplied by each other, the resulting OEE number may end up hiding the areas that have the most problems, because these sub-metrics (components) compensate for each other. For example, low quality may be compensated by high availability and performance. OEE has another limitation being aggregate measure, it assumes that each of the sub-metrics have equal importance.

OEE can be directly calculated as = Std. time for good units / Planned production time
= (12,000 units / 30) / 465 min. x 100
= 400 min. / 465 min. x 100 = 86.02%

Here is worth noting that calculation of OEE involves multiplication of sub-metrics of Availability. Performance and Quality, which aggravate a falling situation and attract further attention to it.

For example, if all the sub-metrics has rate of 85% then OEE will be only 61.41%, and if all the sub-metrics has rate of 90% then OEE will be 72.90%.

As an aggregate quantitative metric OEE can mislead by hiding underlying issues, instead of clarifying areas for improvement, hence in-depth study of each sub-metrics is essential.

Connection between TQM and TPM

The connection between TQM and TPM is summarized below:

- TQM and TPM make company more competitive by reducing costs, improving customer satisfactions and slashing lead times.
- Involvement of the workers into all phases of TQM and TPM is necessary.
- Both processes need fundamental training and education of participants.
- TPM and TQM take long time to notice sustained tangible benefits.
- Commitment from top managements is necessary for successful implementation.

Question 16 : [Jan. 2021 Exam - 5 Marks]

DISCUSS the connection between the Total Quality Management and Total Productive Maintenance. **(5 Marks)**

Answer 16 :

Discussion - The aim of both TQM and TPM are to improve the efficiency of resources (man / machine) which can only be attained by minimising waste through total employee involvement and providing quality service to customers. **TPM is maintenance approach** while TQM is total **quality control.** Employee empowerment is a tool used in TQM implementation, while TPM uses optimisation. The connection between TQM and TPM are summarized below :

- TQM and TPM make company more competitive by reducing costs, improving customer satisfactions and slashing lead times.
- Involvement of the workers into all phases of TQM and TPM is necessary.
- Both processes need fundamental training and education of participants.
- TPM and TQM take long time to notice sustained tangible benefits.
- Commitment from top managements is necessary for success of the implementation of TQM & TPM.

Question 17 : Case Study on TPM

Super Refineries Limited is a leading oil refining company operating in India. The company has three plants - one each situated in North, South and West. The company has a refining capacity of 30 million barrels. The company currently enjoys a 40% share of the domestic market. The plants run on all 365 days in a year and operate at 100% of the capacity. The company currently does not have any maintenance schedule in place for its plant and machinery. Any repair requirement of plant and machinery is carried out on ad-hoc basis.

The company has implemented Total Quality Management (TQM) to ensure that the company rolls out top quality products. The company did not receive any complaints from its customers regarding poor quality of products or products not meeting the specifications. The entire production team is quite excited with superior quality of products.

However, in the last three months, about 30% of the dispatches to customers were delayed. This comes at a time when the entire plant had to be shut for maintenance activity due to breakdown in the machineries for a week. The company also witnessed 20% rejection of the final products. The customers claimed that the products did not meet the specification agreed by them with the company. The Director of Refineries is worried about the worsening situation of production at plants. Another concern for the director is the increase in number of accidents and loss of productive time due to this.

The chairman of the company convened an urgent meeting of the Board of Directors to understand the impact and reasons of the situation at production plants. A key issue highlighted by plant supervisors is that the scheduled maintenance activity for plants was never carried out. The underlying assumption for not carrying out such maintenance activity was - "Since the plant is running smoothly, there is no requirement of preventive maintenance activity. Such activities cost a lot in terms of money and also cause loss of productive time which could otherwise be used for production". The maintenance departments and production department functioned in silos (i.e. airtight) with almost no co-ordination amongst themselves. The most critical parts of the plant were not maintained for a long time.

The chairman called you after the meeting and asked you to help him understand the current issue at the plant. "We had Total Quality Management (TQM) in place at all our plants. I understand from the production director that TQM is working as intended. Why are we facing the breakdown problem inspite of having a TQM in place"- said the Chairman.

Required :

The Chairman has asked you to quickly prepare a note highlighting the following points -

(i) What could be the likely losses arising due to breakdown of machinery due to non maintenance?

(ii) What kind of maintenance programme could address the issue being faced by the company?

(iii) EXPLAIN the key features of such programme.

(iv) COMPARE the programme identified above and TQM.

(v) What are the various types of maintenance practices that the company can implement?

Solution 17 :

Issue

Super Refineries Limited has implemented a Total Quality Management and is known for producing top quality products. The company enjoys 40% market share in the domestic market. The plants operate at 100% capacity and on all days of the year. This indicates that the company does not carry out preventive and corrective maintenance. The company has not received any complaints with respect to quality from its customers. This can be attributed to a solid TQM in place.

However, in the last three months, the company has faced delays in supplies and customer rejections. The delay in supplies could be attributed to the breakdown in the machineries. The production could have been of an inferior quality if the production managers would have rushed to meet the production deadlines due to loss of production time owing to breakdown.

The discussions at the board meeting indicate that the company has not prioritized preventive maintenance. Maintenance is being carried out on an ad-hoc basis without a proper preventive maintenance schedule. The company is concerned about costs of maintenance and hence no preventive maintenance was carried out. Further, there is no co-ordination between the production team and maintenance team.

(i) Losses Arising Due to Breakdown

The following are the losses which can be associated with the breakdown of machinery at Super Refineries Limited -

- Equipment failure leading to unexpected loss of time - The production at plants was interrupted and the supplies to customers were delayed.
- Idle waits and stoppages due to ad hoc maintenance requirements. Since the interruption is unplanned, the productive labour time is wasted.
- Production of inferior quality products causes financial losses. The company would also incur additional costs to remake the product without any additional revenues.
- The company would also incur losses in terms of additional set up costs. Every time a machine breaks down, a significant amount of time would be wasted in setting up the production processes again.

(ii) Total Productive Maintenance (TPM)

Based on the facts of the case, it is very clear that the company has not prioritised maintenance. The company can use TPM philosophy to address the issue.

TPM is a maintenance philosophy aimed at eliminating production losses due to faulty equipment. The objective of TPM is to keep equipments (plant, machinery etc) in such a position to produce expected quality products at the maximum capacity with no unscheduled stops. This also includes attaining:

- Zero breakdowns.
- Zero downtimes.
- Zero failures attributed to poor condition of equipment.
- No loss of efficiency or production capacity due to the equipment.

The concept was initially applied to equipment i.e., plant and machinery. Of late, the concept has also been extended to processes and employees. TPM focuses in keeping equipment and employees in top working condition to avoid any breakdowns and delays in manufacturing process.

Traditionally, maintenance work has been considered as a responsibility of the Maintenance Team which is different from the production team. Total Productive Maintenance seeks to involve workers in all departments and levels in ensuring the effective operations of the plant. When both the teams work in alignment, learning experiences can be shared with each other. The production team also takes ownership of maintenance requirement. A sole focus on higher production without taking care of maintenance requirement can hamper the long-term production requirements, as could be seen in the case of Super Refinery Limited.

(iii) Key Features of TPM

The issues faced by Super Refinery Limited due to unplanned shutdowns can be addressed using a Total Productive Maintenance philosophy. TPM has the following features -

- Traditional maintenance is centered in the maintenance department. However, TPM seeks to involve workers at all departments and levels. There is a great amount of co-ordination between the production and maintenance team in TPM.
- Autonomous maintenance focuses on training operators to be able to take care of minor maintenance tasks. This relieves specialised maintenance staff to focus on critical issues.
- TPM focuses on achieving and sustaining zero loses with respect to minor stops, measurement and adjustments, defects, and unavoidable downtimes.
- Planned Maintenance is aimed to have trouble free machines and equipment producing defect free products for total customer satisfaction. The approach here is proactive maintenance instead of reactive maintenance. Super Refinery limited had a reactive approach to maintenance where maintenance was carried out on an ad hoc basis.
- TPM emphasises on training of workers across all levels and departments. The ultimate objective is to have a factory full of skilled workers.

The following are the Eight Pillars or Principles of TPM -

- Autonomous Maintenance
- Focused Improvement
- Planned Maintenance
- Early Equipment Management
- Quality Maintenance
- Education and Training
- Office TPM
- Safety, Health and Environment

(iv) TQM and TPM

Total Quality Management (TQM) and Total Productive Maintenance are often used interchangeably. However, TQM and TPM are considered as two different approaches. TQM attempts to increase the quality of goods, services and customer satisfaction by raising awareness of quality concerns across the organisation. In other words, TQM focuses on the quality of the product, while TPM focuses on the equipment used to produce the products.

By preventing equipment break-down, improving the quality of the equipment and by standardising the equipment, the quality of the product also increases. TQM and TPM can both ultimately result in an increase in the quality of goods and services. However, the approach of each is different. TPM can be seen as a way to help achieving the goal of TQM.

Super Refinery Limited has implemented TQM and is delivering high quality products to its customers. TQM focuses on the end product being supplied to the customer. In the process of producing high quality and volumes of products, the maintenance aspect of plant and machinery was ignored by all. This led to breakdowns and unplanned shutdown of the plant and machineries. The TPM philosophy would focus on the equipment which support production of high quality products under TQM.

(v) Types of Maintenance under TPM

The following are the types of Maintenance Programmes which Super Refineries Limited can implement -

Breakdown Maintenance

No maintenance is carried out unless the equipment actually fails. This is the approach taken by Super Refineries Limited currently. This type of maintenance is used when the equipment failure does not impact the operations and production significantly and the only cost incurred is the cost of repair. This is not advisable in case of Super Refineries as breakdown of machineries have led to significant delays in deliveries and poor quality of production.

Preventive Maintenance

It is a routine maintenance (cleaning, inspection, oiling and re-tightening), designed to retain the healthy condition of equipment and prevent failure through the prevention of deterioration, periodic inspection or equipment condition diagnosis, to measure deterioration. This can be compared with a routine and periodic maintenance activity of a vehicle.

Corrective Maintenance

Corrective maintenance focuses on making machines easier to clean and maintain. There could be reconfiguration of certain parts of the machines, to ensure that the maintenance staff can carry out maintenance effectively and easily. It is a correction in carrying out the maintenance work.

Maintenance Prevention

Through the analysis of maintenance data, the maintenance technicians can work with the designers of our machines to create machines that are more reliable. Maintenance and repairs that are required can be made as simple and as easy as possible to reduce time, save money and improve safety. It is working towards preventing (i.e. reducing) the maintenance work itself.

Autonomous Maintenance

In case of autonomous maintenance, minor and day to day repairs are carried out by the operators of plant themselves, instead of waiting for technicians. Activities like lubricating, bolt tightening etc. are done along with minor repairs by the floor workers or operators. Maintenance team is called only when sophisticated and highly technical maintenance work is required. For example - one may change the tyre of own car by himself but to repair a puncture or wheel alignment, you visit a technician.

Conclusion

Super Refinery Limited should implement a TPM which would complement and support the TQM philosophy. This would also address the issue of the production team and maintenance team not working in co-ordination. Down time for maintenance should not be considered as a cost or unproductive activity. This should be an integral part of the overall manufacturing plan. This would ensure that emergency and unplanned downtime is kept to a minimum.

PROBLEM NO. 18 : [Old Syllabus]

A company has a continuous manufacturing process involving an output of 6 tons per hour valued at Rs.70 per ton. Process wages cost Rs. 60 per hour and raw material, Rs. 35 per ton of product. Regular maintenance works out to Rs. 750 per week.

The company is experiencing break-down due to mechanical faults averaging 25 hours a week, costing Rs. 7,500 to repairs. It is estimated that these break-downs can be reduced or eliminated if maintenance on the following scale were undertaken:-

Break-down hours per week	0	5	10	15	20
Costs :	Rs.	Rs.	Rs.	Rs.	Rs.
Maintenance Cost	23,000	13,000	6,500	3,000	1,500
Repair Cost	0	2,500	3,000	5,000	6,500

Process labour during stoppages can be used elsewhere up to 10 hours per week, but beyond this level the company will have to pay idle time wages to workers at the same rate.

i. Present, in tabular form the optimum amount of maintenance to be undertaken each week.

ii. What is the effective savings that will be resulting from the optimal level, compared with the present situation?

Process Innovation (PI) & Business Process Re-Engineering (BPR)

Business Process Re-engineering (BPR) and Process Innovation (PI) are similar concepts that emerged in the early 1990s. BPR focuses on amending **existing processes**, while PI attempts to implement **new processes** into an organisation. In many ways, PI is more radical than BPR, because it is changing the overall structure of an organisation, whereas BPR is streamlining processes that are already in place.

PROCESS INNOVATION

Process Innovation means the implementation of a new or significantly improved production or delivery method (including significant changes in techniques, equipment and / or software).

The following are not considered as process innovations -

- Changes, improvements, increase on product or service capability done by addition in manufacturing system
- Discontinuing use of a process, simple capital replacement or extension
- Changes resulting purely from changes in prices, customization, regular seasonal and other cyclical changes
- Trading of new or significantly improved products etc.

The process of innovating new solutions could fall into one of these areas :

- **Production:** This is related to processes, equipment and technology to enhance manufacturing or production processes. This includes computer software.
- **Delivery:** Delivery process innovations involve tools, techniques and software solutions to help in supply chain and delivery systems. This includes barcodes, tracking systems or shipping software.
- **Support Services:** Innovations in processes aren't limited to production or delivery, but also areas including purchasing, maintenance and accounting.

Process Innovation at Ford Motor Company, USA

One of the most widely recognized automobile companies in the world is America-based multinational manufacturer, Ford Motor Company. Now more than 110 years old, the company was founded by Henry Ford and has succeeded in innovative designs and ideas for more than a century.

One of their most notable innovations came more than 100 years ago with the invention of the world's first moving assembly line. The process not only simplified vehicle assembly, but shortened the time necessary to produce a single vehicle from 12 hours to 90 minutes. That process innovation, creating an assembly line to speed up production, not only benefited the auto giant, but manufacturers of other consumer goods such as refrigerators and vacuum cleaners. It remains the typical mode of production for businesses even today.

Process Innovation at Tata Motors at Nano Factory, Sanand

Tata's Nano car is considered to be the world's cheapest car. The production plant at Sanand, Gujarat is one of the best automated assembly plant in India. It uses more than 100 robots during its production cycle. It has a manufacturing capacity of producing around 3,60,000 vehicles a year, which works out to around 1,000 cars per day and around 1 car per minute.

Business Process Reengineering (BPR)

Michael Hammer, an ex-MIT computer professor turned consultant, is credited with first using the term "reengineering". Hammer defines Business Process Reengineering (BPR) (or simply reengineering) as "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical contemporary measures of performance, such as cost, quality, service, and speed." Thus, the four key components of BPR are as follows:

1. Fundamental rethinking
2. Radical redesign
3. Dramatic improvements
4. End to end business processes.

Let's discuss the above key components in further details :

- **Fundamental rethinking** of business processes requires management to challenge the very basic assumptions under which it operates and to ask such basic questions as "Why do we do what we do?" and "Why do we do it the way we do it?"
- **Radical redesign** relies on a fresh-start, clean-slate approach (zero base) to examining an organization's business processes. This approach focuses on answers to the question, "If we were a brand new business, how would we operate our company?" The goal is to reinvent what is done and how it is done rather than to tinker with the present system by making marginal, incremental, superficial improvements to what's already being done.
- **Achieving dramatic improvements** in performance measurements is related to the preceding two elements. The fundamental rethinking and radical redesign of business processes are aimed toward making quantum leaps in performance. BPR is not about improvement in quality, speed, and the like that is on the order of 10%. Improvement of that order of magnitude often can be accomplished with marginal, incremental changes to existing processes. Reengineering, on the other hand, has much loftier objectives. For example, the reengineering of Ford's procurement process reduced the number of persons employed in the process by 75%. In short, we should achieve radical or substantial improvement over the previous performance.
- **Reengineering focuses on end-to-end business processes** rather than on the individual activities that comprise the processes. Michael Hammer contends that the fragmented business processes and bureaucratic, hierarchical organization structures evident in most businesses today have their origins in the Industrial Revolution, when specialization of labour and economies of scale were the promised keys to success. He argues that managers lose sight of their real objectives when processes are segmented into individual tasks, each task is assigned to a specialist, and elaborate mechanisms are established to track and control the performance of those tasks. Instead, BPR takes a holistic view of a business process as comprising a string of activities that cuts across traditional departmental or functional lines. BPR is concerned with the results of the process (i.e. with those activities that add value to the process). This cross functional focus has been used for many years by manufacturing companies. Reengineering would apply that view to all business processes.

  For example, consider the activities such as receiving a customer's order, checking the customer's credit, verifying inventory availability, accepting the order, picking the goods in the warehouse, and shipping the goods to the customer, as discrete activities. Reengineering would change our emphasis by breaking down the walls among the separate functions and departments. Instead of order taking, picking, shipping, and so forth, the entire process of "order fulfillment" would be examined and would concentrate on those activities that add value for the customer. The customer is not concerned with the individual tasks that an organisation undertakes to fulfill an order nor is the customer concerned with how the company organizes itself to carry out those jobs. The customer is concerned only with getting the right goods, in the proper quantities, in satisfactory condition, and at the agreed-upon time and price.

Main Stages of BPR

- Process Identification : Each task to be performed is broken down into a series of processes or activities.
- Process Rationalisation : Processes which are non value adding, to be discarded.
- Process Redesign : Remaining processes are redesigned for better efficiency.
- Process Reassembly : Re-engineered processes are now re-assembled for implementation in the most efficient manner.

Note : The above stages closely resembles to value chain analysis.

Principles of BPR :

The principles of successful BPR are as follows:

- Organise around outcomes
- Have those who need the results of a process perform the process
- Integrate the processing of information into the work process that produces the information
- Treat geographically dispersed resources as though they were centralised
- Line parallel activities instead of integrating their results
- Put the decision point where the work is performed, and build controls into the process
- Capture information once and at the source

Let's discuss the above principles of BPR in greater details :

1. Organize around outcomes, not tasks

This principle argues that an organisation should have one person perform all the steps in a process; design the job around an objective or outcome rather than a single task. For example, at an electronics company a "customer service representative" takes a customer order, translates the order into internal codes for the ordered items, components, requisitions, receives, and assembles the item, and delivers and installs the item. As a result, one person is responsible for getting the item to the customer and for answering customer questions during the process. Notice that while this eliminates many handoffs, numerous errors, delays, and misunderstandings, it also eliminates the traditional segregation of duties that organisations normally associate with the order fulfillment process.

2. Have those who need the results of a process perform the process

Departments in organizations are organized around specialized functions performed for customers for the output of other units. In some situations, reengineering can provide "customers" with more timely service and reduce the overhead needed to coordinate the activities of these units by having customers provide their own service.

For example, in exchange for the promise of more timely repairs, an electronic equipment manufacturer asked its large customers to perform some of their own routine repairs and to carry the spare parts inventory required for their own machines. Now, customers make some repairs themselves using spare parts stored on site. The field service representatives, who had been making all repairs, answer customer calls and guide customers through a repair process using a diagnosis support system (an expert system). A computerized inventory management system monitors the spare parts inventories. Field service representatives are dispatched only for complex problems. The electronics manufacturer achieved better customer service and lower inventory carrying costs.

3. Integrate the processing of information into the work process that produces the information

At Ford Motor Company, the receiving department and the receiving system - produced and processed information about the goods received instead of sending it to accounts payable. The receiving system compared the goods received with the order and took appropriate action (send the goods back or create a payable). Notice again, the relaxing of segregation of duties. Management must evaluate and accept the risks associated with the increased opportunity for unauthorized or inaccurate transaction.

4. Treat geographically dispersed resources as though they were centralized

Decentralized resources typically provide better service to their customers at the expense of creating redundant operations and lost economies of scale. At Hewlett-Packard (HP), a major computer and peripherals manufacturer, 50 decentralized purchasing offices provided excellent responsiveness and service to the plants, but prevented HP from benefiting from quantity discounts. After reengineering, HP has a centralized purchasing function that creates and maintains a centralized database of vendors with whom they have negotiated contracts. Decentralized units can access the database to execute their own purchase orders.

5. Line parallel activities instead of integrating their results

If parallel activities have been created, use communications networks, shared databases, and teleconferencing to coordinate activities that must eventually come together. For example, in the loan application process, decisions by one function that will affect the loan decision must be immediately communicated to other functions.

6. Put the decision point where the work is performed, and build controls into the process

Organisations often distinguish those who do the work from those who monitor and make decisions about the work. This is done under the assumption that those who do the work do not have the time, inclination, knowledge, or responsibility for monitoring and controlling what they do. Organisations can reduce non value-added management and flatten the organization structure if the organisations use information technology to capture and store data, and expert systems to supply knowledge, to enable people to make their own decisions.

This changes the role of manager from controller and supervisor to supporter and facilitator. And, as organisations flatten, they can eliminate the middle managers who had been summarizing and reporting information to upper management. To compensate, executives must be directly lined to databases using executive information systems.

7. Capture information once and at the source

Collect and store data in online data-bases for all who need them. This principle is facilitated by information technology, such as telecommunications, networking, client/server architecture, EDI, image processing, relational database system, bar coding, intelligent workflow software.

For example – when we visit a big shopping mall like Big Bazar, the cash counter or delivery counter will capture the details of goods sold from bar code on the product. This input data is picked up by the software to generate sales invoice, accounting entry for sales is automatically passed, inventory is updated, cash book is updated, GST is calculated, purchase order is prepared if the level of inventory decreases. All this is done, at the time of capturing the information at source. It avoids duplication of work of data entry.

BPR in Practice - Ford Motor Company

Spurred by the depression in the American automotive industry in the early 1980s, Ford's top management decided to examine all of its departments, looking for ways to cut costs. Its North American accounts payable processing alone employed some 500 persons. Management felt that by streamlining the process and installing a new computer system, accounts payable personnel could be reduced by 20%. Although the prospect of reducing accounts payable staff to 400 looked impressive, Ford's management re-examined that target when it learned that Mazda, a Japanese automaker, had only 5 people for the accounts payable function. Even after adjusting for the difference in Mazda's size, Ford concluded that it should aim for a reduction in workforce by several hundred rather than the 100 it originally planned.

Note the dramatic performance improvement it set as the goal of this reengineering project. Under the old system, the accounts payable department had to match 14 different data items among the receiving document, purchase order, and vendor invoice before it could make a payment to the vendor. Since mismatches were numerous, the department spends most of its time resolving the discrepancies. Payments were delayed and multiple documents were generated. A "conventional" solution to these problems might have been to automate the investigation process to make it more efficient. But Ford opted for a better, more radical solution-namely, to prevent the mismatches from ever occurring.

Instead of an accounts payable department, Ford has a new, reengineered procurement process. Emphasis on the words procurement and process shifts focus from the individual activities under old system to the desired outcome of those activities under the new system. The new system represents a radical departure from the old. There are no vendor invoices in the new system. Ford had asked its vendors not to send invoices. When the purchasing department issues a purchase order (PO), it enters the order into an online database. No copies of the order are sent to anyone other than to the vendor. When the goods arrive at the receiving dock, a receiving clerk checks the goods against the database to see that they correspond to an open purchase order. If so, the clerk accepts the shipment and enters the receipt into the computer system. If there are discrepancies between the goods received and the purchase order record per the database, the goods are returned to the vendor. Once the receipt has been entered into the system, the computer prepares the cheque, which is sent to the vendor.

Ford has achieved a 75% reduction in payables processing personnel, rather than the 20% reduction it had envisioned with a more conventional solution. Furthermore, inventory control has been simplified and financial information is more accurate because there are no discrepancies between the financial record and the physical record of the goods received. Obviously, to implement the new system, Ford has had to work closely with its vendors and its employees to help them adapt to this drastic change in their trading partnerships. All parties must now recognize that the purchase order is the important link in the new system. Because a vendor invoice does not exist, the PO must contain all the information about costs, terms, and the like needed to make payment to the vendor. Further, since variances between the PO and goods received are not tolerated, vendors must accept the fact that if they deviate from the PO, they will have the goods returned to them.

Bike Manufacturing Process

Bikes are assembled through passing them along a continuous moving band of metal & rubber and adding parts to each one in a pre-arranged order to arrive at the finished product. This process can be upgraded in terms of efficiency by using automated machines to do some of the repetitive actions. In this manner, the process is being redesigned to include enhanced automated system to make it more efficient. In other words, Business Process Re-engineering is being used to improve the existing process.

But the process itself could be redesigned from scratch. For example, the bike could be manufactured by giving all the parts to a team of specialist and asking them to work together to make it. This will mean creating completely new processes, which may or may not be more efficient than those of the existing system. But the "process vision" of providing better satisfaction to team of workers from the production process itself may supersede the efficiency issues. In this example, Process Innovation results in entirely new process to manufacture the bike, even if we haven't defined them – it's up to the workers to decide.

Tata's Nano Car

In order to achieve substantial cost reduction, a completely new approach for manufacture of car was used by Tata Motors. The engine of the vehicle is shifted to the back side and the boot space in the front side. The engine is located under the back seat and the luggage space in under the front bonnet with a spare wheel. It is a complete transformation from the normal practice and can be treated as Process Innovation.

Tata motors has now launched an automated gear transmission version in Nano car. It is popularly called as gearless car. It has made the job of driving a car very easy. No clutch and no gear in the car. This improvement over the existing model may be called as business process reengineering.

ChotuKool by Godrej & Boyce Mfg. Co. Ltd.

A single door 35L portable refrigerator is manufactured by Godrej & Boyce Co. It is just 7.3 kg. in weight. It can work on normal electricity as well as inverter. Moreover, it remains cool for 3 hours without any electricity connection. It uses an electronic cooling device instead of a compressor. It is a complete process innovation and not BPR.

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4 COST MANAGEMENT TECHNIQUES

COST CONTROL AND COST REDUCTION

Cost Control implies regulation of cost by executive action. For this purpose, the executives are provided with some yardstick such as standards or budgets with which the actual costs and performances are compared to ascertain the degree of achievement made. Therefore, Cost Control involves continuous comparisons of actual with the standards or budgets to regulate the former.

Cost Control is possible only when an organization has an effective Cost Accounting System to provide relevant information. Costs should be categorized into controllable and non-controllable. The organization is divided into various responsibility centers. Every executive is made responsible for the performance of the center under his control.

Amongst the techniques used for Cost Control, the most two popular are Standard Costing and Budgetary Control.

Cost Reduction is the achievement of real and permanent reduction in unit cost of products manufactured. It, therefore, continuously attempts to achieve genuine savings in cost of production, distribution, selling and administration. It does not accept a standard or budget. It rather challenges the standards / budgets continuously to make improvement in them. It attempts to excavate, the potential savings buried in the standards by continuous and planned efforts.

Comparison Table

Cost Reduction	Cost Control
Cost Reduction is the achievement of real and permanent reduction in unit cost of products manufactured.	Cost Control involves a comparison of actual with the standards or budgets, to regulate the actual costs.
Realistic & permanent savings in cost.	There could be a temporary savings in cost.
Product's Utility, Quality and Characteristics are retained.	Quality Maintenance is not a guarantee.
Continuous process of critical examination includes analysis and challenge of standards.	Control is achieved through compliance with standards. Standards by themselves are not examined.
Fully dynamic approach. It is more challenging, innovative and creative in nature.	Less dynamic than Cost Reduction. It is very routine in nature.
Universally applicable to all areas of business. Does not depend upon standards, though target amounts may be set.	Limited applicability to those items of cost for which standards can be set.

Emphasis here is partly on present costs and largely on future costs. It is a future oriented activity.	Emphasis on present and past behaviour of costs. It is a past oriented activity.
The function of Cost Reduction is to find out substitute ways and new means like waste reduction, expense reduction and increased production.	Cost Control does the analysis of actual results with established standards.
Cost Reduction is a preventive measure. It is a proactive measure.	Cost Control is a corrective measure. It is a reactive measure.
Techniques used – JIT, TQM, VCA, VE, Kaizen Costing, Target Costing, BPR etc.	Techniques used – Standard Costing and Budgetary Control.

PROBLEM NO. 1 :

Classify the following items under the more appropriate category:

Category (CC) – Cost Control Or Category (CR) – Cost Reduction.

(i) Costs exceeding budgets or standards are investigated.

(ii) Preventive function

(iii) Corrective function

(iv) Measures to standardize for increasing productivity

(v) Provision of proper storage facilities for materials.

(vi) Continuous comparison of actual with the standards set.

(vii) Challenges the standards set

(viii) Value analysis

TARGET COSTING

The Origin of Target Costing :

In Japan, target costing is widely practiced, in more than 80% of the companies in the assembly industries and more than 60% of companies in processing industries. It emerged in Japan in 1960s as a response to difficult market conditions.

Many Japanese companies considered modified cross-functional activities, as used by Western firms for manufacturing and achieving effective results. They believed that there were advantages in combining employees from strategy, planning, marketing, engineering, finance and production into expert teams. These teams were able to examine new methods and techniques for the design and development of new products, and aimed at enhancing operations. Target costing thus emerged from this environment. A range of specialized engineering were introduced to support target costing. This made Japanese companies particularly effective in the areas of product design and development, where they were able to identify all relevant elements to formulate a holistic management approach, in order to achieve performance levels to meet the firm's objectives.

Definition of Target Costing : It can be defined as "a structured approach to determining the cost at which a proposed product with specified functionality and quality must be produced, to generate a desired level of profitability at its anticipated selling price."

Advantages of Target Costing :

1. It reinforces top-to-bottom commitment to process and product innovation, and is aimed at identifying issues to be resolved, in order to achieve some competitive advantage.
2. It helps to create a company's competitive future with market-driven management for designing and manufacturing products that meet the price required for market success.
3. It uses management control systems to support and reinforce manufacturing strategies; and to identify market opportunities that can be converted into real savings to achieve the best value rather than simply the lowest cost.

Main Features of target costing system :

The main features or practices followed in different Japanese companies can be understood by going through the following points :

1. Target costing is viewed as an integral part of the design and introduction of new products. As such, it is part of an overall profit management process, rather than simply a tool for cost reduction and cost management. The first part of the process is driven by customer, market and profitability considerations. Given the profitability is critical for survival, a target profit margin is established for all new product offerings. The target profit margin is derived from the company's long term business plan, which incorporates its long-term strategic intent and profit margins. Each product or product line is required to earn at least the target profit margin.

2. For any given product, a target selling price is determined using various sales forecasting techniques. Importantly, while setting the target selling price, competitive conditions and customers' demands for increased functionality and higher quality, without significant increase in price, are clearly recognized. Hence, the target selling price is market-driven and should encompass a realistic reflection of the competitive environment.

3. Integral to setting the target selling price is the establishment of target production volumes, given the relationship between price and volume. The expected target volumes are also critical to computing unit costs, especially with respect to capacity-related costs, as product costs are dependent upon the production levels over the life cycle of the product. Once the target selling price and required profit margin have been determined, the difference between these two figures indicates the allowable cost for the product. Ideally, the allowable cost becomes the target cost for the product.

4. The next stage of the target costing process is to determine cost reduction targets. Some firms will do this by estimating the 'current cost' of the product. The current cost is based on existing technologies and components, but encompasses the functionalities and quality requirement of the new product. The difference between the current cost and the target cost indicates the required cost reduction that is needed.

5. It should be noted that a fair degree of judgement is needed where the allowable cost and the target cost differ. As the ideal is to produce at the allowable cost, it is important that the difference is not too great. Once the product-level target cost is set, then it generally cannot be changed, and the challenge for those involved is to meet this target.

6. Having achieved consensus about the product-level target cost, a series of intense activities commence to translate the cost challenge into reality. These activities continue throughout the design stage up until the point when the new product goes into production. Typically, the

total target is broken down into its various components, each component is studied and opportunities for cost reductions are identified. These activities are often referred to as value engineering (VE) and value analysis (VA). Value engineering involves searching for opportunities to modify the design of each component or part of a product to reduce cost, but without reducing functionality or quality of the product. Value analysis entails studying the activities that may be eliminated or minimized to save costs, but without reducing the functionality or quality of the product. Overall, the aim of the process is to ensure that when production commences, the total cost will meet the target, and profit goals will be achieved. There is also an ongoing continuous improvement program, known as Kaizen Costing, that focuses on the reduction of waste in the production process, thereby further lowering costs below the initial targets specified during the design phase.

While the above description captures the essential features of the target costing process, it should be emphasized that successful target costing requires careful planning, attention to details and a strong degree of commitment from those involved.

Another term mentioned in the earlier explanation of the target costing process is **'kaizen costing'.** This is a Japanese term for a number of cost reduction steps that can be used subsequent to issuing a new product design to the factory floor. Some of the activities in the kaizen costing methodology include the elimination of waste in the production, assembly, and distribution processes, as well as the elimination of work steps in any of these areas. Though these points are also covered in the value engineering phase of target costing, the initial value engineering may not uncover all possible cost savings. Thus, kaizen costing is really designed to repeat many of the value engineering steps for as long as a product is produced, constantly refining the process and thereby stripping out extra costs. The cost reductions resulting from kaizen costing are much smaller than those achieved with value engineering but are still worth the effort since competitive pressures are likely to force down the price of a product over time, and any possible cost savings allow a company to still attain its targeted profit margins while continuing to reduce cost.

Steps of Target Costing :

Following are the steps to be performed while target costing applied.

Step 1 – Re-orient culture of thinking and attitude, so that importance must be given to market driven prices and need of customer can be prioritized rather a just technical requirements whenever the product will be developed.

Step 2 – Identify the market requirements as regards design, utility and need for a new product or improvements in the existing products. Be customer-oriented while determining the requirements. If dealing with multiple products, perform this exercise for all product.

Step 3 – Establish the market-driven target price based upon market share, the competition, the price charged by competitors, the elasticity of demand, and strategy.

Step 4 – Determine the volume of product to be produced that will be sold at the established market-driven target price.

Step 5 – Establish the target profit margin (for each product), based on the long-term objectives and considering the financing aspects.

Step 6 – Determine the target cost by reducing the desired/required margin from market-driven target price. At this step, a work sheet needs to be prepared through which target cost need to be allocated to different assemblies of the subsystem.

Step 7 – Establish a balance between target cost and requirement; target cost must be seen in conjunction with requirements of customers which was identified at step two to lock the target cost.

Step 8 – Establish the target costing process. It comprises the persons, their role & responsibilities and tool & techniques to be involved in the process of target costing.

Step 9 – Brainstorm and analyses the alternatives to identify the opportunity to reduce the cost through consideration of the multiple concepts and design alternate for both the product and its manufacturing process at each stage of the development cycle.

Step 10 – Establish product cost models (along with cost table) for each concept and design alternate to support decision making.

Step 11 – Use the tools to closing down the gap between cost as determined by product cost model in step 10 and target cost locked in step 6. Analysis of cost reduction target can be performed to identify cost reduction opportunities (both in design and layout of product and processes) using Value Engineering / Value Analysis.

Step 12 – Reduce the indirect cost applications – Re-engineer the indirect process by eliminating the non-value-added function to minimize the cost. Use Activity Based Costing (along-with knowledge of cost drivers) to understand how design decision impact these indirect costs to explore the scope of avoidance.

Step 13 – Measure the results and maintain management focus on further possibilities of cost reduction as a continuous improvement program.

Impact of Target Costing on Profitability :

Target costing can have a startlingly large positive impact on profitability, depending on the commitment of management of its use, the constant involvement of cost accountants in all phases of a product's life cycle, and the type of strategy a company follows.

Target costing improves profitability in two ways. First, it places such a detailed continuing emphasis on product costs throughout the life cycle of every product that it is unlikely that a company will experience runaway costs. Also, the management team is completely aware of costing issues since it receives regular reports from the cost accounting members of all design teams. Second, it improves profitability through precise targeting of the correct prices at which the company feels it can field a profitable product in the marketplace that will sell in a robust manner. This is opposed to the more common cost plus approach under which a company builds a product, determines its cost, adds a profit and then does not understand why its resoundingly high price does not attract buyers. Thus, target costing results not only in better cost control but also in better price control.

Most Useful Situations for Target Costing :

Target costing is most useful in situations where the majority of product costs are locked in during the product design phase itself. This is the case fit for most of the manufactured products, but not much for services. In the services area, such as consulting, the bulk of all activities can be reconfigured for cost reduction during the phase when services are being provided directly to the customer. In the service sector, the "design team" is more commonly concerned with streamlining the activities conducted by the employees providing the direct services. Though it can be done at any time or on continuous basis, and not just when the initial services process is being laid out. Assembly line production units benefit the most from target costing.

For example, design team can lay out the floor plan of a fast-food restaurant, with the objective of creating an arrangement that allows employees to cover the shortest possible distances while preparing food and serving customers; this is similar to the designing of a new product. However, unlike a product design, this layout can be readily altered at any time if the design team can arrive at a better layout. In this situation costs are not locked in during the design phase, so there is less need for target costing.

Another situation where target costing results in less value, is the production of raw materials, such as chemicals. In this case there are no design features for a design team to work over. Instead, the industrial engineering staff tries to create the most efficient possible production process, which has little to do with cost reduction through the improvement of customer value by creating a product with high ratio of features to costs.

Problems with Target Costing :

Though the target costing system results in clear, substantial benefits in most cases, it has a few problems that one should be aware of and guard against. These problem are as follows :

1. The first problem is that the development process can be lengthened to a considerable extent since the design team may require a number of design iterations before it can devise a sufficiently low-cost product that meets the target cost and margin criteria. This occurrence is most common when the project manager is unwilling to "pull the plug" on a design project that cannot meet its costing goals within a reasonable time frame.
   Usually, if there is no evidence of rapid progress toward a specific target cost within a relatively short period of time, it is better to either pull the plug or at least suspend it for a short time and then try again, on the assumption that new cost reduction methods or less expensive materials will be available in the near future that will make the target cost an achievable one.

2. Another problem with target costing is that a large amount of mandatory cost cutting can result in finger-pointing in various parts of the company, especially if employees in one areas feel they are being called on to provide a disproportionately large part of the savings. For example, the industrial engineering staff will not be happy if it is required to completely alter the production layout in order to generate cost savings, while the purchase staff is not required to make any cost reductions through supplier negotiations. Avoiding this problem requires strong interpersonal and negotiation skills on the part of the project manager,

3. Finally, having representatives from number of departments on the design team can sometimes make it more difficult to reach a consensus on the proper design because there are many opinions regarding designing issues. This is a major problem when there are particularly stubborn people on the design team who are holding out for specific product features. Resolving these differences out is difficult and requires a strong team manager, as well as a long term commitment on the part of a company to weed out those who are not willing to act in the best interest of the company.

Cost Accountant's Role in a Target Costing Environment :

The cost accountant should be able to provide for the other members of the design team a running series of the cost estimates based on initial designs sketch, activities based costing reviews of production processes, and "best guess" costing information from suppliers based on estimated production volumes. Essentially in the earliest stages of a design, the cost accountant works with vague costing information and so must be able to provide estimates within a high-low range costs, gradually tightening this estimated cost range, as more information becomes available.

The cost accountant should work with the design team to help it understand the nature of various costs (such as cost allocations based on an activity-based costing system), as well as the cost-benefit trade-offs of using different design or cost operations in the new product.

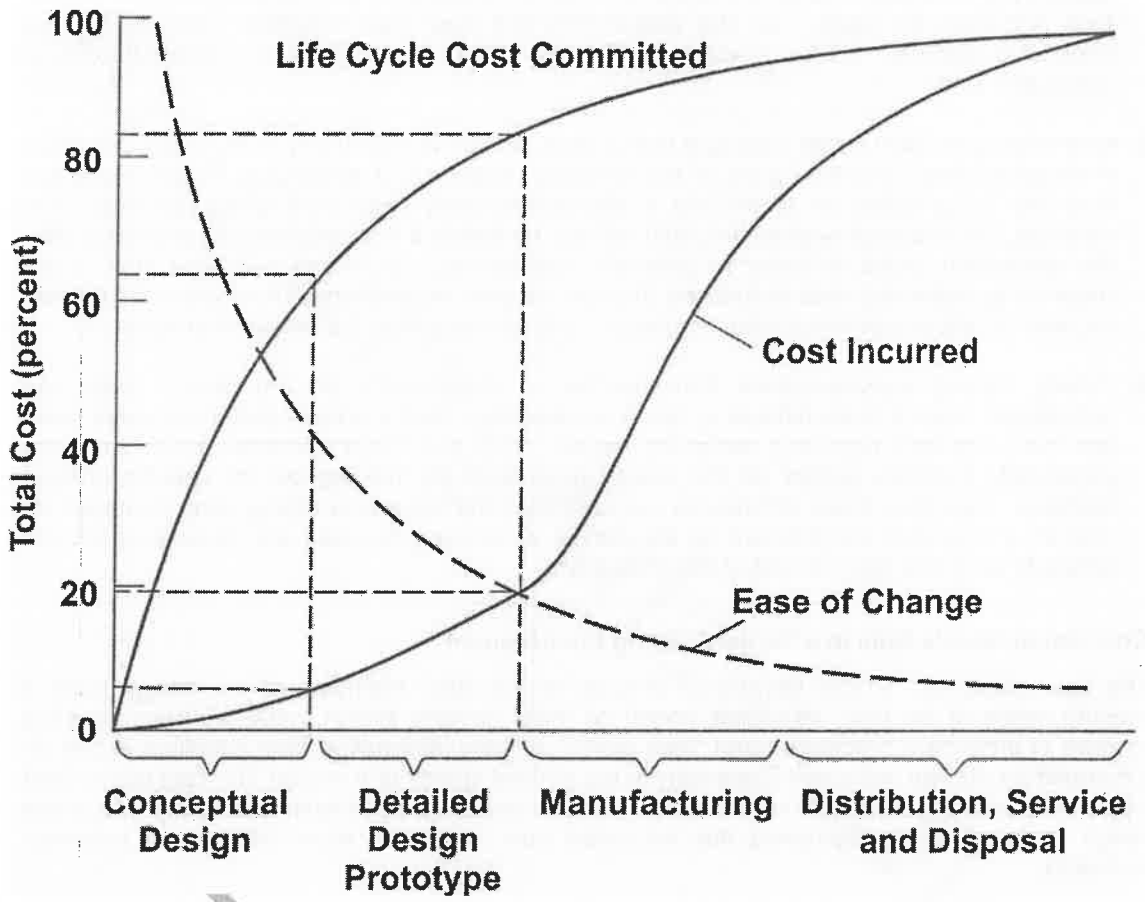
In addition, the cost accountant is responsible for tracking the gap between the current cost or a product design and the target cost, which is the goal of design team. He should provide an item wise list of where cost savings have already been achieved and where there has not been a sufficient degree of progress.

Finally, the cost accountant must continue to compare a product's actual cost to the target cost after the design is completed, and for as long as the company sells the product. This is a necessary step because management must know immediately if costs are increasing beyond budgeted levels and why these increases are occurring.

Product Design

Design of the product has a high possibility for cost reduction, because above 80% of production cost is committed at design phase only. Since designing of the product is the preliminary stage in the manufacturing of a product, hence the impact of any economy or cost reduction will be felt throughout the manufacturing life of the product.

It can be illustrated with the help of following graph -



Practical Questions on Target Costing

PROBLEM NO. 2 : [Old Syllabus]

A company has the capacity of production of 80,000 units and presently sells 20,000 units at Rs.100 each. The demand is sensitive to selling price and it has been observed that every reduction of Rs.10 in selling price the demand is doubled. What should be the target cost at full capacity if profit margin on sale is taken as 25%?

What should be the maximum investment at full capacity, if desired Rate of Return is 15% on investment and the above profit margin is realised.

PROBLEM NO. 3 : [Old Syllabus]

IBM Ltd. Manufactures and sells computers peripherals to several retail outlets throughout the country. Amar is the manager of the printer division. Its two largest-selling printers are P1 & P2.

The manufacturing cost of each printer is calculated using IBM's activity based costing system. IBM has one direct manufacturing cost category (direct materials) and the following five indirect manufacturing cost pools.

	Indirect Mfg. cost pool	Allocation Base	Allocation Rate (Rs.)
1.	Materials handling	No. of parts	Rs. 1.20 per part
2.	Assembly management	Hours of assembly time	Rs. 40 per hour
3.	Machine insertion of parts	No. of machine inserted parts	Rs. 0.70 per part
4.	Manual insertion of parts	No. of manually inserted parts	Rs. 2.10 per part
5.	Quality testing	Hours of quality testing time	Rs. 25 per hour

Product characteristics of one unit of P1 and P2 are as follows :

Particulars	Printer P-1	Printer P-2
Direct materials costs	Rs. 407.50	Rs. 292.10
Number of parts	85	46
Hours of assembly time	3.2	1.9
Number of machine inserted parts	48	31
Number of manually inserted parts	36	15
Hours of quality testing time	1.4	1.1

A foreign competitor has introduced products very similar to P1 and P2. Given their announced selling prices, and to maintain the company's market share and profits, Amar estimated the P1 to have manufacturing cost of approximately Rs. 680 and P2 to have a manufacturing cost of approximately Rs. 390.

He calls a meeting of product designers and manufacturing personnel at the printer division. They all agreed to have Rs. 680 and Rs. 390 as target costs for designed version of P1 and P2 respectively. Product designers examine alternative ways of designing printer with comparable performance but at lower cost. They come up with the following revised designs for P1 and P2, termed as P1 – REV and P2 – REV, respectively.

Particulars	P1 – REV	P2 – REV
Direct materials costs	Rs. 381.20	Rs. 263.10
Number of parts	71	39
Hours of assembly time	2.1	1.6
Number of machine inserted parts	59	29
Number of manually inserted parts	12	10
Hours of quality testing time	1.2	0.9

Required :

(a) Compute the present costs of products P1 and P2 using ABC system.

(b) Compute the manufacturing costs of P1 – REV and P2 – REV. How do they compare with the Rs. 680 and Rs. 390 target costs? Whether target is achieved or not?

PROBLEM NO. 4 : [Old Syllabus]

You are the manager of a paper mill XYZ Ltd. and have recently come across a particular type of paper, which is being sold at a substantially lower rate by another company – ABC Ltd., than the price charged by your own mill. The value chain analysis for one use of one ton of such paper of ABC Ltd. is a follows :

ABC Ltd. ⟶ Merchant ⟶ Printer ⟶ Customer

ABC Ltd. sells this particular paper to the merchant at the rate of Rs. 1,466 per ton. ABC Ltd. pays for the freight which amounts to Rs. 30 per ton. Average discount and allowances amount to 4% of sales and approximately equals Rs. 60 per ton.

The value chain of your company, through which the paper reaches the ultimate customer is similar to the one of ABC Ltd. However, your mill does not sell directly to the merchant, the latter receiving the paper from a huge distribution centre maintained by your company at Haryana. Shipment costs from the mill to the Distribution Centre amount to Rs. 11 per ton while the operating costs in the Distribution Centre have been estimated to be Rs. 25 per ton. The return on investment required by the Distribution Centre for the investments made, amount to an estimated Rs. 58 per ton.

You are required to compute the "Mill Manufacturing Target Cost" for this particular paper for your company. You may assume that the return on investment expected by paper mill equals Rs. 120 per ton of such paper.

PROBLEM NO. 5 : [Old Syllabus]

Even Forward Ltd. is manufacturing and selling two products: Splash and Flash at selling price of Rs 3 and Rs. 4 respectively. The following sales strategy has been outlined for the year :—

(i) Sales planned for year will be Rs. 7.20 lakhs in the case of Splash and Rs. 3.50 lakhs in the case of Flash.

(ii) To meet competition, the selling price of Splash will be reduced by 20% and that of Flash by 12 ½ %.

(iii) Break- even is planned at 60% of the total sale of each product.

(iv) Profit for the year to be achieved is planned as Rs 69,120 in the case of Splash and Rs. 17,500 in the case of Flash. This would be possible by launching a cost reduction programme and reducing the present total annual fixed expenses of Rs. 1,35,000 allocated as Rs. 1,08,000 to Splash and Rs. 27,000 to Flash.

You are required to :

(a) Calculate number of units to be sold of Splash and Flash to break-even as well as the total number of units of Splash and Flash to be sold during the year.

(b) Calculate reduction in fixed expenses product-wise that is envisaged by the Cost Reduction Programme.

PROBLEM NO. 6 : [RTP May 2018 + Nov. 2020 Exam]

Storewell Industries Ltd. manufactures standard heavy duty steel storage racks for industrial use. Each storage rack is sold for ₹ 750 each. The company produces 10,000 racks per annum. Relevant cost data per annum are as follows:

Cost Component	Budget	Actual	Actual Cost p.a. (₹)
Direct Material	5,00,000 sq. ft.	5,20,000 sq. ft.	20,00,000
Direct Labour	90,000 hrs.	1,00,000 hrs.	10,00,000
Machine Setup	15,000 hrs.	15,000 hrs.	1,50,000
Mechanical Assembly	2,00,000 hrs.	2,00,000 hrs.	30,00,000

The actual and budgeted operating levels are the same. Actual and standard rates of material procurement and hourly labour rate are also the same. Any variance in cost is solely on account of difference in the material usage and hours required to complete production.

Aggressive pricing from competitors has driven down sales. A comparable rack is available in the market for ₹ 675 each. Vishal, the marketing manager has determined that in order to maintain the company's existing market share of 10,000 racks, Storewell Industries must reduce the price of each rack to ₹ 675.

Required :

(i) CALCULATE the current cost and profit per unit. IDENTIFY the non-value added activities in the production process.

(ii) CALCULATE the new target cost per unit for a sales price of ₹ 675 if the profit per unit is to be maintained.

(iii) RECOMMEND what strategy Storewell Industries should adopt to attain target cost calculated in (ii) above.

Solution 6 :

(i) The current cost and profit per unit is calculated as below :

Particulars	Actual Cost p.a. (₹) for 10,000 racks	Cost per rack (₹)
(a) Direct Material	20,00,000	200
(b) Direct Labour	10,00,000	100
(c) Machine Setup	1,50,000	15
(d) Mechanical Assembly	30,00,000	300
(e) Total cost [a to d]	61,50,000	615
(f) Sales	75,00,000	750
(g) Profit [f – e]	13,50,000	135

In the above activities, it seems that Machine setup activity is the activity to get the machines ready for production. Activity of mechanical assembly is the activity where the components and parts are assembled to manufacture finished product. Hence, we can say that Machine Setup is a non-value added activity.

(ii) New sale price per rack is ₹ 675 per unit. The profit per unit to be maintained is ₹135. Hence, the new target cost per unit = New selling price per unit – required profit per unit = ₹ 675 - ₹ 135 = ₹ 540 per unit.

(iii) As explained above, current cost per unit is ₹615 while the target cost per unit is ₹540. Hence, the cost has to be reduced at least by ₹75 per unit. Analysis of the cost data shows the variances between the budget and actual material usage and labour hours. It is given that the material procurement rate and labour hour rate is the same for budgets and actuals. Hence, the increase in cost of direct materials and labour is due to inefficient use of material and labour hours to complete the same level of production of 10,000 storage racks.

We may use some of the Cost Control and Cost Reduction techniques, which may result in the following savings:

(a) Inefficiencies resulted in use of extra 20,000 sq. ft of material.

Extra Material cost = ₹ 20,00,000 / 5,20,000 sq. ft x 20,000 sq. ft.
= ₹ 76,923

(b) Inefficiencies resulted in extra 10,000 direct labour hours.

Extra Labour cost = ₹ 10,00,000 / 1,00,000 hrs. x 10,000 hours
= ₹ 1,00,000

(c) Machine setup cost is a non-value added cost. Value analysis can be done to determine if the setup time of 15,000 hrs. can be reduced. However, since these activities have been carried out for a reason, care should be taken to ensure that this change should not adversely impact the production quality.

(d) Mechanical assembly cost is almost half of the total cost. These are costs incurred during the production process on the assembly line. Value analysis can be done to determine if the production process can be made more efficient. For example, the process can be streamlined, such that steps can be combined so that it can be handled by fewer people (process centering). Similarly, value analysis / value engineering can focus on the product re-design.

Some questions to be raised for cost reduction are :

- Can the product be designed better to make the production more efficient?
- Can the design be minimized to include fewer parts and thus make it easier and efficient to manufacture?
- Can we substitute parts to make it more efficient? Or
- Is there simply a better way of producing the same product?

While target costing is a dynamic and corrective approach, care must the taken that the product quality, characteristics and utility are maintained.

PROBLEM NO. 7 : [Nov. 2018 Exam. + Case Study Digest]

Zen Ltd., forms a Committee consisting of its Production, Marketing and Finance Directors to prepare a budget for the next year. The Committee submits a draft budget as detailed below :

Particulars	₹	₹
Selling price per unit		50
Direct material cost per unit	9	
Direct labour cost per unit	9	
Variable overheads (3 hrs. @ ₹ 2)	6	24
Contribution per unit		26
Budgeted sales quantity		25,000 units
Budgeted contribution (25,000 x 26)		6,50,000
Budgeted Fixed Cost		5,00,000
Budgeted Profit		1,50,000

The management is not happy with the budgeted profit as it is almost equal to the previous year's profit. Therefore, it asks the Committee to prepare a budget to earn at least a profit of ₹3,00,000. To achieve the target profit, the Committee reports back with the following suggestions :

The unit selling price should be raised to ₹ 55.

The sales volume should be increased by 5,000 units.

The attain the above said increase in sales, the company should spend ₹ 40,000 for advertising.

The production time per unit should be reduced.

To win the acceptance of the workers in this regard the **hourly rate** should be increased by ₹ 3 besides an annual group bonus of ₹ 30,000.

There is no change in the amount and rates of other expenses. The company has sufficient production capacity.

As the implementation of the above proposal needs the acceptance of the work force to increase the speed of work and to reduce the production time per unit, the Board wants to know the extent of reduction in per unit production time.

Required :

(i) Calculate the target production time per unit and the time to be reduced per unit. [14 Marks]

(ii) Identify the other problems that may arise in production due to decrease in unit production time and also suggest the remedial measures to be taken. [4 Marks]

(iii) State the most suitable situation for the adoption of Target Costing. [2 Marks]

Solution 7 :

Approach : We should first calculate Total Sales. Then deduct desired profit from such sales to get the total cost. Now deduct all other costs (other than labour related cost) from such total cost, to get the labour & variable OH cost as balancing figure. Divide such cost by a combined Labour + Variable OH rate per hour to get total hours and then divide total hours by number of units to get hours per unit.

(i) Calculation of Target Production Time :

Particulars	₹	₹
(a) Budgeted sales revenue [30,000 units x ₹ 55]		16,50,000
(b) Budgeted total profit [given]		3,00,000
(c) Budgeted total cost [a - b]		13,50,000
(d) All costs other than labour related cost :		
Direct material [30,000 units x ₹ 9]	2,70,000	
Budgeted fixed cost	5,00,000	
Extra expenses for advertising	40,000	
Annual group bonus to labour	30,000	8,40,000
(e) Balance cost for labour and variable OH [c - d]		5,10,000
(f) Revised labour + variable OH rate/hr. [*6 + 2]		8
(g) Total target hours needed for production [e/f]		63,750 hrs.
(h) Hours required per unit [63,750 / 30,000 units]		2.125 hrs.
(i) Target reduction in time per unit [3 - 2.125]		0.875 hrs.

***Note :** Labour cost per unit Rs. 9 is given in the question. If we divide this cost by 3 hours p.u. we get wage rate of Rs. 3 per hour. This rate will further increase by ₹ 3 per hour and will now become ₹ 6 per hour.

(ii) Identification of other problem areas and remedial measures :

Possible Problems :

The target costing method is applicable particularly for repetitive manufacturing. It should however be recognised that some products often bear a high degree of repetition and some may not. For achieving reduction in time per unit, we may have to improve product design or production process. Such improvements need considerable time and resources. Working under pressure to finish new design assignments or to re-engineer production processes in a short time may cause unnecessary pressure on existing resources. In such case, there is a risk of not achieving the targets given to the target costing team. In short, decrease in unit production time may lead to unwanted pressure on design and its implementation stage.

Remedial Measures :

As a remedial action, organisation should retain strong control over the design teams headed by a good team leader. This person must have an exceptional knowledge of the design process, good interpersonal skills and a commitment to staying within both time and cost budgets for a design project. If the time is too short even an organisation may reject a project for the time being. Later, it can be tried out with new cost reduction methods or less expensive materials to achieve target cost.

(iii) Most useful situation for adoption of Target Costing :

Target costing is most useful in situations where the majority of product costs are locked in during the product design phase. This is the valid case for most of the manufactured products but not for services. In the service industry, such as consulting, the bulk of the activities can be reconfigured for cost reduction during the 'execution phase', which is when services are being provided directly to the customer. In the services environment, the 'design team' is still present, but is more concerned with the streamlining of activities conducted by the employees and not concerned with designing of activities. Thus, in manufacturing industry, the scope for adoption of target costing is higher.

Value Analysis and Value Engineering

Components of Target Costing System

Typically, the total target is broken down into its various components, each component is studied and opportunities for cost reductions are identified. These activities are often referred to as Value Analysis (VA) and Value Engineering (VE).

Value Analysis is a planned, scientific approach to cost reduction which reviews the material composition of a product and production design so that modifications and improvements can be made which do not reduce the value of the product to the customer or to the user.

Value Engineering is the application of value analysis to new products. Value engineering relates closely to target costing as it is cost avoidance or cost reduction before production. Value analysis is cost avoidance or cost reduction of a product already in production; both adopt the same approach i.e. a complete audit of the product.

Here are some of the issues that are dealt with during a Value Analysis / Value Engineering review:

- Can we eliminate functions from the production process?
- Can we eliminate excess durability or reliability?
- Can we minimize the design?
- Can we design the product better for the manufacturing process?
- Can we substitute parts?
- Can we combine steps?
- Can we take supplier's assistance?
- Is there a better way?

The above points are further explained below :

1. **Can we eliminate functions from the production process?**

   This involves a detailed review of the entire manufacturing process and determine the non-value added activities. By eliminating them, one can take their associated direct or overhead costs out of the product cost. However, these functions were originally put in for a reason, so the team must be careful to develop work-around steps that eliminate one or more activities from the original set of functions and be sure enough that eliminating these activities will not hamper the value added activities in any manner.

2. **Can we eliminate excess durability or reliability?**

   It is possible to design an excessive degree of sturdiness into a product. For example, a vacuum cleaner can be designed to withstand a 1-ton impact. This will involve an extra cost. Although there is a rare chance that such an impact will ever occur. Instead, designing it to withstand an impact of 100 pounds may account for 99.999% of all probable impacts. It will help us to eliminate a great deal of structural material from the design. However, one should not stretch this concept too far and it should be ensured that the functionality of the product is unaffected.

3. **Can we minimize the design?**

   This involves the creation of a design that uses fewer parts or has fewer features. This approach is based on the assumption that a minimal design is easier to manufacture and assemble. Also, with fewer parts to purchase, less procurement overhead is associated with the product. However, reducing a product to extremes, perhaps from dozens of components to just a few molded or prefabricated parts, can result in excessively high costs for these few remaining parts, since they may be so complex or custom made in nature that it would be less expensive to settle for a few extra standard parts that are more easily and cheaply obtained. Also, a proper trade-off between price and quality is necessary in this context.

4. **Can we design the product better for the manufacturing process?**

   Also, known as design for manufacture and assembly, this involves the creation of a product design that can be created in only a specific manner. For example, a toner cartridge for a laser printer is designed so that it can be successfully inserted into the printer only when the sides of the cartridge are correctly aligned with the printer opening; all other attempts to insert the cartridge will fail. When used for the assembly of an entire product, this approach ensures that a product is not incorrectly manufactured or assembled. Otherwise, it would call for a costly disassembly or (even worse) product recalls from customers who have already received defective goods.

5. **Can we substitute parts?**

   This approach encourages the search for less expensive components or materials that can replace more expensive parts currently used in a product design. It is becoming an increasingly valid approach since new materials are being developed every year. However, sometimes the use of a different material impacts the types of materials that can be used elsewhere in the product, which may result in cost increases in these other areas. Thus, any parts substitution must be accompanied by a review of related changes elsewhere in the design. This step is also known as component parts analysis and involves one extra activity i.e. tracking the intentions of suppliers to continue producing parts in the future; if parts will not be available in future, then they must be eliminated from the product design.

6. **Can we combine steps?**

   A detailed review of all the processes associated with a product sometimes reveals that some steps can be consolidated to do the work faster. It is possible that several steps can be accomplished by only one person, rather than different people performing different operations. This is also known as process centering. By combining steps in this manner, we can eliminate some of the transfer and queue time from the production process, which in turn reduces the chance that parts will be damaged during these transfers.

7. **Can we take supplier's assistance?**

   Another approach to value engineering is to call on the services of a company's suppliers to assist in the cost reduction effort. These organizations are particularly suited to contribute information concerning enhanced types of technology of materials, since they may specialize in areas that a company has no information about. They may have also conducted extensive value engineering for the components they manufacture, resulting in advanced designs that a company may be able to incorporate into its new products. Suppliers may have also redesigned their production processes, or can be assisted by a company's engineers in

doing so, producing cost reductions or decreased production waste that can be translated into lower component costs for the company.

8. **Is there a better way?**

   Though this step sounds rather vague, it really strikes at the core of the cost reduction issue. The other value engineering steps previously mentioned focus on incremental improvements to the existing design or production process, whereas this one is a more general attempt to start from scratch and build a new product or process that is not based in any way on pre-existing ideas.

A mix of all the value engineering steps noted above must be applied to each product design to ensure that the maximum permissible cost is safely reached. Also, even if a minimal amount of value engineering is needed to reach a cost goal, one should conduct the full range of value engineering analysis anyway, since this can result in further cost reductions that improve the margin of the product or allow management the option of reducing the product's price, thereby creating a problem for competitors who sell higher-priced products.

The initial value engineering may not uncover all possible cost savings. Thus, Kaizen Costing is designed to repeat many of the value engineering steps for as long as a product is produced. Constantly refining the process and thereby stripping out extra costs (already discussed in Chapter 3). The cost reductions resulting from kaizen costing are much smaller than those achieved with value engineering but are still worth the effort since competitive pressures are likely to force down the price of a product over time, and any possible cost savings allow a company to still attain its targeted profit margins while continuing to reduce cost.

Further, Target Costing System is based on involving representatives of all the Value Chain such as suppliers, agents, distributors and existing after sales service in the target costing system. This aim to spread concepts and efforts to reduce the cost over all the value chain through the development of the spirit co-operation and understanding among all members of organizations associated with the product from suppliers, producers, customers, agents and service providers. The target costing system is based on the concept of long term relations and mutual benefits in the long term between all members in the value chain.

Product Life Cycle Costing (PLC)

Introduction :

Life cycle costing as its name implies measures the costs and revenues of a cost object i.e., a product or a project over its entire projected life. It is used to describe a system that tracks and accumulates the actual costs and revenues attributable to cost object from its inception to its abandonment. The profitability of any given cost object can therefore be determined at the end of its economic life.

Life cycle costing is different to traditional cost accounting system, which reports the profitability on a calendar basis i.e. monthly, quarterly and annually. In contrast, the life cycle costing involves tracing costs and revenues on a product by product basis over the entire economic life of that product. Though the costs can be analysed by time period, but the emphasis is on cost and revenue accumulation over the entire life cycle of each product.

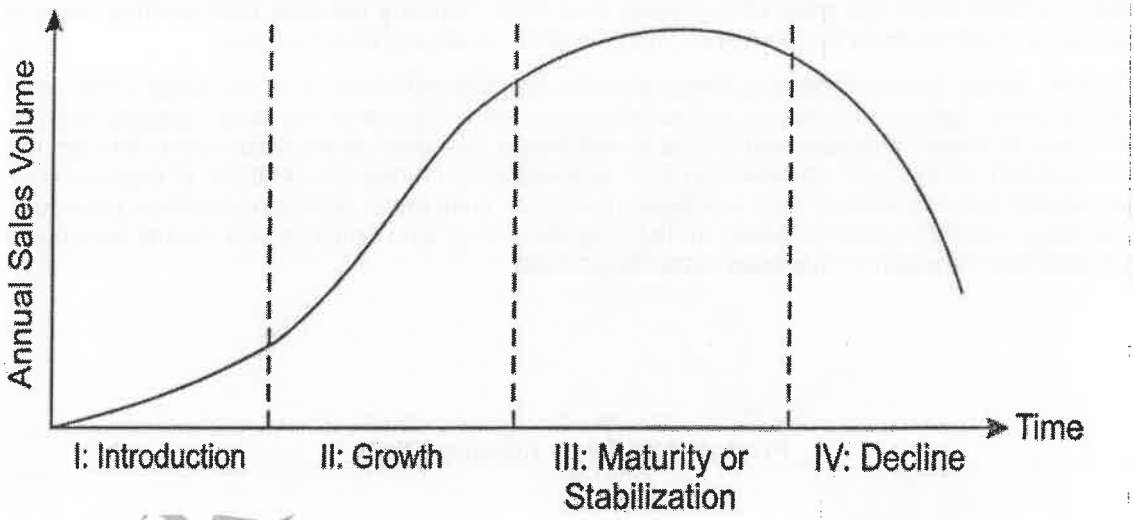
Each product has a life cycle. The life cycle of a product vary from a few months to several years. For example, in the case of cameras, photocopying machines, car etc. the life is more than 10 years. Whereas in the case of black and white T.V. / V.C.R. it was for few years only. Product life cycle is thus a pattern of expenditure, sales level, revenue and profit over the period from idea generation to the deletion of product from product range.

Phases of Product Life Cycle :
The life cycle of a product consists of five phases viz., Introduction; Growth; Maturity; Decline and Deletion. During introductory phase, a product is launched into the market. Competition is almost negligible and profits are non-existent. Under growth phase, sales and profits rise, at a rapid pace. Competitors enter the market often in large numbers. As a result of competitions, profit starts declining near the end of the growth phase.

During the phase of maturity, sales continue to increase, but at a decreasing rate. When sales levels start reducing, profits of both producers and middlemen decline. The main reason is intense price competition, alternative products available in the market, some firms come out with new improved models etc.
Decline in sales volume characterizes this last phase of the product life cycle. The need or demand for product disappears. Availability of better and less costly substitutes in the market indicates the arrival of the Decline phase.

At the end, management takes decision to withdraw the product from the market and stops manufacturing it. This stage is called Deletion.

Diagram of Sales during PLC



General Characteristics of Product Life Cycle : The major characteristics of product life-cycle concept are as follows :-

(i) The products have finite lives and pass through the cycle of development, introduction, growth, maturity, decline and deletion at varying speeds.

(ii) Product cost, revenue and profit patterns tend to follow predictable courses through the product life cycle. Profits first appear during the growth phase and after stabilising during the maturity phase, decline thereafter to the point of deletion.

(iii) Profit per unit varies as products move through their life cycles.

(iv) Each phase of the product life-cycle poses different threats and opportunities that give rise to different strategic actions.

(v) Products require different functional emphasis in each phase-such as an R & D emphasis in the development phase and a cost control emphasis in the decline phase.

(vi) Finding new uses or new users or getting the present users to increase their consumption, may extend the life of the product. It means, management may lengthen the life cycle of the product by taking certain steps, but cannot stop its deletion from the market.

Features of Product Life Cycle Costing :

(i) Product life cycle costing involves tracing of costs and revenues of each product over several calendar periods throughout their entire life cycle.

(ii) Production life cycle costing traces research and design and development costs etc., incurred on individual products over their entire life cycle, so that the total magnitude of these costs for each individual product can be reported and compared with revenues generated by each product over its entire life.

(iii) Thus the net result i.e. profit or loss is calculated for each product over its entire life cycle and can be compared with other products.

Benefits of Product Life Cycle Costing :

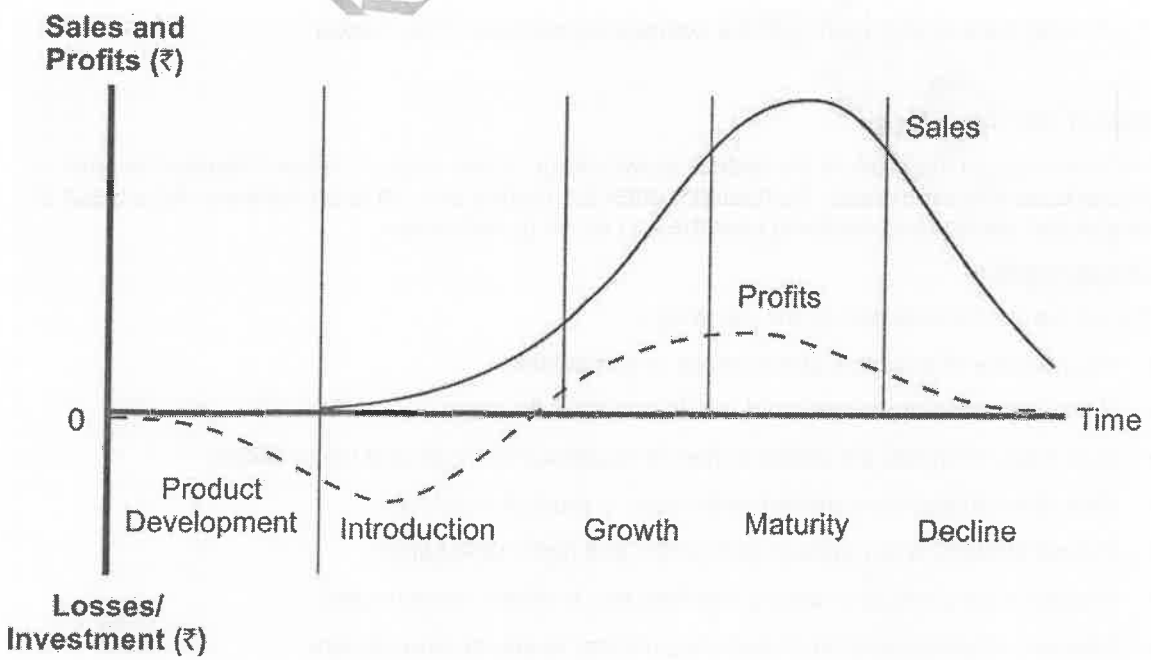
(i) The product life cycle costing results in earlier actions to generate revenue or to lower costs than otherwise might be considered. There are a number of factors that need to the managed in order to maximise return on a product. This helps in proper planning.

(ii) Better decisions should follow from a more accurate and realistic assessment of revenues and costs, at least within a particular life cycle stage.

(iii) Product life cycle thinking can promote long- term rewarding in contrast to short-term profitability rewarding.

(iv) It provides an overall framework for considering total incremental costs over the entire life span of a product, which in turn facilitates analysis of individual phases, where cost effectiveness might be achieved.

Sales & Profit Graph of PLC



Characteristics and Strategies for each Phase of PLC

Stage I : Introduction Stage

Stage one is where the new product is launched in the market. As the product is novel, there is minimal awareness and acceptance of it. Competition is almost negligible and profits are non existent. The length of the introduction stage differs from product to product depending on various factors.

Characteristics

This phase is characterised by the following -

- Decision about the product branding, packaging and labelling is taken
- High distribution and promotional expenses
- Profits are low or negative due to low initial volume
- Pricing may be very low in case of penetration pricing or very high in case of skimming pricing
- Huge efforts to attract various marketing channels
- Aggressive promotional efforts to increase awareness
- Product refinements are not possible
- Few competitors produce basic version of the same product
- Focus on those buyers who are the most ready to buy

Strategies

- Attracting customers by raising awareness of the product through promotion activities.
- Inducing customers to try and buy the product.
- Strengthening or expanding channel and supply chain relationships.
- Building on the availability and visibility of the product that boost channel intermediaries to support the product.
- Setting price in alignment with the competitive realities of the market.

Stage II : Growth Stage

The next stage in the product life cycle is growth stage. Sales begin to expand rapidly because of greater customer awareness. Competitors enter the market often in large numbers. As a result of competition, profit starts declining near the end of the growth stage.

Characteristics

This phase is characterised by the following -

- High volume of business and increase in competition
- Sales increases at an increased rate in early growth stage
- New sales channels are added to handle additional volumes and new markets
- Shift of emphasis from product awareness to product conviction
- Overall strategy is to maintain high profits and high market share
- Improving the product or adding new features to attract more buyers
- Lowering of prices in case of skimming pricing, to attract more buyers

- Money is still spent on promotional activities
- The length of growth stage varies according to the nature of the product and competitive reactions

Strategies

- Establish a clear brand identity through promotional campaigns.
- Maintain control over product quality to assure customer satisfaction.
- Maximize availability of the product through strong distribution channel.
- Find the ideal balance between price and demand as per price elasticity.
- Overall strategy shifts from acquisition to retention of customers, from motivating product trial to generating repeat purchases and building brand loyalty.
- Development of long-term relationships with customers and partners for the maturity stage.
- Value-based pricing strategies may be considered.
- Leverage the product's perceived differential advantages to secure a strong market position.

Stage III : Maturity Stage

During the maturity stage, sales continue to increase, but at a decreasing rate. When sales level reaches to a saturation point, profits of both producers and middlemen decline. The main reason is intense price competition; some firms extend their product lines with new models. This stage poses difficult challenges.

Characteristics

This phase is characterised by the following -

- Overcapacity in the industry
- Intensified competition
- Population growth and replacement demand governs future sales
- Profit per unit starts declining
- No new distribution channels are added
- Customers start moving towards other products and substitutes
- Strong marketing challenges

Strategies

- Strong marketing efforts are needed to win over the competitor's customers.
- Product features may be improved or enhanced to differentiate product from that of the competitors.
- Prices may have to be reduced to attract the price-sensitive consumers.
- Various sales promotion incentives are necessary for the consumers as well as dealers to maintain their interest in the product.
- Distribution becomes more intensive and incentives may be offered to encourage our product over competing products.

Stage IV : **Decline Stage**

Decline in sales volume characterizes this last stage of the product life cycle. The need or demand for product disappears. Availability of better and less costly substitutes in the market indicates the arrival of this stage.

Characteristics

This phase is characterised by the following -

- Sales revenue drops sharply
- Profits (per unit and total) start declining and at times become negative
- No. of organisations producing the similar product drops

Strategies

- The product can be maintained in the market by differentiation, keeping low cost for some more time by adding certain new features and finding new uses.
- The firm can continue to offer the product to its loyal customers (niche segment) at a reduced price.
- Firm can even discontinue the product at the end of this phase.
- Use the product as replacement product for launching another new product successfully in the market.
- The various marketing decisions in the decline stage will depend on the fact that, whether it is being revived, or given a new lease of life, or left unchanged if it is to be withdrawn.
- The reduced price may be maintained or further reduced drastically if product is to be withdrawn from the market.

Practical Insight of Maruti Suzuki Ltd.

Product Name : Maruti 800 (with 800 cc engine)

Maruti 800 is a small city car that was manufactured by Maruti Suzuki in India from 1983 to 2014. With life cycle of over 31 years (of production), Maruti 800 remains the second longest production car in India, next only to Hindustan Motor's Ambassador. About 2.87 million Maruti 800s were produced during its course of which 2.66 million were sold in India itself.

Introduction Stage (1983-1986)

- First Car imported and sold in 1983.
- Cheapest car in the market.
- Huge gap between demand and supply, it took them 3 years to clear the waitlist.

Growth Stage (1986-1998)

- Ensure people's expectations match product promise
- Increase in production and sale.
- Increase in profits.
- Competition started getting stiffer - Tata Motors entered the passenger vehicle market in 1988 (In 1998 Tata launched the first fully indigenous Indian passenger car 'Indica') & In 1994 General Motor India started producing and selling Opel branded vehicles & Ford India began production in 1998 of Ford Escort model (later became Ford Ikon).

Maturity Stage (1998-2004)

- Sales touched 2,00,000 units in 1999.
- It remained the best-selling car in India until 2004, when the Maruti Alto took the title.

Decline Stage (2004-2014)

- Drastic decrease in sales, able to sell Just 33,028 units in 2009-2010.
- Maruti Suzuki did not have plans to upgrade it to Euro IV or BS-IV emission norms.
- In April 2010 starts working on phase-out and halted the sale of car in 13 cities including all 4 metros.
- The last Maruti 800 was rolled off the production lines on 18 January 2014.
- Successor is Maruti Alto 800.

Practical Questions on Product Life Cycle Costing

PROBLEM NO. 8 : [Nov. 2010 Old Syllabus – 4 Marks]

A company has four products M, N, O and P in the market. Identify the phase of life cycle for each product with a brief reason.

M : There is a lot of competition. Quantity sold has been increasing at 10%, 8% and 7% in the last 3 years.

N : Until last year, N had no competition. Suddenly the company finds 4 new products very similar to N in the market. However, N continues to have good sales.

O : There is intense competition. Achieving targeted sales is becoming increasingly difficult. Hence the company is introducing slightly modified features in the fresh production.

P : Huge inventory of P is available. P is being sold, but there are many products in the market which are priced lesser than P, but have the same utility as P.

PROBLEM NO. 9 : [Nov. 2018 Exam]

JK Ltd., is following Life Cycle Costing. its four products P4, P3, P2 and P1 are in the market respectively in Introduction, Growth, Maturity and Decline stages (phases). The Management wants to analyse the marketing challenges faced by the products to take strategical measures to stabilise the products in the market. For this purpose the Board directed the Secretary to get a product-wise report from the marketing chief of each product. The chiefs were asked to give one characteristic possessed by the product because of which the product is being classified in the respective stage and two strategical measures to be taken to overcome the market challenges faced at that stage (phase). The Secretary received the report from all the chiefs and handed them over to the computer operator to get it printed in a tabulated form. But the operator, without understanding the significance of the products, phases, characteristics and strategies, mixed all the twelve items [(1 + 2) x 4] and got it printed as a list as given below :

(i) Over capacity in the industry.

(ii) The company can continue to offer the product to our loyal customers at a reduced price.

(iii) Few competitors produce basic version of our product.

(iv) Product features may be improved or enhanced to differentiate our product from that of the competitors.

(v) Attracting customers by raising awareness about our product through promotion activities.

(vi) High volume of business and increase in competition.

(vii) Use the present product as replacement product for launching another new product successfully in the market.

(viii) Value based pricing strategies may be considered.

(ix) Profits start declining and at times become negative.

(x) Maintain control over product quality to assure customer satisfaction.

(xi) Strengthening or expanding channel and supply chain relationships.

(xii) Prices may have to be reduced to attract the price sensitive customers.

The items are required to be tabulated as in the format given below :

Required :

(i) Complete the table given below by entering the twelve items under appropriate category columns. You need not rewrite the items. Write the serial numbers of the items only in columns (3) and (4). [4 + 8 = 12 Marks]

Products (1)	Phases / Stages (2)	Characteristics (3)	Strategies (4)
P4	Introduction		
P3	Growth		
P2	Maturity		
P1	Decline		

(ii) List down the importance (any four) of the Product Life Cycle Costing. [4 Marks]

(iii) State the benefits (any four) of Product Life Cycle Costing. [4 Marks]

Solution 9 :

(i) Table showing Characteristics and Strategies for the four products :

Products (1)	Phases / Stages (2)	Characteristics (3)	Strategies (4)
P4	Introduction	(iii)	(v), (xi)
P3	Growth	(vi)	(x), (viii)
P2	Maturity	(i)	(iv), (xii)
P1	Decline	(ix)	(ii), (vii)

(ii) **Importance of the Product Life Cycle Costing :**

- As a planning tool, it characterizes the marketing challenges in each stage and posses major alternative strategies, i.e. application of Kaizen.
- As a control tool, the PLC concept allows the company to measure product performance against similar products launched in the past.
- As a forecasting tool, it is very important because sales histories exhibit diverse patterns and the stages vary in duration.
- It leads to appropriate strategy formulation depending on the stages of the product life cycle.

(iii) Benefits of Product Life Cycle Costing :

- The product life cycle costing results in earlier actions to generate revenue or to lower costs than otherwise might be considered. There are a number of factors that need to the managed in order to maximise return on a product. This helps in proper planning.
- Better decisions should follow from a more accurate and realistic assessment of revenues and costs, at least within a particular life cycle stage.
- Product life cycle thinking can promote long- term rewarding in contrast to short-term profitability rewarding.
- It provides an overall framework for considering total incremental costs over the entire life span of a product, which in turn facilitates analysis of individual phases, where cost effectiveness might be achieved.

Question No. 10 :

P & G International Ltd. (PGIL) has developed a new product 'A3' which is about to be launched into the market. Company has spent ₹ 30,00,000 on R&D of product 'A3'. It has also bought a machine to produce the product 'A3' costing ₹ 11,25,000 with a capacity of producing 1,100 units per week. Machine has no residual value.

The company has decided to charge price that will change with the cumulative numbers of units sold:

Cumulative Sales (units)	Selling Price (₹ per unit)
0 to 2,200	750
2,201 to 7,700	600
7,701 to 15,950	525
15,951 to 59,950	450
59,951 and above	300

Based on these selling prices, it is expected that sales demand will be as shown below:

Weeks	Sales Demand per week (units)
1-10	220
11-20	550
21-30	825

31-70	1,100
71-80	880
81-90	660
91-100	440
101-110	220
Thereafter	NIL

Unit variable costs are expected to be as follows:

No. of Units	₹ per unit
First 2,200 units	375
Next 13,750 units	300
Next 22,000 units	225
Next 22,000 units	188
Thereafter	225

PGIL uses just-in-time production system. Following is the total contribution statement of the product 'A3' for its Introduction and Growth stage:

Particulars	Introduction	Growth	
Weeks	1 - 10	11 – 20 and	21 – 30
Number of units Produced and Sold	2,200	5,500	8,250
	₹	₹	₹
Selling Price per unit	750	600	525
Less : Variable Cost per unit	375	300	300
Contribution per unit	375	300	225
Total Contribution	8,25,000	16,50,000	18,56,250

Required :

(i) PREPARE the total contribution statement for each of the remaining two stages of the product's life cycle.

(ii) DISCUSS Pricing Strategy of the product 'A3'.

(iii) FIND possible reasons for the changes in cost during the life cycle of the product 'A3'.

Solution 10 :

Working Note :

Cumulative Sales along with Sales Price and Variable Cost

Weeks	Demand per week	Total Sales	Cumulative Sales	Selling Price per unit (₹)	Variable Cost per unit (₹)
1 - 10	220	2,200	2,200	750	375
11 - 20	550	5,500	7,700	600	300
21 - 30	825	8,250	15,950	525	300
31 - 50	1,100	22,000	37,950	450	225
51 - 70	1,100	22,000	59,950	450	188
71 - 80	880	8,800	68,750	300	225
81 - 90	660	6,600	75,350	300	225
91 - 100	440	4,400	79,750	300	225
101 - 110	220	2,200	81,950	300	225

(i) Contribution Statement for remaining two stages

Particulars	Maturity		Decline
Weeks	31 - 50	51 - 70	71 - 110
Number of units Produced and Sold	22,000	22,000	22,000
	₹	₹	₹
Selling Price per unit	450	450	300
Less : Variable Cost per unit	225	188	225
Contribution per unit	225	262	75
Total Contribution	49,50,000	57,64,000	16,50,000

(ii) Pricing Strategy for Product 'A3'

- PGIL is following the skimming price strategy, that's why it has planned to launch the product 'A3' initially with high price tag.
- A skimming strategy may be recommended when a firm has incurred large sums of money on research and development for a new product.
- In the problem, PGIL has incurred a huge amount on research and development. Also, it is very difficult to start with a low price and then raise the price. Raising a low price may annoy potential customers.
- Price of the product 'A3' is decreasing gradually stage by stage. This is happening because PGIL wants to tap the mass market by lowering the price.

(iii) Possible Reasons for the changes in cost during the life cycle of the product 'A3'

Product life cycle costing involves tracing of costs and revenues of each product over several calendar periods throughout their entire life cycle.

Possible reasons for the changes in cost during the life cycle of the product are as follows:

- PGIL is expecting reduction in unit cost of the product 'A3' over the life of product as a consequence of economies of scale of production.
- Learning effect may be another possible reason for reduction in per unit cost if the process is labour intensive. When a new product or process is started, performance of worker is not at its best. As the experience is gained, the performance of worker improves, time taken per unit reduces and thus his productivity goes up. The amount of improvement or experience gained is reflected in a decrease in cost.
- Till the stage of maturity, PGIL is in the expansion mode. The PGIL may be able to take advantages of quantity discount offered by suppliers or may negotiate the price with suppliers.
- Product 'A3' has the least variable cost ₹188 in last phase of maturity stage. This is because a product which is in the mature stage may require less marketing support than a product which is in the growth stage. Hence, there might be a saving of marketing cost per unit.
- Again the cost per unit of the product 'A3' jumps to ₹225 in decline stage. As soon as the product reaches its decline stage, the need or demand for the product disappear and quantity discount may not be available. Even PGIL may have to incur heavy marketing expenses for stock clearance.

Question 11 : [May 2018 Exam]

MNP Co. Ltd. makes digital watches. The company is preparing a product life cycle budget for a new watch. Development on the new watch is to start shortly. Estimates for new watch are as under :

Life Cycle units manufactured and sold	2,40,000
Selling price per watch	₹ 500
Life Cycle Costs :	
R&D and design cost	₹ 80 lakh
Manufacturing :	
Variable cost per watch	₹ 120
Variable cost per batch	₹ 4,000
Watches per batch	300
Fixed cost	₹ 112 lakh
Marketing :	
Variable cost per batch	₹ 24
Fixed cost	₹ 8 lakh
Watches per batch	96
Distribution :	
Variable cost per watch	₹ 240
Fixed cost	₹ 45 lakh
Customer service cost per watch	₹ 10

Required :

(i) Calculate the budgeted life cycle operating income for the new watch. **(5 Marks)**

OR

Suggest the strategies to be adopted by the MNP Co. Ltd. to develop a new watch.

(ii) What percentage of the budgeted total product life cycle costs will in incurred by the end of the R&D and design stage? **(2 Marks)**

(iii) An analysis reveals that 75% of the budgeted total life cycle costs of new watch will be locked in at the R&D and design stage. What are the implications for managing costs of the new watch? **(3 Marks)**

Solution 11 :

(i) Budgeted Operating Income for the new watch during its life cycle :

Particulars	₹ Lakhs	₹ Lakhs
R&D and design cost		80
Manufacturing Cost :		
Variable cost per watch [2,40,000 units x ₹ 120]	288	
Variable cost per batch [800 batches x ₹ 4,000]	32	
Fixed cost	112	432
Marketing Cost :		
Variable cost per batch [*2,500 batches x ₹ 24]	0.6	
* No. of batches = (2,40,000 units / 96 units)		
Fixed cost	8.0	8.6
Distribution Cost :		
Variable cost per watch [2,40,000 units x ₹ 240]	576	
Fixed cost	45	
Customer service cost per watch [2,40,000 units x ₹ 10]	24	645
Total budgeted cost for life cycle		1,165.6
Total Sales Revenue [2,40,000 units x ₹ 500]		1,200.0
Total budgeted profit during life cycle		34.4

OR

Strategy : MNP Co. Ltd. should analyse the total cost into two parts. That is committed cost and non-committed cost. It means, the costs which are locked at the planning and design stage itself and cannot be altered later on are committed costs.

While developing a new watch, the company should do a market survey to find out the probable demand and the probable selling price. Then it should deduct its desired profit margin from sales revenue to find out the target cost.

Now, the work should be assigned to a 'Target Costing Team' to design a watch, which will meet all the requirements of a customer but can be manufactured at the target cost. If the target cost is not met, then the project should be dropped. This will ensure that the company can earn desired profit margin on new watch.

(ii) Percentage of R&D and cost to total budgeted cost :

$$= \frac{₹\ 80\ \text{lakhs}}{₹\ 1165.6\ \text{lakhs}} \times 100 = 6.86\%$$

(iii) Implications for managing costs :

If an analysis reveals that 75% of the total product life cycle costs of the new watch will be locked in at the R&D and design stage, then hardly 25% cost if left to be managed at a later stage. In short, majority cost is committed at the design stage itself, which is difficult to alter later on, once the design is finalised.

Hence, management should pay more attention to R&D and design stage itself. If the designed watch doesn't meet the target cost, then it is better to scrap that design and work again on the new design. As calculated above, design cost is only 6.86% of the total cost. We may treat it as a sunk cost and go for a new or modified design, instead of continuing with the same design.

Question 12 : [May 2019 Exam]

DK International is developing a new product. During its expected life, 16,000 units of the product will be sold for ₹ 102 per unit.

Production will be in batches of 1,000 units throughout the life of the product.

The direct labour cost is expected to reduce due to the effects of learning for the first eight batches produced. Thereafter, the direct labour cost will remain constant at the same cost per batch as in the 8^{th} batch.

The direct labour cost of the first batch of 1,000 units is expected to be ₹ 55,000 and a 90% learning effect is expected to occur. The direct material and other non-labour related variable costs will be ₹ 50 per unit throughout the life of the product.

There are no fixed costs that are specific to the product.

The learning index for a 90% learning Curve = - 0.152; $8^{-0.152} = 0.729$; $7^{-0.152} = 0.744$

Required :

(i) CALCULATE the expected direct labour cost of the 8^{th} batch. **(3 marks)**

(ii) CALCULATE the expected contribution to be earned from the product over its lifetime. **(3 marks)**

(iii) CALCULATE the rate of learning required to achieve a lifetime product contribution of ₹5,00,000, assuming that a constant rate of learning applies throughout the product's life. **(4 marks)**

Answer 12 :

(i) Total Direct Labour Cost for first 8 batches based on learning curve of 90% shall be :

$y = ax^b$

Where,

y = Average Direct Labour Cost per batch for 'x' batches

a = Direct Labour Cost for first batch

x = Cumulative No. of batches produced

b = Learning Coefficient Index

$y = ₹\ 55,000 \times (8)^{-0.152}$

$= ₹\ 55,000 \times 0.729$

= ₹ 40,095 [It can be calculated using doubling approach also]

Total Direct Labour Cost for first 8 batches shall be -

= 8 batches x ₹ 40,095

= ₹ 3,20,760

Average Direct Labour Cost for first 7 batches based on learning curve of 90% shall be :

$y = ₹ 55,000 \times (7)^{-0.152}$

= ₹ 55,000 x 0.744

= ₹ 40,920

Total Direct Labour Cost for first 7 batches

= 7 batches x ₹ 40,920

= ₹ 2,86,440

Hence, Direct Labour Cost for 8th batch shall be :

= Total cost for first 8 batches - Total cost for first 7 batches

= ₹ 3,20,760 – ₹ 2,86,440

= ₹ 34,320

(ii) Statement Showing "Life Time Expected Contribution"

Particulars	Amount (₹)
Sales (₹ 102 x 16,000 units)	16,32,000
Less : Direct Material and Other Non Labour Related Variable Costs (₹ 50 x 16,000 units)	8,00,000
Less : Direct Labour Cost using LCR [Cost of first 8 batches + Cost of next 8 batches] [₹ 3,20,760 + (₹ 34,320 x 8 batches)]	5,95,320
Hence, Expected Contribution	2,36,680

(iii) In order to achieve a Contribution of ₹ 5,00,00,000 the Total Direct Labour Cost over the Product's Lifetime should be :

Statement Showing "Life Time Direct Labour Cost"

Particulars	Amount (₹)
Sales (₹ 102 x 16,000 units)	16,32,000
Less : Direct Material and Other Non Labour Related Variable Costs (₹ 50 x 16,000 units)	8,00,000
Less : Desired Life Time Contribution	5,00,000
Hence, Direct Labour (balancing figure)	3,32,000

Average Direct Labour Cost per batch for 16 batches shall be -

= ₹ 3,32,000 / 16 batches = ₹ 20,750

Average Direct Labour cost for 16 batches based on learning curve of r% shall be :

$y = ₹ 55,000 \times (16)^{b}$

$₹ 20,750 = ₹ 55,000 \times (16)^{b}$

$0.3773 = (16)^{b}$

Taking log of both sides, we get -

log 0.3773 = b x log (16)

$$\log 0.3773 = b \times \log 2^4$$
$$\log 0.3773 = b \times 4 \log 2$$
$$\log 0.3773 = \frac{\text{Log LCR}}{\text{Log 2}} \times 4 \log 2$$
$$\log 0.3773 = \log LCR^4$$
$$0.3773 = r^4$$
$$r = \sqrt[4]{0.3773}$$
$$r = 78.37\%$$

Alternatively

Using doubling approach, the average cost of first batch ₹ 55,000 should get reduced to ₹ 20,750 after first 16 batches. If we assume the LCR as 'r', then the equation shall be -

$$₹ 20,750 = (₹ 55,000 \times r \times r \times r \times r)$$
$$₹ 20,750 = (₹ 55,000 \times r^4)$$
$$20,750 / 55,000 = r^4$$
$$0.3773 = r^4$$
$$r = \sqrt[4]{0.3773}$$
$$r = 78.37\%$$

Pareto Analysis

Introduction :

Pareto Analysis is based on the 80:20 rule that was a phenomenon, first observed by Vilfredo Pareto, a nineteenth century Italian economist. He noticed that 80% of the wealth of Milan was owned by 20% of its citizens. This phenomenon, or some kind of approximation of it say, (70 : 30 etc.) can be observed in many different business situations. The management can use it in a number of different circumstances to direct management attention to the key control mechanism or planning aspects. This is also known as Selective Management Policy.

Usefulness of Pareto Analysis

It provides the mechanism to control and direct effort by fact, not by emotions. It helps to clearly establish top priorities and to identify both profitable and unprofitable targets. Pareto analysis is useful to:

- Prioritize problems, goals, and objectives to identify root causes.
- Select and define key quality improvement programs.
- Select key customer relations and service programs.
- Select key employee relations improvement programs.
- Select and define key performance improvement programs.
- Allocate physical, financial and human resources.

Application of Pareto Analysis :

The Pareto Analysis is generally applicable to the following business situations :

(i) **Pricing of a product :** In the case of a firm dealing with multi products, it would not be possible for it to analyse price-volume relationships for all of them. Pareto Analysis is used for analysing the firm's estimated sales revenues from various products and it might indicate that approximately 80% of its total sales revenue is earned from about 20% of its products. Such analysis helps the top management to delegate the pricing decision for approximately 80% of its products to the lower levels of management, thus freeing themselves to concentrate on the pricing decision for products approximately 20% which are essential for company's survival. e.g. HLL's 20 Power brands.

(ii) **Customer Profitability :** Instead of analysing products, customers can be analysed for their relative profitability to the organisation. Again it is often found that approximately 20% of customers generate 80% of the profit. There will always be some customers who are less profitable than others, just as some products are less profitable than others. Such an analysis is useful tool for evaluation of the portfolio of customer profile.

(iii) **Stock Control :** Another application of Pareto analysis is in stock control where it may be found that only a few of the goods in stock make up most of the value. The outcome of such analysis is that by concentrating on small proportion of stock items that jointly accounts for 80% of the total value a firm may well be able to control most of monetary investment in stocks. i.e. ABC Analysis.

(iv) **Application in Activity Based Costing :** In Activity Based costing it is often said that 20% of an organisation's cost drivers are responsible for 80% of the total cost. By analysing, monitoring and controlling those cost drivers that cause most cost, a better control and understanding of overheads will be obtained.

(v) **Quality Control :** Pareto analysis seeks to discover from an analysis of defect report or customer complaint, that which 'vital few' causes are responsible for most of the reported problems. Often, 80% of reported problems can usually be traced to 20% of the various underlying causes. By concentrating on rectifying the vital 20% problems, one can have the greatest immediate impact on product quality and consumer satisfaction. Pareto Analysis indicates how frequently each type of failure (defect) occurs. The purpose of the analysis is to direct management attention to the area where the best returns can be achieved by solving most of quality problems, perhaps just with a single action.

Question 13 :

A Toy company performs a Pareto analysis, given a set of 'defect types' and frequencies of their occurrence. The sample data consists of information about 84 defective items. The items have been classified by their 'defect types' as follows :

Defect Types	No. of Toys
Cracks (due to mishandling of raw material)	10
Improper shapes	8
Incomplete	8
Surface scratches	53
Other (due to bad quality raw material)	5

You are required to carry out Pareto Analysis and offer your comments.

Solution 13 :

Frequency table indicating the frequency of occurrence of defects in decreasing order of their occurrence will be as follows :

Defect type	No. of Items	%	Cumulative %
Surface scratches	53	63.10	63.10
Cracks	10	11.90	75.00
Improper shape	8	9.52	84.52
Incomplete	8	9.52	94.05
Other	5	5.95	100.00
Totals	84	100%	

Comments :

The purpose of Pareto analysis in this example, is to direct attention to the area where best returns can be achieved by solving most of the quality problems, perhaps just with a single action. In this case, use of good quality raw material say plastic may solve 63% of problem and if raw material is handled properly at least 75% of the problems may be taken care of.

Question 14 : [ICAI Module]

The following information is given about the type of defects during a production period and the frequencies of their occurrence in a spectacle manufacturing company :

Particulars	No. of items
End frame not equidistant from the centre	10
Non uniform grinding of lenses	60
Power mismatches	20
Scratches on the surface	110
Spots / Stains on lenses	5
Rough edges of lenses	70
Frame colour shade differences	25

Required :

Prepare a frequency table so that a Pareto Chart can be constructed for the defect type. Also identify key areas of focus.

Solution 14 :

Note : We should arrange the reasons for no. of defective items in the decreasing order and then should calculate their percentage to the total no. of defective items.

Statement showing Pareto Analysis of Defects

Particulars	No. of items	% defects	Cum. % defects
Scratches on the surface	110	36.67%	36.67%
Rough edges of lenses	70	23.33%	60.00%
Non uniform grinding of lenses	60	20.00%	80.00%
Frame colour shade differences	25	8.33%	88.33%
Power mismatches	20	6.67%	95.00%
End frame not equidistant from the centre	10	3.33%	98.33%
Spots / Stains on lenses	5	1.67%	100.00%
Totals	**300**	**100.00%**	

Comment : The company should focus on eliminating scratches on the surface, rough edges of lenses and grinding of lenses related defects on priority basis. These three defects account for 80% of the total defective items produced. By resolving these issues on priority basis, we can reduce the customer complains substantially and thus improve the customer satisfaction ratio, using Pareto Analysis.

ENVIRONMENTAL MANAGEMENT ACCOUNTING [EMA]

Introduction :

- EMA is the process of collection and analysis of the information relating to environmental cost for internal decision making.
- EMA identifies and estimates the costs of environment related activities and seeks to control these costs.
- The focus of EMA is not only on financial costs but it also considers the non-financial costs and benefit of any decisions made.
- EMA is an attempt to integrate best management accounting thinking with best environmental management practice.

Environmental Costs

The US Environmental Protection Agency in 1998 has categorized Environmental Costs in four sections:

- Conventional Costs: Raw material and energy costs having environmental relevance.
- Hidden Costs: Costs which have been accounted for but then lose their identity in 'general overheads'.
- Contingent Costs: Costs to be incurred at a future date – for example, clean- up costs.
- Relationship Costs: Intangible Costs, for example, the costs of preparing environmental reports.

The United Nations Division for Sustainable Development (UNDSD), on the other hand, described Environmental Costs as comprising of:

- Costs incurred to protect the environment – for example, measures taken to prevent pollution, and
- Costs of wasted material, capital and labor, i.e. inefficiencies in the production process.

In practice, Environmental Costs can be split into further two categories as Internal Costs and External Costs. Internal Costs have direct impact on the income statement of a company. On the other hand, External Costs are imposed on society at large, but not borne by the company. Recently governments of many countries are becoming increasingly aware of these external costs and are using taxes and regulations to convert them to internal costs. For example, if the activities of companies lead to forest degradation they might be required to have a tree plantation programme. There is also a movement towards carbon credits. Those companies who pollute the environment by emitting green house gases (GHG) will have to buy carbon credits (by paying money) from those companies who save the environment and earn carbon credits. This is a process of giving monetary reward to those who save environment and monetary penalty for those who pollute environment.

Hansen and Mendoza point out that environmental costs are incurred because of poor quality controls. They advocate the use of a periodical environmental cost report, **based on the principles of cost of quality**, with each category of cost being expressed as a percentage of sales revenues or operating costs so that comparisons can be made between different periods and / or organisations. The categories of costs would be as follows:

- **Environmental Prevention Costs** – Those costs associated with preventing adverse environmental impacts. Examples include
  - Evaluating and picking pollution control equipment
  - Creating environmental policies
  - Environmentally driven R & D
  - Site and feasibility studies
  - Investment in protective equipment
- **Environmental Appraisal Costs** – The cost of activities executed to determine whether products, process and activities are in compliance with environmental standards, policies and laws. Examples include
  - Monitoring, testing, inspection and reporting
  - Improved systems and checks in order to prevent fines / penalties
  - Regulatory compliances
  - Performing contamination tests
  - Audit of environmental activities
- **Environmental Internal Failure Costs** – Costs incurred from activities that have been produced but not discharged into the environment. Examples include
  - Recycling scrap
  - Disposing toxic material
  - Back end costs such as decommissioning costs on project completion
- **Environmental External Failure Costs** – Costs incurred on activities performed after discharging waste into the environment. These costs have adverse impact on the organisation's reputation and natural resources. Examples include
  - Cleaning up contaminated soil.
  - Restoring land to its natural state

Question 15 : [RTP May 2021]

Sheetal Paper Mart (SPM) is in process of getting ISO 14001:2004 Environmental Management Systems (revised ISO 14001:2015) certification. SPM is selling eco-friendly and wheat straw-based paper of different sizes (A3, A4, and A5) and GSM under the brand 'Prime'. Prime is a famous name among both commercial and household consumers.

For the purpose getting certified, a cross-functional team is constituted, which is responsible **'to improve the environmental impact & image of SPM as eco-friendly enterprise and control environmental cost',** which collects the following particulars relating to the H1 and H2 (first and second half of the relevant fiscal year respectively).

Disposing of the toxic material costs ₹ 1.2 crores to SPM in H2 which is 20% lesser than what was spent during H1. Committee responsible for formulating policy matters on environment-related aspects in SPM has departmental budget of ₹ 6 lakhs p.a., in H1 the utilisation rate was 80% and in H2 it was 110%.

Environmental audits earlier used to be conducted on a half-yearly basis, but management decided to reduce the frequency to quarterly audits, in the mid of such year. Each such audit cost ₹ 8 lakhs to SPM. In the H2 SPM extends the production capacity and installed the new plant & machinery which has put to use cost of ₹ 77.25 crores, this is the premium version of the plant and machine due to its capability to reduce the generation of waste. Erection and other installation costs including dry-run were ₹ 65 lakhs and the same for all versions. The standard version has on-board cost of ₹ 76.20 crores.
SPM is practicing the recycling policy, which was formulated around three years ago; for the scrap, it generates in its plant. The review of the recycling policy is pending for the last 12 months. The cost incurred during the fiscal year was ₹ 2.75 crores, spent in alignment to scrap generated during the year. The policy document also states – 'zero discharge of waste/scrap into the environment, in order to be true-sense eco-friendly enterprise'.

In H2 contamination test was performed which cost ₹ 4 lakhs to SPM. The monitoring cost incurred during the year was ₹ 78 lakhs; in H2 this was double than H1.

Required :

(i) PREPARE the environmental cost statement as per the classification suggested by 'Hanson and Mendoza'.

(ii) ANALYSE the elements of environmental cost at SPM.

(iii) EVALUATE whether the cross-functional team is successful in serving their 'terms of reference'.

Note :- Clearly State the assumption (if any).

Annexure
Scrap Generated (during the year)

Quarter	First	Second	Third	Fourth
Scrap generated and recycled	1,572 MT	1,428 MT	1,114 MT	886 MT

Answer 15 :

Student Note : Hansen and Mendoza in the year 1999 pointed out that environmental costs are incurred because of poor quality controls. They classified the environmental cost into the following four categories. It is similar to Cost of Quality -

- **Environmental Prevention Costs –** Those costs, which are associated with preventing adverse environmental impacts.
- **Environmental Appraisal Costs –** The costs of activities executed to determine whether products, process and activities are in compliance with environmental standards, policies and laws.
- **Environmental Internal Failure Costs –** Costs incurred from activities that have produced waste but not discharged into the environment.
- **Environmental External Failure Costs –** Costs incurred on activities performed after discharging waste into the environment.

Hint : You have to just pick up the environmental costs given in the question and put it under the appropriate category to make a cost statement.

Sheetal Paper Mart

(i) Environmental Cost Statement :

Particulars	H1		H2	
	Amount (in lakhs)	% to total	Amount (in lakhs)	% to total
Environmental Preventive Costs				
Creating Environment policies [(6L/2) x 80%] & [(6L/2 x 110%]	2.4	0.68	3.3	0.96
Investment in protective equipment [(7,725 – 65) – 7,620]	-	-	40	11.58
Sub-Total (a)	**2.4**	**0.68**	**43.3**	**12.54**
Environmental Appraisal Costs				
Monitoring cost (78L in the ratio of 1 : 2)	26	7.40	52	15.06
Performing Contamination test	-	-	4	1.16
Environmental Audit [1 x 8L] & [2 x 8L]	8	2.28	16	4.63
Sub-Total (b)	**34**	**9.68**	**72**	**20.85**
Environmental Internal Failure Costs				
Recycling Scrap (275L in the ratio of 3 : 2)	165	46.95	110	31.86
Disposing of Toxic Material	150	42.69	120	34.75
Sub-Total (c)	**315**	**89.64**	**230**	**66.61**
Grand Total (a + b + c)	**351.4**	**100**	**345.3**	**100**

Student Notes :

1. Investment in protective equipment : Since the details regarding useful economic life of the newly erected plant and machine is not given, hence the entire incremental cost recognised in H2 only (when put to use); despite the benefit will arise over the useful economic life in form of a reduction in generation of waste.

   It is assumed by ICAI that the cost of 7725L includes erection, installation and dry run cost. It is excluded from total cost of new machine without assigning any reasons. At the same time, cost of standard version of equipment i.e. 7620L is deducted by ICAI from the cost of new machine, to calculate only the incremental cost to save environment.

2. Recycling Scrap : This cost is shared between H1 & H2 in the ratio of actual scrap generated and recycled during the year. If you see the Annexure, you will find that scrap recycled is 3,000 MT in H1 and 2,000 MT in H2 i.e. in the ratio of 3 : 2.

(ii) Analysis :

The environmental cost incurred in H2 (₹ 345.3 lakhs) is comparatively less than what was was incurred in H1 (₹ 351.4 lakhs). Environmental internal failure costs reduced in H2 (₹ 230 lakhs) in comparison to H1 (₹ 315 lakhs), but still a substantial component of total environmental costs (66.61% in H2 against 89.64% in H1). The reduction of environmental internal failure costs is the outcome of increased environmental prevention costs (12.54% in H2 against 0.68% in H1) and environmental detection i.e. appraisal cost (20.85% in H2 against 9.68% in H1).

Note – Since the policy document also states 'zero discharge of waste/scrap into the environment, in order to be true-sense eco-friendly enterprise' hence there are no **environmental external failure costs.**

(iii) Evaluation :

Apart from getting the certificate, the cross-functional team has terms of reference **'to improve the environmental impact & image of SPM as eco-friendly enterprise** and **control environmental cost'**

In the context of **controlling environmental cost,** the team attained a reasonable reduction in total environmental cost. Impact in this environmental cost statement (over H1 and H2) seem low because the incremental cost due to purchase of premium version of plant and machine is charged in H2, which will benefit in the form of reduced waste over the useful economic life.

In the context of **improving the image of SPM as an eco-friendly enterprise,** the policy document which in practice also states – 'zero discharge of waste / scrap into the environment, in order to be true-sense eco-friendly' and same is also visible through environmental cost statement as there are no environmental external failure costs.

In the context of **improving the environmental impact,** SPM is able to generate low waste in H2 (2,000 MT) in comparison of H1 (3,000 MT) just by installing new plant and machine which produce less waste, increased monitoring, and audits.

Hence, it can be concluded that the team is successfully serving the terms of reference.

One more way to analyse the environmental cost is - Internal & External cost :

Internal Environmental Costs - These are the costs which are incurred by organisation out of pocket and have an impact on its income statement.

It includes -

- Waste disposal costs
- Cost incurred to improve the systems and checks to avoid violation
- Regulatory costs including duty, taxes, and cess
- Up-front and back-end costs (permission and decommissioning etc.)

External Environmental Costs - These costs are born by the society and not the organisation who causes it.

It includes -

- Consumption of water, energy resources from the environment
- Emission of carbon and green house gases
- Health care cost of a person affected by the environmental effect of business activity
- Soil erosion and forest degradation
- Increase in average temperature level or climate change etc.

EMA Methodology :

A 3 phase approach has to be adopted for managing environmental costs -

Phase I - Identification of environmental costs

Phase II - Allocation of environmental cost to cost centre and cost units

Phase III - Controlling the environmental costs

Identification of Environmental Costs

To identify and calculate the environmental costs, we need to review and revamp the whole accounting system. Since the environmental costs are generally 'hidden' in 'general overheads' of the company, it becomes difficult for management to identify them and to reduce them. Allocation of environmental costs to the processes or products which give rise to them is equally important for organisations in making well-informed business decisions. For example, a pharmaceutical company has to decide on the production of one of its drugs. In order to incorporate environmental aspects into its decision, it needs to know exactly how many inputs are consumed into the process; how much waste is created during the process; how much labour and fuel is used in making the drug; how much packaging the drug uses and what percentage of that is recyclable etc. Only by identifying these costs and allocating them to the product can an informed decision be made about the environmental effects of continued production.

In 2003, the UNDSD identified four management accounting techniques for the **Identification and Allocation** of Environmental Costs. These are -

1. Input – Output Analysis
2. Flow Cost Accounting
3. Life Cycle Costing
4. Activity Based Costing

Input-Output Analysis

This technique records material inflows and balances it with outflows. Logically, what comes in must go out. So, if 100kg of materials has been bought and only 80kg of output is produced, then the 20kg difference must be accounted for in some way. It may be, that 10% of it has been sold as scrap and the remaining 10% of it is waste. By accounting for outputs in this way, both in terms of physical quantities and in monetary terms too, businesses are forced to focus on environmental costs.

Flow Cost Accounting

This technique uses material flow from input stage to processing to delivery and disposal stage for the purpose of accounting. Flow cost accounting makes material flows transparent by using various data, which are quantities (physical data), costs (monetary data) and values (quantities x costs). Wastage and other environmental costs are recorded at each such stage. As the recording is done with the flow of material in the organisation, it is popularly called as flow cost accounting.

It can be compared with process costing studied at intermediate stage. As we keep the record process wise and calculate the cost of production at each stage, in the similar manner, the environmental cost is calculated at each stage up to delivery to customer and disposal of goods.

For example – when we buy a new battery for home inverter to replace the old one, the supplier takes away the old battery. There are laws for reuse and disposal of this hazardous waste. Battery manufactures should consider this cost of disposal also as a product cost.

Life Cycle Costing

Lifecycle costing considers the costs and revenues of a product over its whole life rather than one accounting period. Therefore, the full environmental cost of producing a product will be taken into account over the life of the product. In order to reduce lifecycle costs an organization may adopt a TQM approach. Such organizations pursue objectives that may include zero complaints, zero spills, zero pollution, zero waste and zero accidents. Information system needs to be developed to know the success or otherwise - of the organizational efforts in achieving such objectives.

Activity Based Costing (ABC)

ABC allocates costs to cost centres and cost drivers on the basis of the activities that give rise to the costs. In an environmental accounting context, it distinguishes between environmental costs with other costs for each activity. It is difficult to find out the hidden environmental costs.

The environment-driven costs are removed from general overheads and traced to products or services. The cost drivers are determined based on environment impact that activities have and costs are charged accordingly. This should provide an accurate allocation of environmental costs to individual products and should result in better control of costs.

Controlling Environmental Costs

After Identification and Allocation of Environmental Costs, the task of controlling starts. Suppose we group the main environmental costs as follows:

- Waste
- Water consumption
- Energy
- Transport and travel
- Consumables and raw materials.

An organization may try to control these cost as mentioned below -

Waste

'Mass balance' approach can be used to determine how much material is wasted in production. In mass balance approach, the weight of materials bought is compared to the product yield. From this process, potential cost savings may be identified. In addition to these monetary costs to the organization, waste has environmental costs in terms of lost land resources (because waste has been buried) and the generation of greenhouse gases in the form of methane. Cost of disposal of waste material; taxes for landfill; fines for compliance failures are considered as environmental cost associated with waste.

Water

Businesses pay for water twice – first, to buy it and second, to dispose it. If savings are to be made in terms of reduced water bills, it is important for organizations to identify where water is used and how consumption can be decreased.

Energy

Often, energy costs can be reduced significantly at very little efforts. Environmental management accounts may help to identify inefficiencies and wasteful practices and, therefore, opportunities for cost savings.

Transport and Travel

Again, EMA techniques may be used to identify savings in terms of travel and transport of goods and materials. For example - a business can invest in more fuel-efficient vehicles for transportation of goods.

Consumables and Raw Materials

These are directly attributable costs and discussions with management can reduce such costs. For example, toner cartridges for printers could be refilled rather than replaced. This should produce a saving both in terms of the financial cost for the organization and a waste saving for the environment (toner cartridges are difficult to dispose of and less waste is created this way).

Reasons for Controlling Environmental Cost

There are three main reasons why the management of environmental costs is becoming increasingly important in organizations.

First, a 'carbon footprint' (as defined by the Carbon Trust) measures the total greenhouse gas emissions caused directly and indirectly by a person, organization, event or product. People are now becoming aware about the 'carbon footprint' and recycling. Several companies have initiated CSR committees as they feel that portraying themselves as environmentally responsible makes them popular among consumers.

Second, environmental costs are becoming huge for some companies, particularly those operating in highly industrialized sectors such as oil production. In some cases, these costs can amount to more than 20% of operating costs. Such significant costs need to be managed.

Third, regulation is increasing worldwide at a rapid pace, with penalties for non-compliance also increasing accordingly. In the largest ever seizure related to an environmental conviction in the UK, a plant hire firm, John Craxford Plant Hire Ltd, had to not only pay £85,000 in costs and fines but also got £1.2m of its assets seized. This company had illegally buried waste and breached its waste and pollution permits. And it's not just the companies that need to worry. Every person found guilty of breaching environmental regulations knowingly is liable to criminal prosecution as per the regulatory laws.

Problems in EMA

The management of environmental costs is not an easy process.

- This is because EMA is difficult to define, so too are the actual costs involved.
- Second, having defined them, some of the costs are difficult to separate out and identify.
- Third, the costs can need to be controlled but this can only be done if they have been correctly identified in the first place.

Role of EMA in Product / Process Related Decision Making

The correct costing of products is a pre-condition for making sound business decisions. The accurate product pricing is needed for strategic decisions regarding the quantity of products to be produced. EMA converts many environmental overhead costs into direct costs and allocate them to the products that are responsible for their incurrence. The results of improved costing by EMA may include:

- Differential pricing of products as a result of re-calculated costs;
- Re-evaluation of the profit margins of products;
- Phasing-out certain products when the change is dramatic;
- Re-designing of processes or products in order to reduce environmental costs and
- Improving housekeeping and monitoring of environmental performance.

Advantages of EMA

- **Improving Revenue**

  Production of new products or services meeting the environmental needs or concerns of customers can lead to increased sales. It may also be possible to sell such products for a premium price. Improved sales may also be a consequence of improving the reputation of the business.

- **Cost Reductions**

  Paying close attention to the use of resources can lead to reductions in cost. Often simple improvements in processes can lead to significant costs savings.

- **Improve in Image**

  The image of the organisations who adopt EMA improves as a corporate citizen, among all the stakeholders.

Disadvantages of EMA

- **Increase in Costs**

  Cost of complying with legal and regulatory requirements and additional costs to improve the environmental image of the organization may result in increase in some costs. However, some of these costs may be offset by government grants and this expenditure may save money in the long-term as measures taken may prevent future losses.

- **Costs of Failure**

  Significant costs may be incurred if there is poor environmental management. Thus, the cost of clean-up and fines on violation of any government environmental policy may be huge.

- **Additional Burden on Top Management**

  The implementation of EMA causes additional burden on the top management and their attention may get diverted from core activities.

EMA in Practice at Xerox Corporation

Xerox Limited, a subsidiary of Xerox Corporation, introduced the concept of lifecycle costing for its logistic chain. Manufacturing photocopiers is the core business of Xerox. The photocopiers are leased rather than sold. This means the machines are returned to Xerox limited at the end of their lease.

Previously, machines were shipped in a range of different types of packaging, which could rarely be re-used by customers to return the old copiers. The customer had to dispose of the original packaging and to provide new packaging to return the machine at the end of its lease. Packing used by customer, in turn could not be used to re-ship other machines by Xerox Ltd. It means, packing material at both ends gets wasted. So, Xerox ultimately lost the original cost of packing and even had to bear the additional costs of disposal of the new packaging.

A new system was invented which used a standard pack (tote). Two types of totes were introduced to suit the entire range of products sold by Xerox. Totes can be used for both new machines delivery and for returning the used machinery after the lease period. The cost analysis showed the considerably lower cost of the tote system, compared to the previously existing system and the supply chain became more visible. The tote system resulted not only in cost savings but also in reduced unpacking time and improved customer relations.

Question 16 : [RTP - Nov. 2018]

A fertilizer company produces Grade A and Grade B fertilizers. One kilogram of Grade A fertilizer sells for ₹ 280 per kilogram and one kilogram of Grade B fertilizer sells for ₹ 400 per kilogram.

The products pass through three cost centers CC1, CC2 and CC3 during the manufacturing process. Total direct material cost per kilogram of fertilizer produced is ₹ 300 and direct labor cost per kilogram of fertilizer produced is ₹ 200. Allocation between the cost centres is given below:

Particulars	CC1	CC2	CC3	Total
Cost of Direct Material (per kg of fertilizer produced)	₹ 90	₹ 120	₹ 90	₹ 300
Cost of Direct Labour (per kg of fertilizer produced)	₹ 60	₹ 80	₹ 60	₹ 200
Cost Allocation to Grade A	30%	50%	30%	
Cost Allocation to Grade B	70%	50%	70%	

All of expenses (considered to be overheads) per kilogram of fertilizer produced is ₹ 150. This is allocated equally between Grade A and Grade B fertilizer. Pricing decisions for the fertilizers is made based on the above cost allocation.

The management accountant of the company has recently come across the concept of environmental management accounting. Pricing of products should also factor in the environmental cost generated by each product. An analysis of the overhead expenses revealed that the total cost of ₹ 150 per kilogram of fertilizer produced, includes incinerator costs of ₹ 90 per kilogram of fertilizer produced. The incinerator is used to dispose the solid waste produced during the manufacturing process. Below is the cost center and product wise information of solid waste produced :

Waste produced (in tons per annum)	CC1	CC2	CC3	Total
Grade A	2	3	1	6
Grade B	2	2	5	9

Based on the impact that each product has on the environment, the management would like to revise the cost allocation to products, taking into account the incinerator cost for waste that each product generates. The remaining overhead expenses of ₹ 60 per kilogram of fertilizer produced can be allocated equally.

Required :

(i) CALCULATE product wise profitability based on the original cost allocation. RECALCULATE the product wise profitability based on activity based costing methodology (environmental management accounting). [12 Marks]

(ii) ANALYZE difference in product profitability as per both the methods. [4 Marks]

(iii) RECOMMEND key takeaways for the company to undertake the above analysis of overhead costs and pricing as per environmental management accounting. [4 Marks]

Solution 16 :

Student Note : On the first reading of question, we find that the Direct Material and Direct Labour cost per kg of fertilizer produced is ₹ 300 + ₹ 200 = ₹ 500 per kg. However, selling price is ₹ 280 and ₹ 400 per kg.; which is lower than the direct cost itself. It will lead to losses and the question will lose its significance. I think there is a mistake in framing the question or the wordings of the question.

However, ICAI has interpreted it as the total cost of producing Grade A plus Grade B fertilizer and hence it is to be apportioned between these two products in the proportion given in the question.

For example, Direct Material as well as Direct Labour Cost of CC1 will be apportioned between A & B in the ratio 30:70. Similarly, cost of CC2 will be apportioned in the ratio 50:30 and so on. Overheads is to be apportioned equally.

It technically means that the cost given in the question was not per kg. of output, but it was given for 1 kg. of A + 1 kg. of B = For 2 kg. of output together.

Based on the above interpretation, the following answer is developed.

(i) Product Wise Profitability as per Original Allocation Methodology

(Figures in ₹ per kilogram of fertilizer produced)

Particulars	Grade A	Grade B	Total
(a) Direct Material Cost of CC1 apportioned in the ratio of 30 : 70	27	63	90
(b) Direct Material Cost of CC2 apportioned in the ratio of 50 : 50	60	60	120
(c) Direct Material Cost of CC3 apportioned in the ratio of 30 : 70	27	63	90

(d) Total Material Cost [a + b + c]	114	186	300
(e) Direct Labour Cost of CC1 apportioned in the ratio of 30 : 70	18	42	60
(f) Direct Labour Cost of CC2 apportioned in the ratio of 50 : 50	40	40	80
(g) Direct Labour Cost of CC3 apportioned in the ratio of 30 : 70	18	42	60
(h) Total Labour Cost [e + f + g]	76	124	200
(i) Overheads (allocated equally)	75	75	150
(j) Total Cost of output [d + h + i]	265	385	650
(k) Selling price (given)	280	400	680
(l) Profit [k - j]	15	15	30
(m) Profitability % to sales [l / k x 100]	5.36%	3.75%	---

Revised Profitability as per Activity Based Costing Methodology :

It requires the following steps: (as per ICAI answer)

(i) Overhead expenses of ₹ 150 per kilogram of fertilizer produced be first bifurcated into incinerator costs and other overhead costs.

(ii) Incinerator costs of ₹ 90 per kilogram of fertilizer needs to be allocated on the basis of waste generated at each cost centre for each Grade. For example - Incinerator costs of ₹ 90 per kilogram will be divided by total waste generated i.e. 15 tons, to get a rate of ₹ 6 per ton. We can use this rate to charge the cost to each product.

(iii) As mentioned in the problem, other overhead costs are allocated to each product at each cost centre level equally. It means, remaining ₹ 60 per kilogram will be divided between each Grade equally.

Accordingly, the Revised Product Profitability would be as follows :

(Figures in ₹ per kilogram of fertilizer produced)

Particulars	Grade A	Grade B	Total
(a) Direct Material (as above)	114	186	300
(b) Direct Labour (as above)	76	124	200
(c) Incinerator costs @ ₹ 6 per ton	36 (6 x 6 tons)	54 (6 x 9 tons)	90
(d) Other Overheads (equally)	30	30	60
(e) Total Cost of output [a + b + c + d]	256	394	650
(f) Selling Price	280	400	680
(g) Profit [f - e]	24	6	30
(h) Profitability % to sales [g / f x 100]	8.57%	1.50%	---

Student Note : The above answer is ICAI answer and according to me, the allocation of overheads is wrong. Waste produced is given in tons per annum and overheads cost is given as cost per kg. of fertilizer produced. In the above calculation, waste per annum is used to allocate cost per kg., which is technically incorrect. Similarly, the overheads cost is assumed to be for all the three cost centers together.

According to me, Overheads cost should have been given on per annum basis, then it would be appropriate to apportion the cost to each Cost Centre on the basis of waste produced per annum. Thereafter, the total overheads so apportioned to each cost centre should be divided by total output quantity (in kgs.) of each cost centre, to get the cost per kg. of output.

Summarizing Product Profitability as per both methods:

Product	(Profit in ₹ per kg of fertilizer produced)		Profit % to sales	
	Original Method	ABC (as per EMA) Method	Original Method	ABC (as per EMA) Method
Grade A	15	24	5.36%	8.57%
Grade B	15	6	3.75%	1.50%

(ii) As summarized above, originally the profit generated from Grade A and Grade B products, was ₹ 15 per kilogram each. Grade A was the more profitable product giving return of 5.36% compared to Grade B's return of 3.75%. This has been calculated by allocating overheads equally to Grade A and B.

During the year, 15 tons of waste is produced during the manufacturing process. Grade B fertilizer produces more waste that accounts for 60% of the waste. Therefore, Grade B should bear higher amount of the incinerator cost compared to Grade A. Allocation based on this premise, dramatically changes the profitability of the products. As calculated above, Grade A fertilizer, due to lower incinerator cost allocation, generates a profit of ₹ 24 per kilogram of fertilizer. Grade B's profits accordingly are lower, since the product generates more waste and has to bear a larger share of clean-up expenses. Profitability of Grade A increases to 8.57% while Grade B falls dramatically to 1.50%.

(iii) The company can draw a number of conclusions from this analysis of overhead costs as per environmental management accounting. This analysis has helped the company reach the conclusion that Grade B fertilizer produces more waste. The company could adopt either of the following approaches:

(a) To maintain the same level of profitability, the company can increase the price of Grade B by another ₹ 9 per kilogram. This is a 2.25% increase in the sale price of Grade B fertilizer. Depending on the market for this grade of fertilizer, the company has to decide whether to increase the price of the product. While a price increase may be possible if the company has a strong market hold, it might be difficult if competition in the market is high. or

(b) The other approach, a more sustainable approach that is the aim of environmental management accounting, would be to reduce the waste produced in the manufacturing process. This analysis, has quantified the waste generated in the process. Better manufacturing techniques, could save the company's incinerator costs, that would yield better profits for the company.

Question 17 : [May 2019 Exam – 20 Marks]

Excel Ltd. is the leading manufacturer and exporter of high quality leather products - Product A and Product B.

Selling price per unit of Product A and Product B is ₹ 620 and ₹ 420 respectively.

Both the products pass through three processes – Tanning, Dyeing and Finishing during manufacturing process. Allocation of costs per unit of leather products manufactured among the processes are given below :

Particulars	Tanning	Dyeing	Finishing	Total
Direct Materials per unit	140	180	140	460
Direct Labour per unit	90	120	90	300
Cost allocation to Product A	70%	50%	70%	
Cost allocation to Product B	30%	50%	30%	

General overheads per unit of leather products manufactured are ₹ 230 which is allocated equally between Product A and Product B. Above cost allocation is the basis for the decisions regarding pricing of the products.

In this Industry, all the major production processes have environmental impact at all stages of the process including generation of waste, emission of harmful gases, noise pollution, water contamination etc.

The management of the company is worried about the above environmental impact and has taken initiative to preserve the environment like – research and development activities aimed at reducing pollution level, planting trees, treatment of harmful gases and airborne emissions, wastewater treatment etc.

The management of the company desires to adopt Environmental Management Accounting as a part of strategic decision making process. Pricing of products should also factor in environmental cost generated by each product.

General overheads per unit of leather products manufactured are ₹ 230 which includes:

Treatment cost of harmful gases	₹ 80
Wastewater treatment cost	₹ 100
Cost of planting of trees	₹ 20

Process wise information related to generation of wastewater and harmful gases is given below:

Particulars	Tanning	Dyeing	Finishing	Total
Wastewater generated (litres per week)	900	600	0	1,500
Emission of harmful gases (cc per week)	400	300	100	800
Cost allocation to Product A	70%	50%	70%	
Cost allocation to Product B	30%	50%	30%	

The remaining overheads cost and cost of planting trees can be allocated equally between Product A and Product B.

Required :

(a) CALCULATE the product wise profitability based on the original cost allocation. **(2 marks)**

(b) RECALCULATE the product wise profitability based on activity based costing (Environment driven cost). **(5 marks)**

(c) ANALYZE the difference in product profitability as per both the methods. **(2 marks)**

(d) RECOMMEND and EXPLAIN the four management accounting techniques for the identification and allocation of environmental costs. **(8 marks)**

(e) STATE why the management of environmental costs is becoming increasingly important in organizations. Give reasons. **(3 marks)**

Answer 17 :

(a) Product Wise Profitability as per Original Allocation Methodology :

(Figures in Rs. per unit of leather produced)

Particulars	Product A	Product B	Total
Selling price	620	420	1,040
Direct Material (Refer Table 1)	286	174	460
Direct Labour (Refer Table 1)	186	114	300
Overheads (allocated equally)	115	115	230
Total Expenses	587	403	990
Profit	33	17	50
Profitability (%)	**5.32%**	**4.05%**	--

Workings :

Table 1 : Direct Cost Allocation to the Products

(Figures in Rs. per unit of leather produced)

Particulars	Tanning			Dyeing			Finishing			Total		
	A	B	Total	A	B	Total	A	B	Total	A	B	Grand Total
Direct Material	98	42	140	90	90	180	98	42	140	286	174	460
Direct Labour	63	27	90	60	60	120	63	27	90	186	114	300

(b) Product wise profitability based on activity based costing using environment driven costs requires the following steps:

- Breakdown of overhead cost of Rs.230 per unit into treatment cost of harmful gases, wastewater treatment cost, cost of planting trees and other overhead costs. Refer Table 2 for the breakup.
- Treatment cost of harmful gases and waste water treatment cost need to be individually allocated to various processes based on relevant cost drivers. Refer Table 3 for cost allocation to process.
- The overheads mentioned in point 2 thus allocated to the various processes, will be further allocated to products based on the specific ratios given in the problem. Refer Table 4 for cost allocation to products.

Product Wise Profitability Statement based on ABC using environment driven costs : (Figures in Rs. per unit of leather products)

Particulars	Product A	Product B	Total
Selling Price	620	420	1,040
Direct Material (Refer Table 1)	286	174	460
Direct Labour (Refer Table 1)	186	114	300
Allocation of Overheads :			
Treatment Cost of Harmful Gases (Refer Table 4)	50	30	80
Wastewater Treatment Cost (Refer Table 4)	62	38	100
Cost of Planting Trees (shared equally)	10	10	20
Other Overhead Cost (shared equally)	15	15	30
Total Expenses	609	381	990
Profit	11	39	50
Profitability %	**1.77%**	**9.29%**	--

Workings :

Table 2 : Breakup of General Overheads per unit :

Overhead	Amount (Rs.)	Allocation basis between process / products
Treatment Cost of Harmful Gases	80	Emission of Harmful Gases (cc per week)
Wastewater Treatment Cost	100	Wastewater Generated (litres per week)
Cost of Planting Trees	20	Equally between Products A and B
Other Overheads (balancing figure)	30	Equally between Products A and B
Total General Overheads per unit	230	

Table 3 : Allocation of Treatment Cost to various processes :

Overhead	Amount (Rs)	Allocation Basis	Tanning (Rs.)	Dyeing (Rs.)	Finishing (Rs.)
Treatment Cost of Harmful Gases	80	4 : 3 : 1	40	30	10
Wastewater Treatment Cost	100	9 : 6 : 0	60	40	0

Table 4 : Allocation of Overhead Cost to Products A and B

Overhead	Tanning	Dyeing	Finishing	Total
Treatment Cost of Harmful Gases	40	30	10	80
Cost Allocation % to Product A	70%	50%	70%	
Cost Allocation % to Product B	30%	50%	30%	
Cost Allocation to Product A	28	15	7	50
Cost Allocation to Product B	12	15	3	30
Wastewater Treatment Cost	60	40	0	100
Cost Allocation % to Product A	70%	50%	70%	
Cost Allocation % to Product B	30%	50%	30%	
Cost Allocation to Product A	42	20	-	62
Cost Allocation to Product B	18	20	-	38

(c) Analysis of the difference in product profitability as per both the methods :

In the first method, general overhead costs are allocated to the products A and B, irrespective of the environment costs that each product incurs. General overhead costs are allocated to each product equally. The resultant product profitability shows that Product A yields 5.32% and Product B yields 4.05% profitability. Therefore, the Excel Ltd. would conclude that Product A is more profitable.

In the next method, general overhead costs are bifurcated to identify "hidden" environment costs that are incurred on account of manufacturing these products. Environmental costs are first traced to the process that generates harmful gases and wastewater, for which treatment is done. It can be seen that Tanning process, followed by Dyeing and Finishing process generates the maximum amount of waste. Therefore, by apportioning the cost based on the waste generated, more cost is allocated to Tanning process. Similarly, Dyeing and Finishing are allocated lesser cost since they do not generate as much waste. It is further given that 70% of the cost of Tanning relates to Product A. This is much higher than the 50% that was allocated to Product A as per the first method.

Accordingly, the revised workings show that Product A yields 1.77% and Product B yields 9.29% profitability. The reason being Product A generates more environment driven costs as compared to Product B.

Excel Ltd. would therefore increase the selling price of Product A, if it wants to maintain profitability as per the original method. However, the more sustainable approach would be to find out ways of reducing wastewater and harmful gases in the manufacturing process. This would in turn result in reduction of environmental driven costs such as wastewater treatment and treatment of harmful gases. This would sustain profits in the long run.

(d) Four Techniques for the identification and allocation of Environmental Costs :

Input-Output Analysis : This technique monitors the material input with the output that is produced. For example, if 100 kg of material have been bought as input in the process resulting in 80 kg output material, the 20 kg must been accounted for in some way. Some part of this may say 10% (2 kg) may have been sold as scrap while the remaining 90% (18 kg) of it may be waste. Possibly scrap can be reused therefore may have neutral environment impact. The company can then concentrate on minimizing waste generation.

Flow Cost Accounting : This technique uses not only material flows but also the organizational structure. Classic material flows are recorded as well as material losses incurred at various stages of production. Flow cost accounting makes material flows transparent. It tracks :

(i) Quantities (physical data)
(ii) Costs (monetary data) and
(iii) Values = (quantities x costs)

Material flows are divided into three categories : material, system, and delivery/disposal.

(i) The material values and costs apply to the materials which are involved in the various processes.
(ii) The system values and costs are the in-house handling costs, which are incurred inside the company for the purpose of maintaining and supporting material throughput. Example, personnel costs or depreciation.
(iii) The delivery and disposal values and costs refer to the costs of flows leaving the company. For example, transport costs or cost of disposing waste.

The focus of flow cost accounting is on reducing the quantities of materials, which leads to increased ecological efficiency.

Life Cycle Costing : This technique considers the costs and revenues of a product over its whole life rather than one accounting period. Therefore, the full environmental cost of producing a product will be taken into account. In order to reduce lifecycle costs, an organization may adopt a TQM approach. Good environmental management is increasingly recognized as an essential component of TQM. Such organizations pursue objectives that may include zero complaints, zero spills, zero pollution, zero waste and zero accidents. Information system needs to be enabled to support such environmental objectives via provision of feedback of the organizational efforts in achieving such objectives.

Activity Based Costing (ABC) : ABC allocates internal costs to cost centres and cost drivers on the basis of the activities that give rise to the costs. Environment-related costs can be attributed to joint cost centres and environment-driven costs are hidden on general overheads. Environment-driven costs are removed from general overheads and traced to products or services. The cost drivers are determined on environmental impact that activities have and costs are charged accordingly. This should give a good attribution of environmental costs to individual products that should result in better control of costs.

(e) Reasons why environmental costs is becoming important in organizations :

(i) "Carbon footprint" measures the total greenhouse gas emissions caused directly and indirectly by a person, organization, event or product. People are now becoming aware about the carbon footprint and recycling. Several companies have initiated CSR committees as they feel that portraying themselves as environmentally responsible makes them popular among their consumers.
(ii) Environmental costs are becoming huge for some companies particularly those operating in highly industrialized sectors such as oil production. Such significant costs need to be managed.
(iii) Regulation is increasing worldwide at a rapid pace, with penalties for non-compliance also increasing accordingly.

Question 18 : [Nov. 2019 Exam]

A chemical company produces two chemicals SX and ZX. Environmental activities and costs associated with the two chemicals are as follows :

	SX	ZX
Unit produced (kg.)	6,00,000	15,00,000
Packing Materials (kg.)	80,000	40,000
Energy Usage (KWH)	60,000	30,000
Toxin releases (Pounds into air)	2,00,000	40,000
Pollution control machine hours	32,000	8,000

Cost of environmental activities :

Packing material Costs	₹ 3,60,000
Energy Costs	₹ 96,000
Fines for release of toxins into air	₹ 48,000
Operating costs of pollution control equipments	₹ 1,12,000

Required :

Calculate the environmental cost per kilogram for each chemical produced by the company.

[5 Marks]

Solution 18 :

Environment costs can be allocated to Chemicals SX and ZX using Activity Based Costing System as follows :

Particulars	Total Cost (₹)	Cost Drivers	SX	ZX
Packing Material Costs	3,60,000	Packing Materials [80 : 40]	2,40,000	1,20,000
Energy Cost	96,000	Energy Usage (KWH) [60 : 30]	64,000	32,000
Fines for Release of Toxins into Air	48,000	Toxins Released [20 : 4]	40,000	8,000
Operating Costs of Pollution Control Equipment	1,12,000	Pollution Control Machine Hours [32 : 8]	89,600	22,400
Total Cost	6,16,000		4,33,600	1,82,400
Units Produced (kg,)			6,00,000	15,00,000
Environment Cost per kg. of output			**0.7227**	**0.1216**

* * * * *

5 COST MANAGEMENT FOR SPECIFIC SECTORS

Introduction:

In this chapter, 3 sectors were covered. These were –

1. Power sector
2. Agriculture sector
3. Information technology sector

Good News : ICAI issued a notification in June, 2021 and this entire chapter is deleted from your syllabus. Enjoy, your workload is reduced to some extent.

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6 DECISION MAKING

CVP Analysis

CVP Analysis is Cost Volume Profit Analysis. It is also known as BEP Analysis i.e. Break Even Point Analysis. All these are parts and parcels of Marginal Costing Technique. This technique is popularly used for Business Decision Making. Variety of business decisions is taken using marginal costing technique or using CVP analysis.

CVP analysis involves analysing the interrelationships among revenues, costs, levels of activity, and profits. CVP analysis is useful for numerous decisions related to production, pricing, marketing, cost structure, and many more. Although CVP analysis is most useful for planning, it can also be used to assist with controlling decisions and evaluating decisions.

The main features of marginal costing are as follows -

i. Costs are separated into fixed and variable elements. Semi-variable (or semi-fixed) costs are also analysed into fixed and variable. The usefulness of the marginal cost system depends upon a correct appreciation of the behavior of costs with changes in output.
ii. Only the variable or marginal costs are taken into account for computing product costs.
iii. Fixed costs are written off during the period in which they are incurred and so they do not find place in product cost.
iv. Prices are based on marginal costs and marginal contribution.
v. Marginal costing combines the techniques of cost recording and cost reporting.
vi. Profitability of departments or products is determined in terms of marginal contribution.

Basic Formulae of CVP Analysis

Basic Equation : Profit = Sales - Total Cost

1. PROFIT	= Sales - Total Cost	OR = Sales - (Variable Cost + Fixed Cost)	
		OR = Contribution - Fixed Cost	
2. SALES	= Total Cost + Profit	OR = (Variable cost + Fixed Cost) + Profit	
		OR = Variable Cost + Contribution	
3. CONTRIBUTION	= Sales - Variable Cost	OR = Profit + Fixed Cost	
4. FIXED COST	= Total Cost - Variable Cost	OR = Contribution - Profit	
5. VARIABLE COST	= Total Cost - Fixed Cost	OR = Sales - Contribution	

6. PROFIT VOLUME RATIO OR P/V RATIO $= \frac{\text{Contribution}}{\text{Sales}}$ OR $= \frac{\text{Marginal Change in Profit}}{\text{Marginal Change in Sales}}$

7. BREAK EVEN POINT :

$$= \frac{\text{Fixed Cost}}{\text{Contribution per unit}} \quad \textbf{No. of Units}$$

$$= \frac{\text{Fixed Cost}}{\text{P V Ratio}} \quad \textbf{Rs. Sales}$$

$$= \frac{\text{Fixed Cost}}{\text{Contribution at 1\% capacity}} \quad \textbf{\% Capacity}$$

8. PROFITABILITY AT DESIRED LEVEL OF OUTPUT :

= Contribution - Fixed Cost

OR

= (No. of Units X Contribution per unit) - Fixed Cost

OR

= (Rs. Sales X P / V Ratio) - Fixed Cost

OR

= (% Capacity X Contribution at 1 % capacity) - Fixed Cost

9. VOLUME OF SALES REQUIRED TO EARN DESIRED PROFIT :

$$\textbf{In No. of Units} = \frac{\text{Desired Profit + Fixed Cost}}{\text{Contribution per unit}}$$

$$\textbf{In Rs. Sales} = \frac{\text{Desired Profit + Fixed Cost}}{\text{P / V Ratio}}$$

$$\textbf{In \% Capacity} = \frac{\text{Desired Profit + Fixed Cost}}{\text{Contribution at 1\% capacity}}$$

10. MARGIN OF SAFETY = Total Sales - Break Even Sales

11. PERCENTAGE OF MARGIN OF SAFETY or MOS RATIO

$$= \frac{\text{Margin of Safety (sales)}}{\text{Total Sales}} \times 100$$

12. Variable Cost per Unit $= \frac{\text{Change in Total Cost}}{\text{Change in Output}}$

13.	**Contribution per Unit**	=	Change in Profit / Change in Output

14.	**P/V Ratio**	=	Change in Profit / Change in Sales x 100

15.	**Variable Cost Ratio**	=	Change in Total Cost / Change in Sales x 100

16.	**Net Profit**	= Margin of Safety Sales x P/V Ratio
	OR	= MOS units x Contribution per unit

Basic Questions of CVP Analysis

Q. 1. The following information is given to you :

Fixed Overheads	Rs. 1,80,000
Variable Cost per unit	Rs. 14
Selling Price per unit	Rs. 20

Calculate :

a. the break-even point
b. the turnover required to earn a profit of Rs. 36,000.
c. at a profit of Rs. 36,000 express the "Margin of Safety" available to it.

Q. 2. Raj Ltd. has prepared the following budget estimate for the year ending 31st March :

Sales Units	15,000
Fixed Expenses	Rs. 34,000
Sales Value	Rs. 1,50,000
Variable Costs	Rs. 6 per unit

You are required to -

i. Find the P.V.Ratio, Break-even point & Margin of safety
ii. Calculate the revised P.V.Ratio, Break-even point and Margin of safety in each of the following cases :
   a. Decrease of 10% in Selling Price
   b. Increase of 10% in Variable Costs
   c. Increase in Sales Volume by 2,000 units
   d. Increase of Rs. 6,000 in Fixed Costs

Q. 3. S. Ltd., furnished you the following information relating to the half year ended 30th Sept. 2016.

Fixed Expenses	Rs. 45,000
Sales Value	Rs. 1,50,000
Profit	Rs. 30,000

During the second half of the year the company has projected a loss of Rs. 10,000.

Calculate :

i. The break even point and margin of safety for six months ended 30th September, 2016.

ii. Expected Sales Volume for the second half of the year assuming that the P/V Ratio and Fixed expenses remain constant for the second half year also.

iii. The Break-even point and Margin of safety for the year ended 31st March 2017.

Q. 4. Calculate break-even point from the following figures-

	Sales (Rs.Lakhs)	Profit (Rs.Lakhs)
Year - 1	160	4
Year - 2	175	10

From the above data predict the variable cost, contribution, fixed cost and profit associated with a sales volume of Rs. 250 Lakhs, and set out your prediction in the form of a profit statement.

Q. 5. ABC Ltd., furnished you the following data for 2020 -

	January-March	April-December
	Rs.	Rs.
Sales	3,00,000	12,00,000
Net Profit	10,000	90,000

Find out : a. Break-even Sales for 2020

b. Annual Sales required to earn profit of Rs.1,20,000

Q. 6. Shri Doulet Rai earns a gross profit (before charging selling expenses) of 25% of cost of goods purchased and incurs 5 percent of sales as selling charges. His fixed overheads are Rs. 30,000 per annum. Find out extent of sales required to "Break-even" that is to cover exactly the fixed overheads.

Q. 7. A firm has Rs. 10,00,000 invested in its plant and sets a goal of a 15% annual return on investment. Fixed costs in the factory presently amounts to Rs. 4,00,000 per year and variable costs amounts to Rs.15 per unit produced. In the past year the firm produced and sold 50,000 units at Rs. 25 each and earned a profit of Rs. 1,00,000. How can management achieve their target profit goal by varying a different variables like fixed costs, variable costs, quantity sold or increasing the price per unit.

Q. 8. A, B and C are three similar plants under the same management who want them to be merged for better operation. The details are as under –

Particulars	Plant-A	Plant-B	Plant-C
Capacity Operated	100%	70%	50%
	Rs. (in lakhs)	Rs. (in lakhs)	Rs.(in lakhs)
Turnover	300	280	150
Variable Cost	200	210	75
Fixed Cost	70	50	62

Find out -

i. the capacity of the merged plant for break even

ii. the profit at 75 % capacity of the merged plant

iii. the turnover from the merged plant to give a profit of Rs. 28 lakhs

Q. 9. A company has an opening stock of 6,000 units of output. The production planned for the current period is 24,000 units and expected sales for the current period amounts to 28,000 units. The selling price per unit of output is Rs. 10. Variable Cost per unit is expected to be Rs. 6 per unit while it was only Rs. 5 per unit during the previous period. Total fixed cost for the current period is Rs. 86,000. Calculate Break Even volume in units and also the margin of safety in units using FIFO, LIFO and Weighted Average Cost method.

Q. 10. The cost structure of an article the selling price of which is Rs. 45,000 is as follows –

Direct Materials	50%
Direct Labour	20%
Overheads	30%

An increase of 15% in the cost of materials and of 25% in the cost of labour is anticipated. These increased costs in relation to the present selling price would cause a 25% decrease in the amount of present profit per article.

You are required to -

1. To prepare a statement of profit per article at present and
2. The revised selling price to produce the same percentage of profit to sales as before.

Q. 11. Evenkeel Ltd., manufactures and sells a single product X whose selling price is Rs. 40 per unit and the variable cost is Rs. 16 per unit.

If the fixed costs for this year are Rs. 4,80,000 and the annual sales are at 60% margin of safety, calculate the rate of net return on sales, assuming an income tax level of 40%.

Use of Cost BEP for Decision Making

Introduction :

Cost BEP refers to a situation where the total cost of operating under two alternatives are equal. The point enables the firm to identify which alternative is the best to operate at a given level of output assuming that sales price per unit is the same.

In the range below Cost BEP, the alternative with lower fixed cost is better and in the range above Cost BEP, the alternative with lower variable cost (i.e. higher P/V Ratio) is better. Thus it helps management in choosing a right alternative. The same logic can be extended for more than 2 alternatives also by forming the pairs of two alternatives each.

PROBLEM NO. 12 :

Let's assume that we have to decide between purchase of 2 vehicles, say a Scooter and a Motorcycle. It has the following cost data -

Annual Fixed Cost for a Scooter is ₹ 5,000 and variable cost is ₹ 1.2 per km. whereas Annual Fixed Cost for a Motorcycle is ₹ 8,000 and variable cost is ₹ 0.8 per km.

Find out the range in which the two vehicles can be preferred.

PROBLEM NO. 13 :

Two competing companies ABC Ltd., and XYZ Ltd., produce and sell the same type of product in the same market. For the year ending 31st March, 2018 their forecasted profit and loss accounts are as follows -

Particulars	ABC Ltd.		XYZ Ltd.	
	Rs.	Rs.	Rs.	Rs.
Sales		2,50,000		2,50,000
Less : Variable Cost	2,00,000		1,50,000	
Fixed Cost	25,000	2,25,000	75,000	2,25,000
Forecasted Net Profit		25,000		25,000

You are required to compute for each company :

1. P / V Ratio
2. Break-even Sales volume

You are also required to state which company is likely to earn greater profits in conditions of -

(a) Low demand and

(b) High demand.

PROBLEM NO. 14 :

Find the cost break-even points between pair of plants whose cost functions are given below and interpret the results.

Plant A : Rs. 6,00,000 + Rs.12 X

Plant B : Rs. 9,00,000 + Rs.10 X

Plant C : Rs.15,00,000 + Rs. 8 X (Where X is the number of units produced)

PROBLEM NO. 15 :

A practicing Chartered is considering two alternatives, the purchase of a new small car or an old bigger car. Calculate Cost BEP from the following estimated cost figures –

Item of Cost	New Small Car	Old Bigger Car
Purchase Price (Rs.)	3,50,000	2,00,000
Sale Price, after 5 years (Rs.)	50,000	20,000
Repairs and services p.a. (Rs.)	10,000	12,000
Taxes and Insurance p.a. (Rs.)	4,700	1,700
Mileage per liter of petrol	12 K.M.	7.2 K.M.
Petrol Price per liter (Rs.)	36	36

What are the non-financial considerations involved, which may influence the decision?

PROBLEM NO. 16 :

A company proposes to install a machine for the manufacture of a component which at present is being purchased at Rs. 24 each. There are two alternatives, namely (a) installation of an automatic machine and (b) installation of a semi-automatic machine. The details of the two machines are as under :

Particulars	Semi-automatic Machine	Automatic Machine
Initial cost of the machine	Rs. 6,00,000	Rs. 9,00,000
Life of machine	10 years	10 years
Fixed overheads other than depreciation on machine (p.a.)	Rs. 84,000	Rs. 1,62,000
Variable expenses of the component	Rs. 15	Rs. 12

The company charges depreciation on straight line method. Scrap value of the machine at the end of the life is nil. The demand for the components at present is 20,000 units per annum. This demand is expected to increase to 40,000 units.

Required -

(a) For each of the two volumes of output namely 20,000 and 40,000 units, state with supporting calculations whether the components should be purchased or manufactured by installation of machine. If your decision is in favour of installation of machine, which model will you advise?

(b) At what volume of output should the company change over from purchase of components to manufacture by installation of (i) semi-automatic machine and (ii) automatic machine.

(c) At what volume of manufacture of the components will the company switch over from installation of one type of machine to the other?

Continue or Shut Down Decision

Introduction :

This type of decision is required to be taken when the firm is suffering a loss. A general opinion would be to shut down the business when it suffers a loss. However, sometimes we may have to continue inspite of losses just to minimise the loss.

In this case the management is thinking whether to continue the operations or to shut down for a temporary period. Please note that shut down does not mean a permanent closure of business. Shut down is a short term decision to minimise losses. Under such situation, the management should compare the expected losses on temporary shutdown as well as on continuing the operations. An alternative involving lower loss should be selected.

Shut down may lead to savings in certain fixed costs i.e. avoidable fixed cost. However, certain fixed costs are unavoidable, which are known as shut down costs. These must be considered while calculating the shut down point. Shut down point is the point at which loss under the two alternatives is same. Shut down point may be calculated as differential fixed cost divided by contribution p.u.

PROBLEM NO. 17 :

Universe Ltd. manufactures 20,000 units of 'X' in a year at its normal production capacity. The unit cost as to variable costs and fixed costs at this level are Rs. 13 and Rs. 4 respectively. The selling price per unit is Rs. 20.

Due to trade depression, it is expected that only 2,000 units of 'X' can be sold during the next year. The management plans to shut-down the plant. The fixed costs for the next year then is expected to be reduced to Rs. 33,000. Additional costs of plant shut-down are expected as Rs. 12,000. Should the plant be shut-down? What is the shut-down point?

PROBLEM NO. 18 :

A paint manufacturing company manufactures 2,00,000 per annum medium sized tins of "Spray Lac Paints" when working at normal capacity. It incurs the following costs of manufacture per unit.

Direct Material	Rs. 7.80	Variable Overhead	Rs. 2.50
Direct Labour	Rs. 2.10	Fixed Overhead	Rs. 4.00

Each unit (tin) of the product is sold for Rs. 21 with variable selling and administrative expenses of 60 paise per tin.

During the next quarter only 10,000 units can be produced and sold. Management plans to shut down the plant estimating that the fixed manufacturing cost can be reduced to Rs. 74,000 for the quarter.

When the plant is operating, the fixed overheads are incurred at a uniform rate throughout the year. Additional costs of plant shut-down for the quarter are estimated at Rs.14,000.

You are required :

(a) To express your opinion, along with the calculations, as to whether the plant should be shut down during the quarter, and

(b) To calculate the shut down point, for quarter in units (tins) of products.

Relevant – Irrelevant Cost Concept in Decision Making

In every business decision, we use the concept of relevant and irrelevant cost. The cost data which is relevant for decision making is considered in the calculations and the irrelevant data is ignored. However, one need to carefully distinguish between the relevant and irrelevant data. As a thumb rule, the costs which are affected by the decision are relevant for decision making and the cost which remain common or constant are treated as irrelevant for decision making. The following table will illustrate it further.

Relevant Cost	Irrelevant cost
1. Incremental cost	1. Not an incremental cost
2. Avoidable cost	2. Unavoidable cost
3. Variable cost i.e. Product cost	3. Unavoidable Fixed cost
4. Discretionary cost	4. Non discretionary cost
5. Specific overheads	5. General or absorbed overheads
6. Example – depreciation of machinery specially purchased for the job	6. Proportionate rent of the factory charged to a job as per absorption costing
7. Future cost or cost to be incurred	7. Historical cost or committed cost or Sunk cost or Past cost
8. Cost which changes due to decision	8. Cost which remains same irrespective of decision

Relevant & Irrelevant Cost for Material Lying in Stores :

1. Historical Cost or Book Value – It is a sunk cost, hence irrelevant.
2. Realisable Value (i.e. sale value) – It is relevant only if the material has no alternative use.
3. Replacement Cost (i.e. latest purchase price) – It is relevant only if the material is of regular use and its consumption will necessitate additional purchase. It is generally assumed to be higher than realisable value.

PROBLEM NO. 19 :

ABC Ltd. has been approached by a customer who would like a special job to be done for him and is willing to pay Rs. 22,000 for it. The job would require the following materials.

Material	Total units required	Units already In stock	Book value of Units in stock Rs./unit	Realisable value Rs./unit	Replacement Cost Rs./unit
A	1,000	0	-	-	6
B	1,000	600	2	2.50	5
C	1,000	700	3	2.50	4
D	200	200	4	6.00	9

Material B is used regularly by ABC Ltd. and if units of B are required for this job, they would need to be replaced to meet other production demand.

Material C and D are in stock as the result of previous over buying, and they have a restricted use. No other use could be found for material C, but the units of material D could be used in another job as substitute for 300 units of material E, which currently costs Rs. 5 per unit, of which the company has no units in stock at the moment. Calculate the relevant cost of material required for special job.

PROBLEM NO. 20 :

Novel Accessories have been manufacturing alloy figurettes to be fitted on car bonnets. One of the figurettes resembles a tiny model of Ashokan Pillar with the Lion Capital. As the cars fitted with these have been mistaken by the public as belonging to Government dignitaries, on a complaint, the police authorities have banned the use of this on car bonnets. The company is now left with an inventory of 8,000 units of this figurette and the manufacturing costs per unit were as follows -

Materials Rs. 1.20; Labour Rs. 0.80; Fixed Overheads Rs. 0.50; Total Cost Rs. 2.50 per unit.

Prior to being banned, the selling price was Rs. 3 per unit. The casts for this figurette cost Rs.1000 when originally acquired. The company has examined the situation and has come out with three alternative courses of action :-

i. Sell the unit as scrap metal for Rs. 6,500.

ii. Rework them by putting a base on them which would allow them to be sold as Drawing Room curios at a price of Rs.3.20 each. Such work would require Rs. 2 per unit of additional labour and a fixed overhead charge of Re. 1 each would be entailed in terms of the company's absorption costing system. No further materials would be required.

iii. Melt them down and use the metal as a substitute in a strong selling line where the metal currently used costs 50 % more than the metal used in the figurettes. This process would incur a material loss of three eighths of the original metal.

You are required to examine each of these alternatives and arrive at the decision which would result in the greatest benefit to the company. Your calculations should be justified by appropriate reasoning and explanation.

PROBLEM NO. 21 :

A company has been making a machine to order for a customer, but the customer has since gone into liquidation, and there is no prospect that any money will be obtained from the winding up of the company.

Costs incurred to-date in manufacturing the machine are Rs.50,000 and progress payment of Rs.15,000 have been received from the customer prior to the liquidation. The sales department has found another company willing to buy the machine for Rs. 34,000 once it has been completed. To complete the work, the following costs would be incurred :

(a) Materials - these have been bought at a cost of Rs. 6,000. They have no other use and if the machine is not finished, they would be sold for scrap for Rs. 2,000.

(b) Further labour costs would be Rs. 8,000. Labour is in short supply, and if the machine is not finished, the work force would be switched to another job, which would earn Rs.30,000 in revenue, and incur direct costs (not including direct labour) of Rs.12,000 and absorbed (fixed) overhead of Rs. 8,000.

(c) Consultancy fees Rs. 4,000. If the work is not completed, the consultant's contract would be cancelled at a cost of Rs. 1,500

(d) General overheads of Rs. 8,000 would be added to the cost of the additional work.

Should the new customer's offer be accepted? Prepare a statement showing the economics of the proposition.

PROBLEM NO. 22 :

Pick out each of the following items, costs that can be classified under 'committed fixed costs' or 'discretionary fixed costs'.

(i) Annual increase of salary and wages of administrative staff by 5% as per agreement.

(ii) New advertisement for existing products is recommended by the Marketing Department for achieving sales quantities that were budgeted for at the beginning of the year.

(iii) Rents paid for the factory premises for the past 6 months and the rents payable for the next six months. Production is going on in the factory.

(iv) Research costs on a product that has reached 'maturity' phase in its life cycle and the research costs which may be needed on introducing a cheaper substitute into the market for facing competition.

(v) Legal consultancy fees payable for patent rights on a new product. Patenting rights have been applied for.

PROBLEM NO. 23 :

A company can make any one of the 3 products X, Y or Z in a year. It can exercise its option only at the beginning of each year. Relevant information about the products for the next year is given below.

Particulars	X	Y	Z
Selling Price (₹ / unit)	10	12	12
Variable Cost (₹ / unit)	6	9	7
Market Demand (Units)	3000	2000	1000
Production capacity (units)	2000	3000	900
Total Fixed Costs (₹)	3,000		

You are required to compute the opportunity costs for each of the products.

PROBLEM NO. 24 : [ICAI Module + Nov. 2020 Exam]

Y-Connections, China based firm, has just developed ultra-thin tablet S-5 with few features like the ability to open two apps at the same time. This tablet cost ₹ 5,00,000 to develop; it has undergone extensive research and is ready for production. Currently, the firm is deciding on plant capacity, which could cost either ₹ 35,00,000 or ₹ 52,00,000. The additional outlay would allow the plant to increase capacity from 500 units to 750 units. The relevant data for the life cycle of the tablet at different capacity level are as under:

Expected Sales	500 units	750 units
Sale Price	₹ 79,600 per unit	₹ 69,600 per unit
Variable Selling Costs	10% of Selling Price	10% of Selling Price
Salvage Value - Plant	₹ 6,25,000	₹ 9,00,000
Profit Volume Ratio	40%	

Required : Advise Y-Connections, regarding the 'Optimal Plant Capacity' to install. The tablet's life cycle is two years.

Note: Ignore the time value of money.

Solution 24 :

Approach : The Plant capacity at which total profit during the life cycle of the product is highest, shall be treated as 'Optimal Plant Capacity'. In the given question, variable manufacturing cost is missing. We need to calculate it first using the data of 500 units capacity. Once the variable cost of manufacture is calculated, then we can use the same for 750 units capacity also. The given capacity is for the entire life cycle of the product.

(i) Statement Showing Calculation of "Variable Manufacturing Cost per unit" :

Particulars	₹ per unit
Selling price at 500 units capacity	79,600
Less : Contribution (79,600 x 40%)	(31,840)
∴ Total variable cost per unit	47,760
Less : Variable Selling Costs (79,600 x 10%)	(7,960)
∴ Variable manufacturing cost per unit	39,800

(ii) Statement Showing "Expected Net Profit" during the life cycle :

Particulars	Option I (₹)	Option II (₹)
(a) Selling price per unit (given)	79,600	69,600
(b) Variable cost per unit [WN (i) above]	39,800	39,800
(c) Variable selling cost p.u. [10% of (a)]	7,960	6,960
(d) Contribution p.u. [a - b - c]	31,840	22,840
(e) No. of units to be sold	500	750
(f) Total contribution [d x e]	1,59,20,000	1,71,30,000
(g) Capital cost of plant	35,00,000	52,00,000
(h) Salvage Value of Plant	6,25,000	9,00,000
(i) Total depreciation over life [g - h]	28,75,000	43,00,000
(j) Net Profit over life cycle [f - i]	1,30,45,000	1,28,30,000

Note : Development cost of ₹ 5,00,000 is a common cost for both the options and it is a sunk cost. Hence, it is irrelevant for decision making and ignored.

Advice :

Based on the above 'Expected Net Profit' statement, it is advisable to select the plant capacity of 500 units. That is high selling price and low volume level. This advice is based purely on financial considerations.

However, non-financial considerations are also important for the long term growth and success of the organization. Here, it is important to note that the life cycle of product is just two years and there is no significant difference between the total profits at both levels. The difference is hardly ` 2,15,000. In this scenario, firm may opt for the plant having higher capacity to increase its market share and also to establish a long term brand image with a larger customer base.

Question 25 : [RTP - Nov. 2018]

Golden Pacific Airlines Ltd. operates its services under the brand 'Golden Pacific'. The 'Golden Pacific' route network spans prominent business metropolis as well as key leisure destinations across the Indian subcontinent. 'Golden Pacific', a low-fare carrier launched with the objective of commoditizing air travel, offers airline seats at marginal premium to train fares across India.

Profits of the 'Golden Pacific' have been decreasing for several years. In an effort to improve the company's performance, consideration is being given to dropping several flights that appear to be unprofitable.

Income statement for one such flight from 'New Delhi' to 'Leh' (GP - 022) is given below :

(figures per flight)

Particulars	₹	₹
Ticket Revenue (175 seats x 60% Occupancy x ₹ 7,000 ticket price)		7,35,000
Less: Variable Expenses (₹ 1,400 per person)		1,47,000
Contribution Margin		5,88,000
Less: Flight Expenses :		
Salaries of Flight Crew	1,70,000	
Salaries of Flight Assistants	31,500	
Baggage Loading and Flight Preparation	63,000	
Overnight Costs for Flight Crew and Assistants at destination	12,600	
Fuel for Aircraft	2,38,000	
Depreciation of Aircraft	49,000*	
Liability Insurance	1,47,000	
Flight Promotion	28,000	
Hanger Parking Fee for Aircraft at destination	7,000	7,46,100
Net Gain / (Loss)		(1,58,100)

* Based on obsolescence

The following additional information is available about flight GP-022.

1. Members of the flight crew are paid fixed annual salaries, whereas the flight assistants are paid by the flight.
2. The baggage loading and flight preparation expense is an allocation of ground crew's salaries and depreciation of ground equipment.
3. One third of the liability insurance is a special charge assessed against flight GP022 because in the opinion of insurance company, the destination of the flight is in a "high-risk" area.
4. The hanger parking fee is a standard fee charged for aircraft at all airports.
5. If flight GP-022 is dropped, 'Golden Pacific' Airlines has no authorization at present to replace it with another flight.

Required :

Using the data available, prepare an ANALYSIS showing what impact dropping flight GP022 would have on the airline's profit. [10 Marks]

Solution 25 :

As per the statement given in the problem, Flight GP-022 incurs a net (loss) of ₹ 1,58,100. This is the net result of revenue less costs. Revenue is entirely variable depending upon passenger occupancy. Costs are both variable and fixed nature. To analyze the impact of dropping flight GP-022, we need to re-compute net gain/ (loss) that Golden Pacific earns when it operates the flight based on relevant costing principles.

Net Gain/(Loss) = Revenue earned from flight operations less Relevant costs of operation

Revenue earned is the ticket revenue earned from flight operations of GP-022, this is entirely variable. Relevant costs of flight operations are those expenses that would be incurred only when the flight is operated. These include variable expenses per passenger, salaries flight assistants, overnight costs for flight crew and assistants, fuel for aircraft, a third portion of flight insurance that is specifically related to this flight sector and flight promotion expense. These are expenses that will not be incurred if the flight is not operated. Hence, relevant for decision making.

Other expenses like salaries of flight crew and hanger parking fees for aircraft are fixed expenses that will be incurred even if the flight does not operate. Loading and flight preparation expense is an allocated cost that will continue to be incurred even if flight GP-022 does not operate. Depreciation of aircraft and liability insurance expense (2/3rd portion not related to a specific flight sector) are sunk costs. These expenses have already been incurred and hence are irrelevant to decision making. Therefore, these fixed, allocated and sunk expenses are ignored while analyzing the decision whether to continue operating flight GP-022.

Statement Showing Net Gain/(Loss) using Relevant Cost Approach :

Particulars	₹	₹
Contribution Margin if the flight is continued		5,88,000
Less: Relevant Flight Costs		
Salaries of Flight Assistants	31,500	
Overnight Costs for Flight Crew and Assistants	12,600	
Fuel for Aircraft	2,38,000	
Liability Insurance (1/3 × ₹ 1,47,000)	49,000	
Flight Promotion	28,000	3,59,100
Net Gain/ (Loss)		2,28,900

Comments : If Golden Pacific Airlines Ltd. discontinues flight GP-022, profits will reduce by ₹ 2,28,900. The statement showing loss in operations of ₹ 158,100 is misleading for decision making purpose because it accounts for costs that are fixed and irrelevant. However, since flight GP-022 yields a net gain of ₹ 2,28,900, flight operations should continue.

Student Note : Depreciation is based on obsolescence (i.e. getting outdated). It seems that ICAI assumption is whether one uses the aircraft or not, it will still get outdated and hence it is an irrelevant cost. If the depreciation is based on actual usage, then it may be a relevant cost.

Product Mix Decision / Key Factor Questions

Introduction :

Any manufacturing resource which is in short supply is called as 'Key Factor'. Such shortage of resource puts a restriction on the profitability of the company. **Key Factor** is also known as - **Limiting Factor** or **Scarce Factor** or **Governing Factor** or **Principal Factor**. The following are the various key factors, which exists in practice – for example, Material availability, Machine capacity, Manpower availability, Market demand etc.

Many times, the management has to take a decision, whether to produce one product or another. Specially, when we have an option to produce multiple products using same limited resources, this type of situation occurs. Management of a company has to ensure the optimum utilisation of such key resources to generate maximum profit. Ensuring optimum (i.e. best) utilisation of resources is also known 'Optimum Product Mix' i.e. designing the best production plan at which our profit is maximum. The combination of various products, which generates the maximum contribution is often called as "Product Mix Decision".

Steps for Solving Product Mix Questions :

1. Identify the key factor
2. Calculate contribution per unit for various products
3. Calculate contribution per key factor for each product
4. Assign Ranking to the products based on contribution per key factor
5. Allocate the key resources based on such ranking
6. The resultant answer is optimum product mix i.e. best production plan.

Multiple Key Factors :

It is also possible that there are more than one key factors given in the question. In case of multiple key factors with conflicting ranking of products, we may have to make use of Quantitative Technique called Linear Programming. It is popularly called as Linear Programming Problems i.e. LPP. We will solve such questions later in this chapter.

PROBLEM NO. 26

A company has a limited supply of material X to the extent of 50,000 kgs. This material is used to manufacture three types of products namely – A, B and C. The cost details of these products are given below :

Particulars	A	B	C
Selling Price (Rs./unit)	120	80	200
Variable Cost (Rs./unit)	100	70	150
Material required (kgs./unit)	1	2	5
Market Demand (units)	15,000	20,000	5,000
Total Fixed Cost	Rs. 2,00,000		

Advise the management about the optimum utilisation of available material, to maximise the profits of the company. Also calculate such profit.

PROBLEM NO. 27

V Ltd., produces two products 'P' and 'Q'. The draft budget for the next month is as under -

Particulars	P	Q
Budgeted production & sales (units)	80,000	40,000
Selling price (Rs./unit)	50	25
Total cost (Rs./unit)	40	20
Machine Hours per unit	1	2
Maximum sales potential (units)	1,00,000	60,000

The fixed expenses are estimated at Rs. 9,60,000 per month. The company absorbs fixed overheads on the basis of machine hours which are fully utilised by the budgeted production and cannot be further increased. When the budget was discussed, the Managing Director stated that the product mix should be altered to yield optimum profit.

Required -

Revise the product mix based on data given for P and Q to yield optimum profit. Also calculate such profit.

PROBLEM NO. 28

As a part of its rural upliftment programme, the Government has put under cultivation a farm of 96 hectares to grow tomatoes of four varieties : Royal Red, Golden Yellow, Juicy Crimson and Sunny Scarlet. Of the total, 68 hectares are suitable for all four varieties, but the remaining 28 hectares are suitable for growing only Golden Yellow and Juicy Crimson. Labour is available for all kinds of farm work and is no constraint.

The market requirement is that all the four varieties of tomatoes must be produced with a minimum of 1,000 boxes of each variety.

The farmers engaged have decided that the area devoted to any crop should be in terms of complete hectares and not in fractions of a hectare. The other limitation is that not more than 22,750 boxes of any one variety should be produced. The following data are relevant :-

Particulars	Royal Red	Golden Yellow	Juicy Crimson	Sunny Scarlet
Annual Yield (Boxes per hectare)	350	100	70	180
Costs :	**Rs.**	**Rs.**	**Rs.**	**Rs.**
Material per hectare	476.00	216.00	196.00	312.00
Growing per hectare	896.00	608.00	371.00	528.00
Harvesting & packing per box	3.60	3.28	4.40	5.20
Transport per Box	5.20	5.20	4.00	9.60
Market price per box	15.38	15.87	18.38	22.27

Fixed Overheads per annum	Rs.
Growing	11,200
Harvesting	7,400
General Administration	10,200
Transport	7,200

Find out :-

i. Within the given constraints, the area to be cultivated with each variety of tomatoes, if the largest total profit has to be achieved.

ii. The amount of such profit in rupees.

PROBLEM NO. 29 :

A company manufactures two products. Each product passes through two departments A and B before it becomes a finished product. The data for a year is as under :

Products	**Aristocrat**	**Deluxe**
Maximum sales potential in units	7,400	10,000
Product unit data :		
Selling price per unit	Rs. 90	Rs. 80
Machine hours per unit :		
Dept. A Hours	0.50	0.30
Dept. B Hours	0.40	0.45

Maximum capacity of department A is 3,400 hours and of Department B is 3,840 hours. Maximum quantity of direct materials available is 17,000 kg. Each product requires 2 kg of direct materials. The purchase price of the direct materials is Rs. 5 per kg. Variable costs budgeted at Rs. 50 per hour for Department A and Rs. 60 per hour for Department B.

In view of the aforesaid production capacity constraints, the company has decided to produce only one of the two products during the year under review.

Required :

Which of the two products should be produced and sold in the year under review to maximise the profit. State the number of units of that product and the resultant contribution.

PROBLEM NO. 30 : [May 2018 Exam]

JM Ltd. is engaged in the manufacture of plastic bottles of a standard size. The factory has 5 machines of identical size, each capable of producing 40 bottles per hour. The variable cost per bottle is ₹ 0.32 and the selling price is ₹ 0.80 each. The company has received an offer from another company for manufacture of 40,000 units of a plastic moulded toy. The price per toy is ₹ 30 and the variable cost is ₹ 24 each. In case of the company takes up the job, it has to meet the expenses of making a special mould required for the manufacture of the toy. The cost of the mould is ₹ 1,00,000. The company's time study analysis shows that the machines can produce only 16 toys per hour. The company has a total capacity of 10,000 hours during the period in which the toy is required to be manufactured. The fixed costs excluding the cost of construction of the mould during the period will be ₹ 10 Lakh.

The company has an order for the supply of 3,00,000 bottles during the period.

Required

(i) Do you advise the company to take up the order for manufacturing plastic moulded toys during the time when it has an order in its book for the supply of 3,00,000 bottles.

(3 Marks)

(ii) If the order for the supply of bottles increases to 4,00,000 bottles, will you advise the company to accept the order for supply of plastic moulded toys? State the reasons.

(3 Marks)

(iii) An associate company of JM Ltd. has idle capacity and is willing to take up the whole or part of the manufacturing of the plastic moulded toys on sub-contracting basis. The subcontract price inclusive of the cost of construction of mould is ₹ 28 per toy. Determine the minimum expected excess machine hour capacity needed to justify producing any portion of the toy order by the company itself rather than subcontracting.

(4 Marks)

Solution 30 :

1. Statement of Contribution & Ranking :

Particulars	Plastic Bottle	Moulded Toy
(a) Selling price per unit (₹)	0.80	30
(b) Variable cost per unit (₹)	0.32	24
(c) Cost of Mould (specific cost) [₹ 1,00,000 / 40,000 units]	---	2.50
(d) Contribution per unit (₹) [a - b - c]	0.48	3.50
(e) Output per hour (in units)	40	16
(f) Contribution per hour (₹) [d x e]	19.20	56
(g) Ranking based on (f) above	II	I
(h) Requirement (in units)	3,00,000	40,000
(i) Hours needed [h / e]	7,500	2,500

Advise : As can be seen from the above calculations, that after satisfying the demand of 3,00,000 bottles, we can still fulfill the order for 40,000 toys within available 10,000 hours. The incremental profit from 40,000 toys shall be -

= (40,000 units x ₹ 3.50 p.u.) = ₹ 1,40,000

Considering an incremental profit, it is advisable to take up the order for moulded toys.

Note : The fixed cost excluding the cost of mould is ₹ 10 Lakh for the given period. It is a general cost and hence irrelevant for decision making.

2. Evaluation of offer if demand for bottle increases to 4,00,000 units :

Particulars	Figures
(a) Additional sale of bottles	1,00,000 units
(b) Incremental hours for bottles [1,00,000 / 40]	2,500 hours
(c) Incremental contribution from bottles [1,00,000 x 0.48]	₹ 48,000
(d) Loss of profit on sale of toys [WN 1 above]	₹ 1,40,000
(e) Net incremental loss [c - d]	₹ (92,000)

Advise : As can be seen from the above calculations, manufacturing of extra 1,00,000 bottles is not feasible. Hence, the company should accept the order for 40,000 toys and restrict the order of bottles to 3,00,000 units only.

3. Minimum excess capacity needed to justify producing the toys :

For this part of the answer, we should calculate Cost BEP between own manufacture and subcontracting. Cost BEP is the point at which total cost of the two alternatives is exactly equal.

Let's assume minimum excess capacity as 'X' toys, at which cost of own manufacture and cost of subcontracting is exactly the same.

Cost of Own Manufacture			Cost of Sub-contracting
	24X + 1,00,000	=	28X
Hence,	28X - 24X	=	1,00,000
Hence,	X	=	25,000 toys
That is =	(25,000 / 16)	=	1,562.50 hours

It means, if the demand for toys exceeds 25,000 units or excess capacity needed exceeds 1,562.50 hours, then it is advisable to manufacture the toys on our own. Else, we should get it done on subcontracting basis.

Sell or Further Process Decision

Introduction :

Sell or process further refers to a decision-making situation where an executive has to decide either to sell a component/product/raw material as it is or alternatively process it further by incurring additional expenses. For instance, sometime, a redundant material lying in stores for a long time may be sold as scrap at a small value or may be thrown away as waste. This material may, however, be converted into a product of higher saleable value by carrying out some further operations or processes. On further processing the component/product/raw material will mostly fetch a higher sale value as well. Here if the differential sales value is more than the further processing cost, then it is beneficial to process the product further otherwise sell it without further processing. Such types of decision making problems usually arise in the case of joint products.

There are two rules to follow when ascertaining whether the further processing is worthwhile:

- Only the incremental costs and revenues of the further process are relevant
- The joint process costs are irrelevant - they are already 'sunk' at the point of separation

Qualitative Factors

Qualitative factors related to processing further decisions include resource availability such as the readiness of employees to work extra hours to further process the products and availability of materials required for the processing. In addition, the preference of customer in buying the product as it is or after further processing, should also be considered. Else, we may loose the customers to our competitors.

PROBLEM NO. 31 :

In a joint manufacturing process, 3 products have emerged at split off point i.e. A, B and C. Out of these 3 products, A & C are sold at split off point. However, B can either be sold at split off point @ ₹ 25 per kg. or can be processed further to convert it into a more refined product and then it can be sold @ ₹ 40 per kg.

The quantity produced at split off point is 10,000 kgs. and the loss due to further processing will be 20% of input. The further processing cost is ₹ 50,000.

You have to decide whether product B should be further processed or not?

PROBLEM NO. 32 :

P.W. Perfume Company manufactures various qualities of perfumes and colognes. One popular line of colognes includes three products that result from a joint production process. Below are data from the most recent month of production :

Product		Evergreen	Morning Flower	Evening Flower
Sales Price p.u.	(Rs.)	40	100	150
Quantity	(Nos.)	10,000	6,000	4,000
Joint Cost p.u.	(Rs.)	28	28	28
Cost After Split off p.u.	(Rs.)	20	40	50
Total Cost p.u.	(Rs.)	48	68	78

As the Financial Controller, you are called into the President's Office with the Director of Marketing. The President says, "I don't understand your product cost report. Either, we are selling our largest-volume product at a loss or the product cost data are all wrong. Now what is it?"

Required :

(a) Respond to the President's question.

(b) Another company has just introduced a product that competes directly with Morning Flower. To compete successfully with the other company's product, the price of Morning Flower cologne must be reduced to Rs. 60. Should the company do so and sell below cost.

PROBLEM NO. 33

A company is able to obtain 2,00,000 kgs of A and 4,00,000 kgs of B from the input of 6,00,000 kgs of a raw material 'F'. The selling price of these output are A = Rs. 6 per kg and B = Rs. 4.50 per kg. The processing costs are –

Particulars	Rs.
Raw Materials 6,00,000 kgs @ Rs.2	12,00,000
Variable processing costs	6,00,000
Fixed processing costs	2,00,000
Total Cost	20,00,000

The company has the following proposal for consideration -

The entire quantity of the resultant Product-P can be sold at Rs.13 per kg. Each kg. of 'P' requires one kg. of A and the processing costs amounts to Rs. 16,00,000.

Required –

i. Find the original profit on sale of A and B

ii. Evaluate the proposal for further processing of A into P.

Question 34 : [ICAI Module]

A process industry unit manufactures three joint products viz. A, B and C. C has no realisable value unless it undergoes further processing after the point of separation. The cost details of C are as follows :

Particulars	₹ per unit	₹ per unit
Up to the point of separation		
Marginal Cost	30	
Fixed Cost	20	50
After the point of separation		
Marginal Cost	15	
Fixed Cost	5	20
∴ Total cost per unit		70

C can be sold at ₹ 37 per unit and no more.

Required :

(i) Should we process C further?

(ii) If C is not a joint product, then will you advice sale of C @ ₹ 37 per unit using CVP analysis.

Solution 34 :

(i) If 'C' is a joint product, then the cost up to separation point is a common cost and hence irrelevant for decision making. The only relevant cost is cost after the point of separation. Which is ₹ 20 per unit. If we sale C @ ₹ 37 per unit, then we will earn an incremental profit of ₹ 17 per unit. It will help us to recover the joint processing cost. Hence, we should process C further.

(ii) If 'C' is not a joint product, then only marginal cost would be relevant for decision making. That is 30 + 15 = ₹ 45 per unit. However, if we sale C @ ₹ 37 per unit, then there will be an incremental loss of ₹ 8 per unit. In such case, we should not sale C @ ₹ 37 per unit.

Minimum Pricing Decision

The minimum pricing approach is a useful method in following situations :

- where there is a lot of intense competition,
- there is surplus production capacity,
- the company wants to clear old inventories,
- we want to get the special order and/or want to improve our market share.

The minimum price should be set at the incremental costs of manufacturing, plus opportunity costs (if any). For this type of pricing, the selling price is the lowest price that a company may sell its product. It is usually calculated as the total relevant costs of manufacturing.

PROBLEM NO. 35 :

A toy manufacturer earns an average net profit of Rs. 3 per piece in a selling price of Rs.15 by producing and selling 60,000 pieces at 60% of the potential capacity. Composition of his cost of sales is –

Particulars	Rs. per unit
Direct Materials	4.00
Direct Wages	1.00
Works Overheads	6.00 (50% fixed)
Sales Overheads	1.00 (25% varying)

During the current year, he intends to produce the same number but anticipates that -

a. his fixed charge will go up by 10%

b. rates of direct labour will increase by 20%

c. rates of direct material will increase by 5%

d. selling price cannot be increased.

Under these circumstances he obtains an order for a further 20% of his capacity. What minimum price will you recommend for accepting the order to ensure the manufacturer an overall profit of Rs. 1,80,500.

PROBLEM NO. 36

Indian Plastics makes an average profit of Rs. 3.95 per plastic bucket on a selling price of Rs.16 per piece by producing 60,000 buckets or 60% of the potential capacity. Its cost of sales per piece is -

Direct Material	Rs. 5.00
Direct Wages	Rs. 1.65
Works Overhead (50% Fixed)	Rs. 5.00
Sales Overhead (25% Variable)	Rs. 0.40

During the current year it intends to produce the same number but anticipates that the fixed charges will go up by 10%. While rates of Direct Labour and Direct Materials will increase by 33.33% and 6% respectively. There is no scope for increasing the selling price due to keen competition. Under this situation there is an offer from Indian Railways for a further 20% of its capacity.

What minimum price per piece should be quoted to Railways to ensure that the firm earns the same overall profits as before.

PROBLEM NO. 37

A small scale manufacturer produces an article at the operated capacity of 10,000 units while the normal capacity of his plant is 14,000 units. Working at a profit margin of 20% on sales realisation, he has formulated his Budget as under -

Particulars	10,000 units (Rs.)	14,000 units (Rs.)
Sales Realisation	2,00,000	2,80,000
Variable Overheads	50,000	70,000
Semi-variable Overheads	20,000	22,000
Fixed Overheads	40,000	40,000

He gets an order for a quantity equivalent to 20% of the operated capacity and even on this additional production profit margin is desired at the same percentage on Sales realisation as for production to operated capacity. Assuming prime cost is constant per unit of production, what should be the minimum price to realise this objective?

Keep or Drop Decisions

Another type of operating decision that management must make is whether to keep or drop unprofitable segments, such as product lines, services, divisions, departments, stores, or outlets.

The decision is based on whether or not the segment's revenue exceeds the costs directly traceable to the segment, including any direct fixed costs.

Incremental Revenue

- Incremental revenue is the difference in revenue between the original sales revenue and the new revenue that is expected to result due to dropping a segment.
- If dropping a product will cause an increase in demand for another product, the additional revenue for the other product should be taken into consideration.

Incremental Cost Savings

- Variable costs associated with a segment to be dropped are incremental cost savings that cause profit to increase.
- Direct fixed costs related to a segment being dropped are avoidable if that segment is dropped because they can be eliminated if the segment is dropped.

Relevant Costs & Opportunity Costs

- Loss of contribution from the segment to be dropped, should be treated as an opportunity cost.
- Similarly, the incremental costs required for the new segment should be considered as relevant costs for decision making.

Decision - Keep or Drop?

- If incremental benefit > incremental cost, the segment should be dropped, unless qualitative characteristics fiercely impact the decision.
- If incremental benefit = incremental cost, qualitative effects must be used to make the decision.
- If incremental benefit < incremental cost, the segment should not be dropped, unless qualitative characteristics fiercely impact the decision.

Qualitative Factors

Qualitative factors related to keep or drop decisions often include considerations of employees that will be terminated if the product is dropped, the effect of lay off might have an adverse impact on employees that are not terminated, effects on suppliers from whom the materials will no longer be purchased, and the effect on customers who previously purchased the product being dropped.

Question 38 : [ICAI Module]

Rabi Ltd. is considering the discontinuance of Division C. The following information is given :

(Figures in ₹)

Particulars	Divisions A & B	Division C	Total
Sales (Maximum achievable)	41,40,000	5,17,500	46,57,500
Less: Variable Cost	20,70,000	2,76,000	23,46,000
Contribution	20,70,000	2,41,500	23,11,500
Less: Specific Avoidable Fixed Cost	14,49,000	4,14,000	18,63,000
Divisional Income	6,21,000	(1,72,500)	4,48,500

The rates of Variable Costs are 90% of the Normal Rates due to the current volume of operation. There is adequate market demand. For any lower volume of operation, the rates would go back to the Normal Rates. Facilities released by discontinuing Division C cannot be used for any other purpose.

Evaluate the decision to discontinue Division C using Relevant Cost Approach.

Solution 38 :

Incremental Profit / Loss on discontinuation of division C :

Particulars	Rs.
Loss avoided of division 'C' (i.e. gain or benefit)	1,72,500
Increase in variable cost of Division A & B [10/90 x 20,70,000]	(2,30,000)
∴ Incremental Loss	(57,500)
Decision : Not advisable to discontinue Division 'C'.	

PROBLEM NO. 39 :

Fitwell Ltd., a large manufacturing company has three factories namely factory 'A', factory 'B' and factory 'C'. All the three factories produce the same product which is sold at Rs. 375 per unit. The factory wise estimates of operating results for 2021 are as under :-

(Figures in rupees lakhs)

Particulars	A	B	C	TOTAL
Sales	300	1,200	600	2,100
Costs :				
Raw Materials	75	350	145	570
Direct Labour	75	280	140	495
Factory Overhead - Variable	20	110	55	185
- Fixed	40	120	60	220
Selling & Distb.OH - Variable	23	70	40	133
- Fixed	15	50	30	95
Administration Overhead	20	90	40	150
Head Office Expenses apportioned	12	50	30	92
Total Costs	280	1,120	540	1,940
Profit	20	80	60	160

When the above estimates were under finalization, the company's legal department advised that the lease of factory A was due to expire on 31st December, 2020 and that it could be renewed by enhancing the lease rent by Rs.12 lakhs p.a. Since this enhancement will have a heavy impact on the profitability of the company, the management is constrained to examine the proposals which are as under :-

i. Renew the lease and bear the impact.

ii. Close down factory A, sell off the plant, machinery and stocks and liquidate all liabilities, including the staff and workers, retrenchment compensation from the sale proceeds which are sufficient for this purpose.

In order to maintain the customer relations the total planned output of the factory A will be transferred to either factory B or factory C. Plant capacity is available at both the factories to take over the manufacture. The additional cost involved in the manufacture of the extra output so transferred in factories B and C are estimated as under :-

Particulars	Factory B	Factory C
(a) Additional fixed overheads due to increased capacity utilisation (p.a.)	50 Lakhs	40 Lakhs
(b) Additional freight, selling and other overheads to produce and distribute the output to the present customers of Factory A.	25 per unit	35 per unit

You are required to prepare comparative statement of profitability in the aforesaid alternative courses of action and give your recommendation.

PROBLEM NO. 40 :

A company manufacturing a consumer product and marketing through its network of 400 depots all over the country is considering closing down the depots and resorting to dealership arrangement. The total turnover of the company is Rs. 200 crores p.a. The average turnover, costs etc. in respect of a depot is given below -

Annual Turnover - Rs. 50 lakhs, Average Inventory - Rs. 5 lakhs, Administrative Expenses - Rs. 50,000 p.a. & Staff Salary Rs. 80,000 p.a. The inventory carrying cost is 16% p.a. which is the Rate for working capital finance.

Marketing through dealers would involve engaging dealers for each area. The dealers will assure a minimum sale for each area. This would result in increasing the capacity utilisation from 75% as at present to 90%. The Company's P/V Ratio at present is 10%.

Marketing through dealers would involve payment of a commission of 5% on sales. But 50% of existing Depot staff will have to be absorbed in the company. The dealers will deposit Rs.5 crores with the Company on which interest of 12% p.a. will be paid.

Required :

(1) You are required to work out the impact on profitability of the Company by accepting the proposal of closing down the depots.

(2) What will be your decision if the dealers agree for a commission of 4% on sales.

(3) What are the other non-financial considerations involved in this decision?

Special Order Decisions

Special order decisions focus on whether a special priced order should be accepted or rejected. These special orders may accepted at a price which is lower than the regular selling price. These orders often can be attractive, especially when the firm is operating below its maximum productive capacity.

Uniform Pricing requires that firms sell identical products at the same price to all competing customers in the same market. However, this law does not apply to -

- Non competing customers from the same market
- Potential customers in markets not ordinarily served i.e. new markets

Special order decisions are based on incremental analysis. Incremental analysis enables managers to emphasis on the relevant areas of a decision.

- Incremental revenues are the additional revenues generated from accepting the special order. The revenue can result from additional sales of products or from providing services.

  If the company is presently operating at a lower capacity, revenue of regular customers will not be affected.

  If the company is operating at full capacity, it will have to give up some regular sales in order to fulfill the special order.

- Incremental costs are the additional costs incurred from accepting a special order. Variable operating costs are generally the relevant costs for decision making and it may include – variable cost of production, special packing, commissions, and shipping costs etc.

  Most often, a firm's recurring fixed costs will remain the same in total if a special order is accepted. Hence, the existing fixed cost is treated as irrelevant for decision making.

  Occasionally the acceptance of a special order may cause additional fixed costs such as special purpose tool, Inspection cost. In these cases, these additional fixed costs are relevant and should be considered in an incremental analysis.

Decision - Accept or Reject?

- If incremental revenue < incremental cost, reject the special order, unless qualitative characteristics fiercely impact the decision.
- If incremental revenue = incremental cost, qualitative effects must be used to make the decision.
- If incremental revenue > incremental cost, accept the order, unless qualitative characteristics fiercely impact the decision.

PROBLEM NO. 41

A Company has a capacity of producing 1,00,000 units of a certain product in a month. The sales department report that the following schedule of sale prices is possible –

Volume of Production %	Selling Price per unit Paise
60%	90
70%	80
80%	75
90%	67
100%	61

The variable cost of manufacture between these levels is 15 paise per unit and fixed cost is Rs. 40,000.

a. Prepare a statement showing incremental revenue and differential cost at each stage. Also state at which volume of production will the profit be maximum?

b. If there is bulk offer for export at 50 paise per unit for the balance capacity over the maximum profit volume and price quoted will not affect the internal sale, will you advise accepting this offer and why?

PROBLEM NO. 42 :

Perfect Pistons Ltd. produces 60,000 pistons per annum for its parent company Perfect Motors Ltd. The pistons are sold to Perfect Motors at Rs. 200 per unit. The variable cost per piston is Rs.180. The annual fixed cost of Perfect Pistons Ltd. is Rs.15 lakhs and it is currently operating at 60% capacity.

The company desires to respond to an export enquiry for 30,000 pistons of the type it is currently manufacturing. The company's aim is to improve capacity utilisation and avoid present loss.

You have to take note of the following benefits that will accrue to the export transaction, while determining the F.O.B. price to be quoted.

i. Export incentive by way of cash assistance at 10% of F.O.B. value of exports.

ii. Reimbursement of excise duty on manufacturing inputs by way of 5% drawback of duty on F.O.B. value of exports.

iii. Entitlement of import license to the extent of 10% on F.O.B. value of exports. The import license can be sold at a premium of 50%.

There are certain special costs related to export of goods as follows –

(a) Special export packing is needed @ Rs. 5 per unit.

(b) Hiring cost of shipping container is Rs. 50,000 for entire consignment.

(c) Transportation cost from factory premises to sea port, loading and unloading at port will cost Rs. 25,000 for the whole consignment.

You are required to calculate the bare minimum FOB price that the company should quote, in order to break-even.

PROBLEM NO. 43 :

Unique Products manufactures and sells in a year 20,000 units of a particular product to definite customers at a price of Rs. 100 per unit. The concern has a capacity to produce 25,000 units of the product per annum. To produce beyond 25,000 units per annum, the concern will have to install a new equipment at a cost of Rs. 15 lakhs. The equipment will have a life span of 10 years and will have no residual value. There is an offer from a client to purchase 10,000 units of the product regularly at a price of Rs. 90 per unit. The order, if accepted, will have to be over and above the existing level of production of 20,000 units. The cost structure is as under :

Particulars	Per unit (Rs.)
Direct Material	30
Direct Labour	20
Variable Overheads	10
Profit	20

During the coming year, it has been estimated that the cost of direct material, as compared to the current year will increase by 10%. Because of certain wage agreement direct labour cost will increase by 25%. Fixed overheads will increase by 10%. If the new order for 10,000 units is accepted, fixed overheads will increase further by Rs. 60,000 due to increased administrative charges.

You are required to analyse whether the concern should accept the order or instead of that try to secure order for the balance unused capacity, as available now, through some sales promotion expenses which will be Rs. 50,000 per annum.

Outsourcing Decision i.e. Make or Buy Decision

Introduction :

Outsourcing decision is often called as 'make or buy' decision. It involves a decision of whether to continue 'making' a product versus 'buying' it from an external firm. Outsourcing enables a firm to

- reduce costs or
- benefit from supplier efficiencies

Outsourcing decision requires incremental analysis. The incremental amounts are based on the difference in the cost of buying a product or service compared to the cost of producing the item or providing the service in house.

Incremental costs are the additional costs incurred for outsourcing. The main cost is the purchase price of the products or the cost of the services that are being provided by external firms.

Incremental benefits (i.e. cost savings) are reductions of costs that will no longer be incurred as a result of outsourcing. They are often called avoidable costs because if a company outsources, it can 'avoid' certain costs. Variable production costs are always avoidable costs. This will help us to improve the profits. In some circumstances, a portion of fixed costs can also be saved such as equipment rental costs or supervisor salaries that can be avoided.

Opportunity costs are the benefits forgone as a result of selecting a different alternative. They are always incremental. For example, if a company decides to manufacture, then it is not able to lease its factory space. This loss of lease rent may be treated as an opportunity cost of manufacture.

Outsourcing Decisions - Accept or Reject Criteria?

If incremental benefits < incremental costs, reject the outsourcing, unless qualitative factors fiercely impact the decision.

If incremental benefits > incremental costs, accept the outsourcing unless qualitative factors fiercely impact the decision.

If incremental cost savings = incremental costs, focus primarily on qualitative factors to evaluate the decision.

Qualitative Factors

While considering the decision of Outsourcing, the management should consider qualitative aspects like quality of goods, reliability of suppliers, impact on the customers and suppliers etc.

A firm generally decides to outsource:

- If it costs less rather than to manufacture it internally;
- If the return on the necessary investment to be made to manufacture is not attractive enough;
- If the company does not have the requisite skilled manpower to make;
- If the concern feels that manufacturing internally will mean additional labour problem;
- If adequate managerial manpower is not available to take charge of the extra work of manufacturing;
- If the component shows much seasonal demand resulting in a considerable risk of maintaining inventories;
- If the process of making is not confidential or patented;
- If there is risk of technological obsolescence for the component is such that it does not encourage capital investment in the component.

Question 44 :

Aditya Ltd. manufactures four products A, B, C and D in Gurgaon and one product F in Faridabad. Aditya Ltd. operates under Just-in-time (JIT) principle and does not hold any inventory of either finished goods or raw materials.

Company has entered into an agreement with M Ltd. to supply 10,000 units per month of each product produced from Gurgaon unit at a contracted price. Aditya Ltd. is bound to supply these contracted units to M Ltd. without fail. Following are the details related with non contracted units of Gurgaon unit.

(Amount in ₹ per unit)

Particulars	A	B	C	D
Selling Price per unit	360.00	285.00	290.00	210.00
Direct Labour @ ₹45 per hour	112.50	67.50	135.00	67.50
Direct Material M-1 @ ₹50 per kg.	50.00	100.00	---	75.00
Direct Material M-2 @ ₹30 per litre.	90.00	45.00	60.00	---
Variable Overhead (varies with labour hrs)	12.50	7.50	15.00	7.50
Variable Overhead (varies with machine hrs)	9.00	12.00	9.00	15.00
Total Variable Cost	274.00	232.00	219.00	165.00
Machine Hours per unit	3 hours	4 hours	3 hours	5 hours
Maximum Demand per month (units)	90,000	95,000	80,000	75,000

The products manufactured in Gurgaon unit use direct material M-1 and M-2 but product F produced in Faridabad unit is made by a distinct raw material Z. Material Z is purchased from the outside market at ₹ 200.00 per unit. One unit of F requires one unit of material Z.

Material Z can also be manufactured at Gurgaon unit but for this 2 hours of direct labour, 3 hours of machine time and 2.5 litres of material M-2 will be required.

The Purchase manager has reported to the production manager that material M-1 and M-2 are in short supply in the market and only 6,50,000 Kg. of M-1 and 6,00,000 litre of M-2 can be purchased in a month.

Required :

(i) CALCULATE whether Aditya Ltd. should manufacture material Z in Gurgaon unit or continue to purchase it from outside market.

(ii) CALCULATE the optimum monthly usage of Gurgaon unit's available resources and make decision accordingly.

(iii) CALCULATE the purchase price of material Z at which your decision in (i) can be sustained.

Solution 44 :

(1) Key Calculations :

Particulars	A	B	C	D
(a) Direct Labour @ ₹45 per hour	112.50	67.50	135.00	67.50
(b) Labour hours per unit [(a) / 45]	2.50	1.50	3.00	1.50
(c) Direct Material M-1 @ ₹50 per kg.	50.00	100.00	---	75.00
(d) Quantity of M-1 used per unit [(c) / 50] in kg.	1.00	2.00	---	1.50

(e) Direct Material M-2 @ ₹30 per litre.	90.00	45.00	60.00	---
(f) Quantity of M-2 used per unit [(e) / 30] in litres	3.00	1.50	2.00	---
(g) Variable Overhead p.u. (varies with labour hrs)	12.50	7.50	15.00	7.50
(h) Variable OH Rate per labour hour [g / b]	5.00	5.00	5.00	5.00
(i) Variable OH p.u. (varies with machine hrs)	9.00	12.00	9.00	15.00
(j) Machine Hours per unit	3 hours	4 hours	3 hours	5 hours
(k) Variable OH Rate per machine hour [i / j]	3.00	3.00	3.00	3.00

(2) Manufacturing Cost of Material Z, if manufactured in Gurgaon unit :

Particulars	Amount (₹)
Direct Labour (2 hours × ₹45)	90.00
Direct Material M-2 (2.5 litre × ₹30)	75.00
Variable Overhead, varies with Labour Hours (2 hours × ₹5)	10.00
Variable Overhead, varies with Machine Hours (3 hours × ₹3)	9.00
Total Variable Cost	184.00

Decision : The purchasing cost of material Z from the outside market is ₹200, which is more than the variable cost to manufacture ₹184. Hence, it will be beneficial for the Aditya Ltd. to manufacture material Z in Gurgaon unit itself.

(3) Monthly Requirement of Direct Material M-1 & M-2

Particulars	**A**	**B**	**C**	**D**	**Total**
(a) Units to be supplied to M Ltd. (commitment)	10,000	10,000	10,000	10,000	---
(b) Quantity of M-1 used per unit [wn1(d)] kg.	1.00	2.00	---	1.50	---
(c) Total Qty. of M-1 needed [a x b] kg.	10,000	20,000	---	15,000	45,000
(d) Quantity of M-2 used per unit [wn1(f)]	3.00	1.50	2.00	---	
(e) Total Qty. of M-2 needed [a x d] kg.	30,000	15,000	20,000	---	65,000
(f) Maximum Demand in outside market (units)	90,000	95,000	80,000	75,000	---
(g) Total Qty. of M-1 needed for outside market [f x b] kg.	90,000	1,90,000	---	1,12,500	3,92,500
(h) Total Qty. of M-2 needed for outside market [f x d] litres	2,70,000	1,42,500	1,60,000	---	5,72,500

(4) Availability and Demand Comparison of Material :

Particulars	Direct Material M-1 (in Kg)	Direct Material M-2 (in Litre)
Total Availability in Market	6,50,000	6,00,000
Less : to be used for commitment	45,000	65,000
Balance quantity left	6,05,000	5,35,000
Less: Required for outside demand	3,92,500	5,72,500
Excess / (Shortfall) Quantity	2,12,500	(37,500)

Note 1 : Material M-2 is a limiting factor as its availability is less than its requirement to produce contracted as well as for non-contracted units.

Note 2 : For optimum usage of resources available in Gurgaon unit, prioritisation of production is necessary. The following is the comparison table of product A, B, C and Z. Product D is not taken into comparison as material M-2 is not required to produce product D. Calculation of Contribution per litre of M-2 is given below.

(5) Statement of Contribution & Ranking :

Particulars	**A**	**B**	**C**	**Z**
(a) Selling Price per unit / Purchase Price	360	285	290	200
(b) Total Variable Cost per unit	274	232	219	184
(c) Contribution / saving per unit [a – b]	86	53	71	16
(d) Quantity of M-2 used per unit [wn1(f)]	3.00	1.50	2.00	2.5
(e) Contribution per litre of M-2 [c / d]	28.67	35.33	35.50	6.40
(f) Ranking for production	III	II	I	IV

(6) Optimum Production Plan (for outside demand) :

Particulars	Units	M2 Qty. Per unit	Total Qty. of M2 used	Balance Qty. Of M2 left
Balance Qty. of M2 left after fixed Commitment [WN 4]				5,35,000
Less : Used for 'C'	80,000	2.00	1,60,000	3,75,000
Less : Used for 'B'	95,000	1.50	1,42,500	2,32,500
Balance M2 used for 'A'	77,500	3.00	2,32,500	NIL

Note : Since, contribution per unit of material Z is lowest as compared to other products consuming material M-2. Material Z cannot be manufactured under the given resource constraint. Hence only existing products of Gurgaon units should be manufactured.

(7) **Calculation of Purchase Price of Z to sustain the decision in (i) :**

In the first answer, we had recommended to manufacture Z, because it's manufacturing cost was lower than it's purchase price. However, due to the limitation of availability of material M2, we have reversed the decision of manufacturing Z.

If we at all want to manufacture Z, then we have to curtail the outside demand of 3rd rank product i.e. A. In such case, the purchase price of Z should be –

= Variable cost of manufacture of Z + Opportunity cost i.e. contribution lost on A

= 184 + (2.5 litre of M2 x 28.67)

= ₹ 255.675 per unit

PROBLEM NO. 45 :

Part No. 4466 is manufactured by Modern Engineers Ltd., and is used extensively in the Company's finished products. The annual requirement for this component is 12,000 units. The lowest price quotation so far received from an outside supplier is Rs. 21.50 per unit. This is being considered as the company wants to discontinue manufacture of this component and buy it from outside.

You are asked to help the company for taking decision. In this connection, the following figures are supplied to you. The total expenses when Part No.4466 was in production for 12,000 units were as under :-

Costs	Rs.	Costs	Rs.
Materials	3,50,000	Power	30,000
Indirect Labour	1,60,000	Insurance	15,000
Direct Labour	4,00,000	Depreciation	2,00,000
Lighting	20,000	Miscellaneous	27,000

Fringe benefits to labour workout normally at 15% of total labour costs. Discontinuing the production of this component would not in any way permit the disposal of any of the factory's assets. The following proportion of expenses can be avoided, if manufacture of Part No.4466 is stopped :-

Materials	30%	Indirect Labour	25%
Direct Labour	35%	Power	20%

When the part is purchased from an outside supplier, shipping charges would average 75 paise per unit and indirect labour cost would be increased by Rs. 20,000 annually for receiving, inspecting and handling the purchase parts.

Prepare a schedule showing the relative cost of buying and making Part No. 4466 and give your recommendation. What would be the non-financial aspects that would be relevant to this decision.

PROBLEM NO. 46 :

Agrocaps Ltd. engaged in manufacturing agricultural machinery, is preparing its annual budget for the coming year. The company has a metal pressing capacity of 20,000 hours, which will be insufficient for manufacture of all requirements of components A, B, C and D.

The company has the following choices -

i. Buy the components entirely from outside suppliers.

ii. Buy from outside suppliers and/or use a partial second shift.

Standard Cost per unit

Components	A Rs.	B Rs.	C Rs.	D Rs.
Variable Cost :				
Direct Materials	37	27	25	44
Direct Wages	10	8	22	40
Direct Expenses	10	20	10	60
Fixed Overhead	5	4	11	20
Total Production Cost	62	59	68	164
Requirements in units	2,000	3,500	1,500	2,800

Direct expenses relate to the use of the metal presses which cost Rs.10 per hour, to operate. Fixed overheads are absorbed as a percentage of direct wages.

Supply of all or any part of the total requirement can be obtained at following prices, each delivered to the factory :-

Component	A	B	C	D
Purchase Price per unit (Rs.)	60	59	52	168

Second shift operations would increase direct wages by 25 percent over the normal shift and fixed overhead by Rs. 500 for each 1,000 (or part thereof) second shift hours worked.

You are required to present, with calculations :-

(a) Which component, and in what quantities should be manufactured in the 20,000 hours of press time available?

(b) Whether it would be profitable to make any of the balance of components required on a second shift basis instead of buying them from outside suppliers.

Question 47 : [Nov. 2018 Exam]

Cool Air Ltd., manufactures and sells 25,000 table fans annually. One of the components required for fans is purchased from an outside at a price of ₹ 190 per unit. Annually it is purchasing 25,000 components for its usage. The production Manager is of the opinion that if all the components are produced at own plant, it is possible to maintain better quality in the finished product. Further, he proposed that the in-house production of the component with other items will provide more flexibility to increase the annual production by another 5,000 units. He estimates the cost of making the component as follows :

Particulars	₹ / unit
Direct material	80
Direct labour	75
Factory overheads [70% variable]	40
Total Cost	195

The proposal of the Production Manager was referred to the Marketing Manager for his remarks. He pointed out that to market the additional units, the overall unit price should be reduced by 5% and additionally ₹ 1,00,000 p.m. should be incurred for advertising. Present selling price and contribution per fan are ₹ 2,500 and ₹ 600 respectively. No other increase or decrease in all other expenses as a result of this proposal will arise.

Since the making cost of the component is more than the buying cost, the Management asks you to :

(i) Analyse the make or buy decision on unit basis and total basis. [8 Marks]

(ii) Recommend the most profitable alternative. [2 Marks]

Solution 47 :

(i) Analysis of Make or Buy Decision on Unit Basis :

Particulars	₹ / unit	₹ / unit
(a) Relevant Cost of Making :		
Direct material	80	
Direct labour	75	
Variable factory overheads [70% x 40]	28	183
(b) Cost of buying from outside [given]		190
(c) Saving per unit if manufactured [b - a]		7

Decision : On per unit basis, making is cheaper than buying the component.

Analysis of Make or Buy Decision on Total Basis :

Particulars	₹
(a) Present contribution per fan (given)	600
(b) Reduction in overall sales price of fan [2,500 x 5%]	125
(c) Saving in variable cost of component [190 - 183]	7
(d) Revised contribution per unit [a - b + c]	482
(e) Revised total contribution [30,000 units x 482]	1,44,60,000
(f) Additional advertising cost [1,00,000 p.m. x 12 months]	12,00,000
(g) Present total contribution [25,000 units x 600]	1,50,00,000
(h) Incremental Profit / (Loss) [e - f - g]	(17,40,000)

Decision : On overall basis, buying of component is more profitable than manufacturing.

(ii) Recommendation :

If we consider only financial prudence, then we should continue the purchase of components from outside supplier. However, as the Production Manager claims that own manufacture will improve the quality and flexibility of production, we should also consider such non-financial aspects in decision making.

Increase in production from 25,000 units to 30,000 units will also help the company in increasing its market share. Else, if we restrict our production to 25,000 units only, without decreasing the selling price and without incurring additional advertisement cost, then it will help in improving the profitability of the company by ₹ 1,75,000 (i.e. ₹ 7 per unit x 25,000 units). In such case, the proposal will also become financially viable.

Non – Financial & Ethical Considerations in Decision Making

Decision Making Model

A general approach to tactical decision making includes:

- Define the problem.
- Identify various alternative solutions and eliminate unfeasible alternatives.
- Identify costs & benefits of each feasible alternative.
- Examine total relevant costs, benefits of each alternative.
- Assess non-financial factors and ethical issues.
- Select alternative with greatest overall benefit.

Non-Financial Considerations

With increase in competition, dynamic market changes and changing needs of customers, non-financial information has gained relevance in the decision-making process. Information to which monetary value can be attached is in the nature of financial information.

Information of an organization like number of employees, employee morale, customer satisfaction etc. cannot be expressed in monetary terms. Non- financial information is long term focused and ensures profitability and sustainability in long term for an organization thereby evaluating the internal performance of the company. Non - Financial information which a company should focus that would turn out to be advantageous while making decisions for a company are:

- Quality
- Employee Satisfaction
- Customer Satisfaction
- Corporate Social Responsibility
- Environmental Factors
- Intellectual Property Rights
- Intangible Assets
- Competitor's Movements
- Brand Name etc.

Decisions made in a business rest on the balance between the perceived effects of financial and non-financial information. Following are Limitations of Non - Financial Information :

- Time and Cost involved.
- Subjective measurement – No common denominator to measure performance.
- Improper measures will lead the companies to draw attention on wrong objectives.
- Lack of Statistical Reliability – Possible chances of error.

Ethical Considerations

Ethics are moral principles that guide the conduct of individuals. By their behaviour and attitude, managers set the company culture. Guideline for Ethical Conduct are :

- Identify an ethical decision by using personal ethical standards of honesty and fairness.
- Identify the consequences of the decision and its effect on others.
- Consider obligations and responsibilities to those who will be affected by decision.
- Make a decision that is ethical and fair to those affected by it.

Some ethical problems can be avoided simply by using common sense and not focusing solely on the short term at the expense of long term.

Firms with a strong code of ethics can create strong customer and employee loyalty. Furthermore, a firm that values people more than profit is more likely to be a commercially successful business.

Question 48 :

Recently, Ministry of Health and Family Welfare along with Drug Control Department have come hard on health care centres for charging exorbitant fees from their patients. Human Health Care Ltd. (HHCL), a leading integrated healthcare delivery provider company is feeling pinch of measures taken by authorities and facing margin pressures due to this. HHCL is operating in a competitive environment so; it's difficult to increase patient numbers also. Management Consultant of the company has come out with some plan for cost control and reduction.

HHCL provides treatment under package system where fees is charged irrespective of days a patient stays in the hospital. Consultant has estimated 2.50 patient days per patient. He wants to reduce it to 2 days. Consultant has calculated the general variable cost of ₹ 500 per patient day. Annually 15,000 patients visit to the hospital for treatment.

Medical Superintendent has some concerns with that of Consultant's plan. According to him, reducing the patient stay would be detrimental to the full recovery of patient. They would come again for admission thereby increasing current readmission rate from 3% to 5%. It means readmitting 300 additional patients per year. Company has to spend ₹25,00,000 more to accommodate this increase in readmission. But Consultant has found bless in disguise in this. He said every readmission is treated as new admission so it would result in additional cash flow of ₹4,500 per patient in the form of admission fees.

Required :

(i) CALCULATE the impact of Management Consultant's plan on profit of the company.

(ii) Also COMMENT on result and other ethical factors that should be kept in mind before taking any decision.

Solution 48 :

(i) Impact of Management Consultant's Plan on Profit of the HHCL

Particulars	₹
(a) Saving in General Variable Cost due to Reduction in Patient Days [15,000 Patients x (2.5 Days – 2.0 Days) x ₹ 500)]	37,50,000
(b) Incremental Revenue from Increased Readmission [15,000 Patients x 2% x ₹ 4,500]	13,50,000
(c) Incremental Cost due to Increased Readmission	25,00,000
∴ Net Incremental Benefit [a + b – c]	26,00,000

(ii) Comments :

- Primary goal of investor owned firms (i.e. Ltd. Co.) is shareholder's wealth maximization, which translates in to maximization of value per share. Management consultant's plan is looking good for the HHCL as there is a positive impact on the profitability of the company as per above analysis.
- Also HHCL operates in a competitive environment so for its survival, it has to work on plans like this.
- But there is also the other side of a coin that cannot also be ignored i.e. humanity values and business ethics. Discharging patients before their full recovery will add discomfort and disruption in their lives which cannot be quantified into money. There could be other severe consequences as well because of this practice. For gaining extra benefits, HHCL cannot play with the life of patients. It would put a question mark on the business ethics of the HHCL.

- HHCL may be able to earn incremental profit due to this practice in short run but It will tarnish the image of the HHCL, which would hurt profitability in the long run.

So, before taking any decision on this plan, HHCL should analyze both quantitative as well as qualitative factors.

Question 49 : [RTP - May 2018] - Case Scenario

Skyview runs the Planetarium Station in New Delhi, India. The strength of the station lies in its live interactions and programs for visitors, students and amateur astronomers. The station is always active with programs for school and college students and for amateur astronomers. One of the station's key attractions is a big screen IMAX theatre. IMAX is a 70 mm motion picture film format which shows images of far greater size and resolution than traditional film systems. The IMAX cinema projection standards were developed in Canada in the late 1960s. Unlike traditional projectors, the film is run horizontally so that the image width is greater than the width of the film.

The average IMAX show at the station attracts 120 visitors (50 children and 70 adults) at a ticket price of ₹160 for children and ₹200 for adults. Skyview estimates that the running cost per IMAX show is ₹10,000. In addition, fixed costs of ₹7,500 are allocated to each show based on annual estimate of the number of IMAX shows.

Delhi Public School has approached Skyview about scheduling an extra show for its class VIII students. One hundred students and five teachers are expected to join the special show on the 'Planets & Solar System', a feature that is currently showing. The school has asked Skyview for a price quote. The special show will take place at 08:30 AM when the IMAX is not usually open.

Required :

RECOMMEND the minimum amount that Skyview should charge.

DISCUSS any other financial or non-financial factors, which are relevant for the decision.

Solution 49 :

The incremental cost associated with the IMAX show appears to be ₹10,000 i.e. cost of running the show. The allocated fixed cost per show is not relevant because the total amount of fixed costs for the year will not change as a result of the special show. Further, the stated ticket prices are not relevant because the show will take place at 08:30 AM when the IMAX is not usually open. Thus, arranging a special show for school will not cause any opportunity loss to Skyview. Based on the financial data provided, the minimum price quote appears to be ₹10,000.

Skyview should also consider the following factors:

- Does the station have a souvenir shop and/or cafeteria? If so, many students are likely to buy food and/or souvenir items, thereby increasing the station's contribution. In turn, this would reduce the minimum price quote.
- What is the impact on future revenue? After seeing the show, many students may return with their parents, thereby increasing future revenue.
- Are there any other costs, which are linked with the special show and that are not included in the ₹10,000 variable running cost? For example, will the station have to pay an overtime premium? If yes, then it should be considered.
- Skyview should also consider the educational mission of the Planetarium Station. Such shows directly contribute to this mission. The special shows may be an excellent way to expose some students to earth science. These students may have never gone through the Planetarium Station if it were not for the school excursion.
- Overall, the "best" price to be charged requires some judgment, as Skyview needs to consider the above financial and non-financial factors.

Question 50 : [ICAI Website + Nov. 2020 Exam]

'S' manages the school canteen (approximately 1,600 students) at Noida. The current cash payment system requires three clerks (paid ₹ 90 per hour), employed for about 4 hours a day. The canteen operates approximately 240 days a year.

'S' is considering a Wireless Cash Management System (WCMS), where a student could just swipe an ID Card for payment. This system would cost ₹ 1,25,000 to setup and ₹ 36,000 per year to operate. 'S' believes that he could manage with one clerk if he were to implement the system.

Required -

(a) ADVISE 'S' on the choice of a plan, assuming working life of WCMS as 5 years. (Ignore the time vale of money).

(b) Are there any other non-financial considerations involved?

Solution 50 :

(a) Evaluation of the plan to install WCMS :

Particulars	Amount (₹)
Net savings in the wages cost of 2 clerks p.a. [4 hours/day x 240 days p.a. x 2 clerks x ₹ 90 per hour]	1,72,800
Less : Annual depreciation of the WCMS system [₹ 1,25,000 / 5 years]	(25,000)
Less : Operational cost of WCMS system p.a.	(36,000)
Net incremental savings p.a.	1,11,800

Conclusion

Obviously, WCMS option is more cost effective for 'S' because there is an annual cost saving of ₹ 1,11,800. Hence, WCMS system should be installed.

(b) Other Relevant Non-Financial Considerations :

The WCMS may be a lot more efficient, but more rigid. For instance, what if, a student forgets to bring his/her card or transaction failure due to connectivity issue or a student may not have enough balance in his card. Automated systems will not be able to handle these situations. Having manual system may add an aspect of flexibility and a human touch, that is hard to quantify. Two employees will lose their job also. When a student can just swipe the card to make payment, it means the card is to be charged with the pre-loaded amount in it. It means, a student will have to pay in advance and we need to check the willingness to do so.

Activity Based CVP Analysis

Introduction

Conventional CVP analysis assumes volume based measures. An alternative approach is activity based costing. In an activity-based costing system, costs are segregated into unit and non-unit-based categories. Activity-based costing acknowledges that some costs vary with units produced and some costs do not. However, while activity-based costing admits that non-unit-based costs are fixed with respect to production volume changes, it also argues that many non-unit-based costs vary with respect to other cost drivers. In contrast, the volume based approach combines the cost of these activities and treat them as fixed costs since they do not vary with output volume. Activity based costing provides a more accurate determination of costs because it separately identifies and traces non-unit based costs to products rather than combining them in a pool of fixed costs as volume based approach does.

The Break-even can then be expressed as follows :

Break-even units =

$$\frac{[\text{(Setup cost} \times \text{Number of Setups)} + \text{(Engineering Cost} \times \text{Number of Engineering Hours)} \quad \text{(Any other activity based cost x Cost driver)} + \text{Remaining Fixed Costs}]}{[\text{Sales Price - Unit Variable Cost}]}$$

A comparison of the ABC break-even point with the conventional break-even point reveals two important differences.

First, the fixed costs differ. Some costs previously identified as being fixed may actually vary with non-unit cost drivers, in this case setups and engineering hours.

Second, the numerator of the ABC break-even equation has two non-unit-variable cost terms: one for batch-related activities and one for product sustaining activities.

"The use of activity-based costing does not mean that CVP analysis is less valuable. In fact, it becomes more valuable, since it delivers more precise understandings concerning cost behaviour. These understandings produce better decisions. CVP analysis within an activity based framework, however, must be improved".

Question 51 : [ICAI Module]

Catalyst Ltd. makes a single product with the following details:

Description	Current Situation	Proposed Change
Selling Price (₹/unit)	10	
Direct Costs (₹/unit)	5	
Present number of setups per production period, (before each production run, setup is done)	42	
Cost per set up (₹)	450	Decrease by ₹ 90
Production units per run	960	1,008
Engineering hours for entire production period	500	422
Cost per engineering hour (₹)	10	

The company has begun Activity Based Costing of fixed costs and has presently identified two cost drivers, viz. production runs and engineering hours. The total fixed costs is presently at ₹ 96,000. However, after the above analysis based on ABC, ₹ 72,100 remains to be analyzed. There are certain changes as proposed above for the next production period for the same volume of output.

Required :

(i) How many units and in how many production runs should Catalyst Ltd. produce under the current situation and proposed scenario in order to break-even?

(ii) Should Catalyst Ltd. continue to break up the remaining fixed costs into activity based costs? Why?

Solution 51 :

(1) Statement of fixed cost and BEP under current situation:

Particulars	₹
(a) Fixed Set up Cost [42 set ups x ₹ 450 per set up]	18,900
(b) Fixed Engineering Cost [500 hours x ₹ 10 per hour]	5,000
(c) Fixed cost analysed using ABC at present [a + b]	23,900
(d) Total fixed cost given under current situation	96,000
(e) Fixed cost remain to be analysed [d – c]	72,100
(f) Total production units [960 units per run x 42 runs]	40,320
(g) Contribution per unit [10 – 5]	5
(h) Present BEP in units [d / g]	19,200
(i) No. of production runs for BEP [h / 960]	20

(2) Statement of fixed cost and key data under proposed situation:

Particulars	₹
(a) Total production units [WN 1(f)] i.e. same	40,320
(b) Production units per run (given)	1,008
(c) No. of production runs needed [a / b]	40
(d) Set up cost per production run [450 – 90]	360
(e) Fixed Set up Cost [40 set ups x ₹ 360 per set up]	14,400
(f) Fixed Engineering Cost [422 hours x ₹ 10 per hour]	4,220
(g) Fixed cost analysed using ABC [e + f]	18,620
(h) Fixed cost remained to be analysed [same as above]	72,100
(i) Total fixed cost under proposed situation	90,720
(j) Contribution per unit [10 – 5]	5
(k) Revised BEP in units [i / j]	18,144
(l) No. of production runs for BEP [k / 1008]	18

(3) Comments:

A company should adopt Activity Based Costing (ABC) system for accurate product costing, as traditional volume based costing system does not take into account the Non-unit Level Overhead Costs such as Setup Cost, Inspection Cost, and Material Handling Cost etc. Cost Analysis under ABC system showed that while these costs are largely fixed with respect to sales volume, but they are not fixed to other appropriate cost drivers. If break up the remaining ₹ 72,100 fixed costs is possible using ABC, then one must do it for correct calculation of BEP.

Question 52 : [ICAI Module]

A company manufactures cycles for both adults and children. Given below is cost information about cycles made for children –

Particulars	Traditional CVP Analysis	Activity Based CVP Analysis
Monthly Demand & Production	10,000 units	10,000 units
Selling price per unit	₹ 8,000	₹ 8,000
Variable cost per unit	₹ 7,500	₹ 7,500
Fixed cost per month (as identified under each system)	₹ 10,00,000	₹ 8,00,000

Fixed costs of ₹10,00,000 per month under Traditional CVP analysis are those that do not vary with respect to volume.

Under Activity Based Costing system, fixed cost that do not vary as per volume or any other cost driver has been identified to be ₹8,00,000 per month.

The ABC study revealed a milling machine is used to cut metal into steer support. Production of these steer support takes place in batches of 25 units. Once a batch for children's cycle is finished, the next batch would be that for adult cycles. Therefore, after each batch there would be a set-up change. If 10,000 children's cycles have to be produced, number of set-ups required = 10,000 steer support / 25 per batch = 400 set-ups. Each set-up costs ₹500, (i.e. 400 set-ups x ₹500 = ₹2,00,000). This cost was previously pooled together with fixed cost under traditional CVP analysis.

Required :

(i) FIND the break-even point per month and profit per month under the traditional CVP method and the Activity Based CVP method.

(ii) As a plant manager, you would like to keep the number of set-ups minimum. Therefore, you propose to increase the batch size of children's steer support to 50 units in one batch. The number of set-ups will reduce from 400 (10,000 units / 25 units) to 200 (10,000 units / 50 units). However, due to larger batch production, additional inventory storage area would be required to store and that will cost the company ₹50,000 per month extra as fixed cost. ANALYSE the impact on BEP (units per month) and profits per month.

CVP Analysis under Just in Time Environment

In a firm which has implemented Just in Time, the variable cost per unit generally gets reduced, because the inefficiencies are identified and removed from the process. Thus, the entire production process becomes lean and thin, which consequently reduces the variable cost of producing and selling each unit of output. However, fixed costs are generally increased. Because, the production is done is small size batches and material is purchased as and when needed, we have to carry out the production set up activity again and again for each production run. Similarly, material is received for each production run and hence material receiving and handling cost increases. These cost are treated as fixed costs, because these cost do not vary with the number of units produced.

Direct labour is also considered as fixed cost instead of variable cost. Workers are not motivated to produce more, but to produce the goods of good quality in a timely manner. Under JIT, direct material is treated as variable cost and other unit based variable costs are power and sales commissions etc. The cost equation for JIT can be expressed as follows:

Total Cost = [(Unit variable cost × Number of units) + (Set up cost x No. of set ups) + (Engineering cost × Number of Engineering hours) + Remaining fixed costs]

CVP Analysis in Service Sector & Non-Profit Organisations

CVP analysis can also be applied to decisions by service industries and non-profit organisations. To apply CVP analysis in service and non-profit organisations, we need to focus on measuring their output, which is different from tangible units sold by manufacturing and merchandising companies.

We have studied the computation of services provided by service industry at Intermediate level in the topic of Service Costing or Operating Costing. We need to quantify the effective services provided by service organisation.

For example – (a) in goods transport service, we use ton-kilometer as service unit (b) in passenger transport service, we use passenger-kilometer as service unit (c) in hospitals, we use patient-day or bed-day as service unit (d) in hotel industry, we use room-day as service unit.

Question 53 : [ICAI Module]

Expert Roadways Services Pvt. Ltd. is planning to run a fleet of 15 buses in Birpur City on a fixed route. Company has estimated a total of 2,51,85,000 passenger kilometers per annum. It is estimated that the buses will have 100% load factor.

Buses are purchased at a price of ₹ 44,00,000 per unit whose scrap value at the end of 5 years life is ₹ 5,50,000. Seating capacity of a bus excluding a Driver's seat is 42. Each bus can give a mileage of 5 kmpl. Average cost of fuel is ₹ 66 per liter. Cost of Lubricants & Sundries per 1,000 km would be ₹ 3,300. Company will pay a salary of ₹ 27,500 per month to a driver and two attendants together for each bus.

Other annual charges per bus are: Insurance ₹ 55,000, Garage Charges ₹ 33,000, Repairs & Maintenance ₹ 55,000. Route Permit Charges upto 20,000 km is ₹ 5,500 and ₹ 2,200 for every additional 5,000 km or part thereof.

Required :

(i) CALCULATE a suggested fare per passenger/km taking into account markup on cost @ 20% to cover general overheads and sufficient profit.

(ii) The Transport Sector of Birpur is highly regulated. The Government has fixed the fare @ ₹ 1.35 per passenger kilometer for next 2 years. COMMENT on the two year's profitability taking into consideration the inflation rate of 8%.

Note: Route permit charges are not subject to Inflation.

Solution 53 :

(1) Key Data :

Total passenger kilometer p.a.

= No. of passengers x Kilometers x No. of buses

= 2,51,85,000 (given in question)

Passenger kilometer p.a. per bus	= 2,51,85,000 / 15 buses
	= 16,79,000
Effective passengers per bus	= 42 – 2 attendants = 40 persons
Kilometers travelled p.a. per bus	= 16,79,000 / 40 persons
	= 41,975 kms.

(2) Statement showing Fare per passenger – km

Particulars	Cost p.a. (₹)
Depreciation [(44,00,000 – 5,50,000) / 5 years]	7,70,000
Fuel Cost [₹ 66 / 5 km. x 41,975 kms.]	5,54,070
Cost of Lubricants and Sundries [₹ 3,300 / 1,000 km. x 41,975 kms.]	1,38,518
Salary of Driver and Two Attendants [27,500 p.m. x 12 months]	3,30,000
Insurance	55,000
Garage Charges	33,000
Repair and Maintenance	55,000
Route Permit Charges [₹5,500 + (5 x ₹ 2,200)]	16,500
Total Cost per annum	19,52,088
Add: Markup @ 20% of Total Cost	3,90,417
Total Revenue	23,42,505
Passenger kilometer p.a. per bus [WN 1]	16,79,000
Fare per passenger kilometer [23,42,505 / 16,79,000]	1.395 (approx)

(3) **Statement of profit for two years per bus:**

Particulars	Year 1 (₹)	Year 2 (₹)
Depreciation [No change – straight line method]	7,70,000	7,70,000
Fuel Cost [with 8% inflation]	5,98,396	6,46,267
Cost of Lubricants and Sundries [with 8% inflation]	1,49,599	1,61,567
Salary of Driver and Two [with 8% inflation]	3,56,400	3,84,912
Insurance [with 8% inflation]	59,400	64,152
Garage Charges [with 8% inflation]	35,640	38,491
Repair and Maintenance [with 8% inflation]	59,400	64,152
Route Permit Charges [No change]	16,500	16,500
Total Cost per annum	20,45,335	21,46,041
Total Revenue [1.35 x 16,79,000 pass-km]	22,66,650	22,66,650
Profit (₹)	2,21,315	1,20,609
Profit as % of Revenue	9.76%	5.32%

(4) Comments :

The gross margin is showing a downward trend because the cost components have taken into the effect of inflation, hence increasing year by year. However, total revenue has remained stagnant due to Government regulations. It has resulted in reduction in profit margin.

The company's gross margin to total revenue ratio has down to 9.76% and 5.32% in first and second year respectively. But initially the company's desired gross margin to total revenue ratio is 16.67% to cover general overheads and sufficient profit. Though the amount of general overheads is not given, but we can safely assume that they may also subject to inflation i.e. increase year by year. In such case the company needs to maintain or increase its gross margin per bus to maintain its net profit after general overheads.

The information about regulated fare in the given case is regarding first two years only but if this regulated fare scenario persists for further years then the project may not be viable for the company.

PROBLEM NO. 54

Public Health Centre runs an intensive Medical Care Unit. For this purpose, it has hired a building at a rent of Rs. 15,000 p.m. with the understanding that it would bear the repairs and maintenance charges also. Each unit consists of 25 beds and 5 more beds can be comfortably accommodated when occasion demands.

The permanent staff attached to the unit are as follows –

2 Supervisors, each at salary of Rs. 5,000 p.m.;

4 Nurses, each at a salary of Rs. 3,000 p.m. and

2 Ward Boys, each at a salary or Rs.1,500 p.m.

Though the unit was open for the patients all the 365 days in a year, scrutiny of accounts in 2019 revealed that only for 120 days in the year, the unit had the full capacity of 25 patients per day and for another 80 days it had on an average 20 beds only occupied per day. But there were occasions when the beds were full, extra beds were hired from outside at a charge of Rs. 5 per bed per day and this did not come to more than 5 beds extra above the normal capacity on any one day. The total hire charges for the extra beds incurred for the whole year amounted to Rs. 2,000.

The unit engaged expert doctors from outside to attend on the patients and the fees were paid on the basis of the number of patients attended and time spent by them and on average worked out to Rs. 20,000 p.m. The other expenses for the year were as under –

Particulars	Rs.
Repairs and maintenance (Fixed)	3,600
Food supplied to patients	44,000
Jenitor and other services for them	12,500
Laundry charges for their bed linen	28,000
Medicines supplied	35,000
Cost of Oxygen, X-Ray, etc. (Fixed)	54,000
General Administration charges allocated to the unit	49,550

Required :

(a) If the unit recovered an overall amount of Rs. 250 per day on an average from each patient, what is the profit per patient day made by the unit in 2019.

(b) What will be the BEP no. of patient days, assuming no extra beds are required ?

PROBLEM NO. 55 :

The manager of a hotel providing lodging facilities wants to expand his services to include manual booking (reservation or cancellation) of railway tickets for his clients. He does not want to have electronic booking due to operational difficulty. He has the following information:

Particulars	₹ per month
Proportion of rent allocated for office space	4,000
General telephone expenses allocated to this service	2,400
Proportion of security charges/maintenance expenses allocated	1,600
Salary to person exclusively doing the booking of tickets	20,000
Mobile phone charges exclusive to person booking ticket	3,000
Share of general miscellaneous fixed expenses allocated	1,000
Conveyance incurred to book tickets (to and fro charges to the nearest booking station) [fixed per month]	4,000

The manager estimates that there will be 2,500 bookings per month for 3 months of peak season, 1,000 bookings per month for 2 months of moderate business and 700 bookings per month during the remaining period. He cannot charge more than the prevailing rate of ₹ 30 per booking charged by other agents.

Calculate the total cost per booking. What is the estimated profit the manager hopes to achieve for the full year? What should be the average minimum volume to justify the setting up of the new service?

PROBLEM No. 56 :

ABC Airways owns a single jet aircraft and operates between Bangalore and New Delhi. Flights leave Bangalore on Monday and Thursday and depart from New Delhi on Wednesday and Saturday. ABC Airways cannot afford any more flights between Bangalore and New Delhi. Only tourist class seats are available on its flights. An analyst has collected the following information:

• Seating capacity of the plane	360
• Average Passengers per flight	100
• Flights per week (one way)	4
• Total Flights per year (one way)	208
• Average one way fare	Rs. 10,000
• Variable fuel costs	Rs. 1,40,000 per flight
• Food service to passengers (provided free of cost)	Rs. 400 per passenger
• Commission paid to travel agents (paid by ABC Airways on each Ticket booked) (Assume that all ABC tickets are booked by travel agents)	8% of fare
• Fixed annual lease costs allocated to each flights	Rs. 5,30,000 per flight
• Fixed ground services Costs allocated to each flight (i.e. maintenance, check-in, baggage handling)	Rs. 70,000 per flight
• Fixed salaries of flights crew allocated to each flight	Rs. 40,000 per flight

Note : The total fixed cost of lease, ground service staff cost and fixed salaries shall remain constant and will not increase with increase in number of flights.

You are required to calculate :

(a) What is the operating income that ABC Airways makes on each one-way flight between Bangalore and New Delhi.

(b) The market research department of ABC Airways indicates that lowering the average one-way fare to Rs. 9,600 will increase the average number of passengers per flight to 106. Should ABC Airways lower its fare?

(c) Travel India, a tour operator, approaches ABC Airways to charter its jet aircraft twice each month, first to take Travel India International tourists from Bangalore to New Delhi and then bring the tourist back from New Delhi to Bangalore. If ABC Airways accepts this offer, then it will be able to offer only 184 (208 minus 24) of its own flights each year. The terms of the charter are : (i) For each one-way flight Travel India will pay ABC Rs. 7,50,000 to charter the plane and to use its flights crew and ground service staff. (ii) Travel India will pay fuel costs; and (iii) Travel India will pay for all food costs. (iv) No commission is payable for direct booking of plane by Travel India.

On purely financial consideration, should ABC Airways accept the offer from Travel India?

PROBLEM 57 :

Entertain U Ltd. hires an air-conditioned theatre to stage plays on weekend evenings. One play is staged per evening. The following are the seating arrangements:

VIP rows – the first 3 rows of 30 seats per row, priced at ₹320 per seat.

Middle level – the next 18 rows of 20 seats per row priced at ₹220 per seat.

Last level – 6 rows of 30 seats per row priced at ₹120 per seat.

For each evening a drama troupe has to be hired at ₹71,000, rent has to be paid for the theatre at ₹14,000 per evening and air conditioning and other stage arrangement charges work out to ₹7,400 per evening. Every time a play is staged, the drama troupe's friends and guests occupy the first row of the VIP class, free of charge, by virtue of passes granted to these guests. The troupe ensures that 50% of the remaining seats of the VIP class and 50% of the seats of the other two classes are sold to outsiders in advance and the money is passed on to Entertain U.

The troupe also finds for every evening, a sponsor who puts up his advertisement banner near the stage and pays Entertain U a sum of ₹9,000 per evening. Entertain U supplies snacks during interval free of charge to all the guests in the hall, including the VIP free guests. The snacks cost Entertain U ₹20 per person. Entertain U sells the remaining tickets and observes that for every one seat demanded from the last level, there are 3 seats demanded from the middle level and 1 seat demanded from the VIP level. You may assume that in case any level is filled, the visitor buy the next higher or lower level, subject to availability.

(i) You are required to calculate the number of seats that Entertain U has to sell in order to break-even and give the category wise total seat occupancy at BEP.

(ii) Instead of the given pattern of demand, if Entertain U finds that the demand for VIP, Middle and Last level is in the ratio 2 : 2 : 5, how many seats in each category will Entertain U have to sell in order to break-even?

Use of Quantitative Techniques in Decision Making - LPP

In this section, we are going to study the use of QT in solving the decision making problems. We can use either Linear Programming Technique (LPP) or Learning Curve Theory to tackle some of the questions of business decision making. In fact, your syllabus covers only these two techniques of QT. Let's first deal with LPP Technique:

Introduction :

Linear programming is an optimization method applicable for the solution of problems in which the objective function and the constraints appear as linear functions of the decision variables. The constraint equations in linear programming problem may be in the form of equalities or inequalities. Linear programming is a powerful and widely used mathematical technique for determining the optimum allocation of resources and obtaining a particular objective when there is alternative use of resources. The technique of linear programming is applicable to problems in which the total effectiveness can be expressed as a linear function of individual allocations and the limitations on resources give rise to linear equalities/inequalities of the individual allocations.

The linear programming problem has two basic parts:

i) **Objective function,** which describes the primary purpose of the formulation i.e. either maximization or minimization and

ii) **Constraint set,** which are the inequalities and/or equalities, which describe the restrictions under which optimization, is to be accomplished.

For solution of a linear programming problem-

i) Find formulation (i.e. objective function + constraints)

ii) Find optimum solution either by :

a. Graphical method (for only 2 variables) OR

b. Simplex method (for 3 or more variables) – it is not covered in your syllabus.

Steps for solving a Question by Graphical Method :

- First covert the data into LPP model i.e. Formulation of question.
- Convert linear inequalities into liner equalities and find the co-ordinates x & y.
- Draw the lines on Graph Paper using above co-ordinates.
- Find out common feasible area and identify the corner points.
- Calculate value of Z for corner points and take a decision.

PROBLEM 58 :

A Company manufactures two products namely A and B. the contribution per kg. of output is Rs. 240 and Rs.140 respectively for products A and B. The total fixed costs amount to Rs.1200 per week. The production of two products is restricted by limited supplies of three items of raw materials namely P, Q, R. The quantities of P,Q and R which are necessary to produce single unit of the products A and B together with the total stock of materials available each week are given below :

Raw materials	A	B	Total quantity available per week
P	16	20	160
Q	10	25	150
R	4	0	32

Using the graphical approach, calculate the maximum profit per week.

PROBLEM 59 :

A manufacturing company produces two types of products, the REGULAR and SUPER. Resources required for production are given in the table below. The hours available per week are : 1600 hours of assembly time, 700 hours of paint time and 300 hours of inspection time. Regular customers demand at least 150 units of REGULAR and 90 units of SUPER type.

Product	Profit ₹ p.u.	Assembly Time Hrs.	Paint Time Hrs.	Inspection Time Hrs.
REGULAR	50	1.2	0.8	0.2
SUPER	75	1.6	0.9	0.2

SOLVE the linear programming problem to determine product mix on a weekly basis.

PROBLEM 60 :

A dealer wishes to purchase a number of fans and sewing machines. He has only Rs. 57,600 to invest and has space for maximum 20 items. A fan costs him Rs. 3,600 and a sewing machine Rs. 2,400. He can sell a fan at a profit of Rs. 220 p.u. and sewing machine at a profit of Rs.180 p.u. Assuming that he can sell all the items which he buys, how should he invest his money in order to maximize his profit? Formulate this problem as a linear programming problem and then use graphical method to solve it.

PROBLEM 61 :

A company manufactures two products A and B, involving three departments – Machining, Fabrication and Assembly. The process time, profit/unit and total capacity of each department is given in the following table :

Product	Machining (Hours)	Fabrication (hours)	Assembly (Hours)	Profit p.u. (₹)
A	1	5	3	80
B	2	4	1	100
Capacity	720	1800	900	

Set up a Linear Programming problem to maximize profits. What will be the product-mix at maximum profit level? What will be the profit?

PROBLEM 62 :

Please find the following information in respect of an engineering company.

Products	**A**	**B**
Raw Material per unit (kg.)	10	6
Labour hours per unit	15	20
Sales price per unit (Rs.)	225	202
Maximum sales demand (units)	6,000	4,000

80,000 kg. raw material is available @ Rs. 10 per kg.

Maximum available labour hours are 1,50,000 @ Rs. 5 per hour.

Overheads are ignored for the purpose of this question.

Required :

(i) What is the product mix which will give the highest profit attainable?

(ii) Calculate such profit also using LPP technique.

Use of Quantitative Techniques in Decision Making – Learning Curve Theory

Introduction :

Learning is a process by which an individual acquires skill, knowledge and ability. When a new product or process is started, performance of worker is not at its best and learning phenomenon takes place. As the experience is gained, the performance of the worker improves, time taken per unit reduces and thus his productivity goes up. This improvement in productivity of worker is due to learning effect.

Learning curve is a geometric progression, which reveals that there is steadily decreasing cost for the accomplishment of a given repetitive operations, as identical operation is increasingly repeated. It is also known as Experience Curve.

Note : This theory was advocated by Mr. T. P. Wright.

There are two approaches to solve the questions :

(a) Doubling Approach and

(b) Formula Approach

Doubling approach says that the average time or cost required to produce one unit reduces by a fixed percentage, every time the output is doubled. The same phenomena is also expressed in a formula pattern as given below.

FORMULAE :

$$\text{Learning curve ratio} = \frac{\text{Average labour time/cost of first 2N units}}{\text{Average labour time/cost of first N units}}$$

This ratio is also known as Practice Curve, Experience Curve, Time Curve etc.

$\mathbf{y = a * X^b}$

Where, X = Cumulative no. of units / lots produced.

y = Average unit cost/time of first x units / lots.

a = Average time/cost of first unit / lot.

b = Learning coefficient = [log LCR / log 2].

Important Note for Students :

ICAI doesn't provide log tables or antilog tables in the exam hall. Hence, it provides the readymade values of log and antilog in the question itself.

Similarly, to calculate value of 'b' i.e. learning coefficient or also called as index, you need to calculate value of log LCR and log 2. But, in absence of log table, we cannot calculate it. Hence, it is provided to us in the question itself.

PROBLEM 63 :

The first unit of a new product launched by a company took 100 minutes of labour time. The workers experience a learning ratio of 80%. Please show the total time needed, average time per unit and incremental time required to produce first 64 units, using doubling approach. Show the above calculations for all the units in the series of doubling approach.

PROBLEM 64 :

In XYZ Ltd. the first item of new product took 100 hours to make. It is observed that total time required to make two units is 190 hrs. Find out Learning curve Ratio?

PROBLEM 65 :

A student has four homework problems in learning curves. She needed 50 minutes to solve the first one, and her learning curve ratio is 70%. As she is about to start doing the problems, a friend calls and asks her to get ready to go to the movie after 2 hours. Will she complete her homework within 2 hours?

PROBLEM 66 :

A company which has developed a new machine has observed that the time taken to manufacture the first machine is 600 hours. Calculate the time which the company will take to manufacture the second machine if the actual learning curve rate is (i) 80% and (ii) 90%. Explain which of the two learning rates will show faster learning.

PROBLEM 67 :

XYZ & Co. has given the following data:

80% Average – Time curve

Cumulative units (x)	Average hours	Total hours	Marginal hours
1	100	100	100
2	80	160	60
3	?	?	?
4	64	256	?

Required : Fill in the blanks.

You may use the following information :

Index at 80% LCR = - 0.322

Log 2 = 0.3010 Log 3 = 0.4771

Antilog 1.8464 = 70.21 Antilog 1.6484 = 44.50

PROBLEM 68 :

H. Ltd. has produced it's first 10 units of product B. The customer is enquiring about the cost of further 30 units of product B. The total cost of original 10 units was:

Direct materials	: Rs. 3,000
Direct Labour	: Rs. 5,000 (500 hrs. @ Rs.10)
Variable overheads	: Rs. 1,000 (proportionate to direct labour)
Other overheads	: Rs. 1,000 (20% of direct labour cost)
Machine tool costs	: Rs. 2,000 (All costs recovered in first order)

Use 80% Learning curve to estimate the total costs for a new batch of 30 units of product B.

PROBLEM 69 :

Illustrate the use of learning curves for calculating the expected average unit cost of making, (a) 4 machines; (b) 8 machines using the data below:

Direct labour needed to make first machine = 1,000 hours

Learning curve = 90%

Direct labour cost = Rs. 15 per hour

Direct material cost = Rs. 1,50,000

Fixed cost for either size orders = Rs. 60,000

PROBLEM 70 :

Customer has asked your company to prepare a bid on supplying 800 units of a new product. Production will be in batches of 100 units. You estimate that for the first batch of the 100 units the labour cost will average Rs. 100 a unit. You also expect that 90% learning curve will apply to cumulative labour cost on this contract.

You may use the following information :

Index at 90% LCR = - 0.1522

Log 2 = 0.3010 Log 3 = 0.4771

Antilog 3.85477 = 7,158 Antilog 4.14523 = 13,970

Required :

(a) Prepare an estimate of labour costs of fulfilling this contract.

(b) Estimate the incremental labour cost of extending the production run to produce an additional 800 units

(c) Estimate the incremental labour cost of extending the production run from 800 units to 900 units.

PROBLEM 71 :

A Company has 10 direct workers to work for 25 days a month of 8 hours per day. The estimated downtime is 25% of the total available time. The company receives an order of new product. The first unit of new product requires 40 direct labour hours to manufacture the product. The company expects 80% (index is – 0.322) learning curve for this type of work. The company uses standard absorption costing and the cost data are as under:

Direct materials	Rs. 60 per unit
Direct labour	Rs. 6 per direct labour hour
Variable overheads	Rs. 1 per direct labour hour
Fixed overheads	Rs. 7,500 per month

You may use the following information :

Log 2 = 0.3010 Log 3 = 0.4771 Log 4 = 0.6021 Log 5 = 0.6990

Antilog 1.055 = 11.35 Antilog 1.1265 = 13.39

Required:

i. Calculate the cost per unit of first order of 30 units.

ii. If the company receives a repeat order of 20 units, what price will be quoted to yield a profit of 25% on selling price?

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7 PRICING DECISION

Introduction :

- A pricing decision is one of the most crucial & difficult decision that a firm has to make.
- Such a decision affects the long term life of any profit oriented enterprise.
- Accounting information is often an important input to pricing decisions.
- Most firms needs to make decision about setting or accepting selling prices for their products or services.
- In some firms selling prices are derived directly from cost information by estimating future product cost and adding a suitable profit margin. In others, an established market price is accepted.
- Fundamentally, in pricing decision, the management must first decide on its pricing goal and then set the base price for goods or services.
- After this the firm may design its pricing strategies.
- In this chapter we are going to discuss pricing methods of a finished product or services and the various types of pricing strategies used by business world.

Methods of Pricing

Costs, demand and competition define the different pricing methods that a firm may adopt. Let's understand these methods. Pricing methods may be broadly classified into 3 categories and then each one can be further classified into sub-categories as follows:

(1) Cost Based Pricing Methods

(a) Cost Plus Pricing

(b) Rate of Return Pricing

(c) Variable Cost Pricing

(2) Value Based Pricing Methods

(a) True Economic Value

(b) Perceived Value

(3) Competition Based Pricing Methods

(a) Going Rate Pricing

(b) Sealed Bid Pricing

Let's discuss each one of them into more details:

(1) Cost Based Pricing Methods:

(a) Cost plus pricing :

In many businesses the common method of price determination is to estimate the cost of product & fix a margin of profit. This may appear contrary to economist's views of the price fixation, which is based on demand and supply position. The term 'cost' here means full cost at current output and wage levels. Full costs are regarded as most relevant in price setting.

A manufacturer having several factories all over the country may determine the weighted average cost of each of the factories and include the same in his computations so as to arrive at a uniform ex-factory price for the country as a whole. In order to frame a price policy, one of the elements that should receive consideration is the determination of normal capacity. Normal capacity is the utilisation of plant that is necessary to meet the average commercial demand over a period of time, long enough to level out peaks which come with seasonal and cyclical variations.

Price determination should normally be based on the level of production and capacity utilisation likely to be achieved. Any assumption of low utilisation may result in over estimation the cost. Conversely, a high utilisation assumption may result in under estimating the cost. It is, therefore, desirable that the level of production and capacity utilisation which are likely to apply, say in the next three years should be arrived at with utmost care on realistic basis keeping in view not only the past performance but also the future demand.

If a firm wants to survive and stay in business, it has to maintain its fixed capital intact so that its fixed assets may be replaced at the end of their useful working life out of the funds generated from profits retained in the business so that the productive capacity of the plant may remain unimpaired. In a period of relatively stable price levels, depreciation based on historical cost of fixed assets would perhaps be adequate for achieving this objective. In the periods of inflation, when price levels are continuously changing, the firm may not be left with adequate funds generated out of accumulated depreciation at the end of the life of the plant to replace the plant at a higher price.

Advantages of Cost Plus Pricing :

- It is a fair method of price fixation. The business executives are convinced that the prices fixed will cover the entire cost.
- If price is greater than cost, the risk is covered. This is true when normal expected capacity basis of cost estimation is used.
- A decision maker has to take decisions in the face of many uncertainties. He may accept a pricing formula that seems reasonable for reducing uncertainty.
- This sort of pricing does not mean that market forces are ignored. The mark up added to the cost to make a price reflect the well established customs of trade which guides the price fixed towards a competitive price.

Disadvantages of Cost Plus Pricing :

- It ignores demand, it fails to take into account the buyer's needs and willingness to pay which govern the sales volume obtainable at each series of prices.
- It fails to reflect competition adequately.
- It takes for granted that the costs have been estimated with exact accuracy, which is not often true, particularly in multi-product firms, because common costs are allocated arbitrarily.
- For many decisions, incremental costs rather than full costs plays a vital role in pricing. This aspect is ignored.

- Since the fixed overheads are apportioned on the basis of volume of production, the cost will be more if a sales volume is less and cost will be less if sales volume is more. The increase or decrease in sales volume again is dependent on prices. Thus it is a vicious circle. Cost plus mark up is price based on sales volume and sales volume is based on price.

(b) Rate of Return Pricing :

Determination of return on capital employed is one of the most crucial aspect of price fixation process. In this process instead of arbitrarily adding a percentage on cost for profit, the firm determines an average mark up on cost necessary to produce a desired rate of return on its investment. Under this method, the following three factors are considered:

- The basis on which the capital employed is computed.
- Items to be covered in the return on capital. For example, operating cost, depreciation, interest, tax etc.
- What rate of return can be regarded as fair? The rate of return to be earned by the firm must depend on the risk involved.

(c) Variable Cost Pricing :

We have seen a number of decisions based on variable or marginal costing principles in the chapter of Marginal Costing. Pricing based on full cost plus is subjected to following two limitations:

- The allocation of inter-departmental overheads is based on an arbitrary basis; and
- The allocation of overheads will require estimation of normal output which often cannot be done precisely.

In order to avoid these complications, variable costs which are considered as relevant costs are used for pricing, by adding a mark up so as to include fixed costs allocation as well as profit margin also.

(2) Value Based Pricing Methods:

There is an increasing trend to price the product on the basis of customer's perception of its value. Value is the benefit or utility received by a customer when he purchases a product or service. Value perceived by the customer may differ from one customer to another. Sometimes, the value received by the same customer may differ from one situation to another. Hence, value perceived by the customer is an opinion of the customer, which may be differ from time to time or situation to situation. Hence, it is very difficult to quantify it in monetary terms.

For example – two customers 'A' and 'B' want to buy a car for the purpose of going to their respective offices. Customer 'A' purchases a Maruti Alto Car of Rs. 5 lakh and Customer 'B' purchases a BMW Luxury Car of Rs. 70 lakhs. The utility or purpose of both the cars (i.e. travelling) is same and fulfilled. But one is buying an entry level car and another is buying a top end luxury car. In case of Customer 'B', the extra price which he is paying is the value of satisfying his ego. It is very difficult to analyse and quantify. However, there are two commonly used methods based on value as follows:

(a) **True Economic Value:**

This is a measure of benefits that a product is intended to deliver to the customer in relation to the other product. It is calculated without giving any regard, whether customer can recognise these benefits or not. True economic value is calculated taking into account two considerations as explained below:

TEV = Cost of the next best alternative + Value of performance differential

Cost of the next best alternative is the cost of a comparable product offered by some other company. Value of performance differential is the value of additional features or utilities provided by the seller of a product. A firm's product may be superior to the next best alternative in some dimensions but inferior in others. We need to do both these adjustments as plus and minus, to arrive at TEV.

Question 1 :

A customer wants to buy a computer system for a single year (after which it will be scrapped) and he plans to use it for 2,500 hours in a year. The following are the details of our computer system 'Y' and the next best system 'X'.

Particulars	System 'X'	System 'Y'
Operating cost per hour	₹ 5.00	₹ 7.50
Probability of System Crash	10%	0.5%
Price	₹ 37,500	?

Find out TEV of our computer system 'Y' if the cost of system crash to the buyer is ₹ 1,00,000.

Solution 1 :

Particulars	**₹**
Price of the next best alternative 'X'	37,500
Add : Saving in the cost of system crash [1,00,000 x (10% - 0.5%)]	9,500
Less : Extra cost of operating system 'Y' [2,500 hours x (7.50 – 5.00)]	6,250
∴ Total Economic Value (TEV)	40,750

(b) Perceived Value:

This is the value that customer understand which will be delivered to him, when he purchases a product or service. It is that price of a product, which a consumer is willing to spend to have that product.

At the time of fixing the sales price of a product, it is to be kept in mind that any price which is set below the perceived value but above our cost of goods sold will benefit both the buyer and the seller as well. The buyer will receive more perceived value than the purchase price which he is paying and the seller will receive more price than the cost of goods sold, thereby making a profit on his transaction. This can be understood with the help of following example.

Illustration on TEV :

Let's consider that a student of CA Final wants to buy video lecture of Strategic Cost Management subject in pen drive mode from the online store www.carakeshagrawal.in. The selling price of this product on the store is ₹ 16,000 and the fees of live batch of CA Rakesh Agrawal is say ₹ 14,000. Then let's calculate the True Economic Value, Perceived Value, Benefit to the buyer and Benefit to the seller of pen drive product.

Particulars	₹	₹
(a) Cost of Product to the Seller:		
Cost of pen drive	2,000	
Cost of printed study material	500	
Proportionate cost of recording the lectures	2,500	
Proportionate cost of editing and encryption	1,500	
Cost of packing material and courier	300	
Fees payable to technical support team	500	
Royalty payable to the author / teacher for IPR	2,000	
Selling, marketing & distribution expenses	1,200	
Administration, enquiry and other support cost	600	
GST payable to Government	2,400	13,500
(b) MRP of the product on online store		16,000
(c) Net benefit to the seller (b – a)		2,500
(d) Perceived value of the buyer due to convenience and a chance of revision and home comfort etc. (in his opinion)		20,000
(e) Net perceived benefit to the buyer (d – b)		4,000
(f) True Economic Value (TEV):		
Price of the competing product i.e. live batch fees	14,000	
Add : Value of extra views provided for revision purpose [14,000 x 50%]	7,000	
Add : Saving in travelling cost [80 days x ₹ 100 per day]	8,000	
Add : Saving in travelling time [80 hours x ₹ 50 per hour]	4,000	
Add : Benefit of not missing a single lecture	2,000	
Add : Value of empty pen drive to be used for storage	2,000	
Less : Loss due to insincerity and irregular studies	(6,000)	31,000
(g) Actual economical benefit to the buyer (f – b)		15,000

Notes :

- TEV is generally greater than the perceived value by the buyer.
- Perceived value is always greater than the purchase price of the buyer.
- Sales price of seller should be generally higher than the cost price.

Process of creating value for customer:

Creating value for the customers is one of the most important objectives of a firm. A firm makes all the efforts to create value and to achieve this, it formulates its marketing strategy in that direction. Understanding customers' wants and needs is foundation for building this value. To create value, a firm makes the following marketing strategies:

- First it develops a product that satisfy the wants and needs of the customers.
- After identification and development, it designs a promotion program to convey the value of the product to the customers.
- It chooses the right distribution channel through which its product will reach to the customers.
- At last it has to design a pricing strategy that creates incentive to purchaser to buy the product and to seller to sell the product.

(3) Competition Based Pricing Methods :

When a company sets its price mainly on the consideration of what its competitors are charging, its pricing policy under such a situation is called competitive pricing or competition-oriented pricing. It is not necessary under competitive pricing to charge the same price as charged by the concern's competitors. But under such a pricing the concern may keep its prices lower or higher than its competitors by a certain percentage.

Competitive price so determined does not maintain a rigid relation between its price, cost or demand. Its own costs or demand may change, but the concern maintains its price because its competitors maintain their prices. Conversely, the concern will change its price when its competitors change their price, even if its own costs or demand have not altered. e.g. mobile service rates, airline industry, teaching industry, interest rates on housing loans, etc. Competitive pricing may be of the following two types -

(a) Going Rate Pricing :

It is the average price charged by other competitors in the same industry. Neither too high or too low as compared to the competitors. This pricing policy allows everyone to earn a reasonable profit margin.

Going rate pricing is primarily used in **homogeneous product** markets. The concern selling a homogeneous product in a highly competitive market has actually very little choice about setting its own price. Going rate price is determined by the collective market forces of demand and supply. The concern which is going to charge more than the going rate would attract virtually no customers. One can charge more than the going rate, only if the seller can differentiate between his product and other competing products.

Thus, under highly competitive conditions in a homogeneous product market (such as food, raw materials and textiles) the concern really has no pricing decision to make. The major challenge before such a concern is good cost control.

(b) Sealed Bid Pricing :

Competitive pricing also dominates in those situations where firms compete on the basis of bids, such as original equipment manufacturer and defense contract work. The bid is the firms offer price, and it is a prime example of pricing based on expectations of how competitors will price rather than on a rigid relation based on the concern's own costs or demand. The objective of the firm in the bidding situation is to get the contract, and this means that it hopes to set its price lower than that set by any of the other bidding firms. But however, the firm does not ordinarily set its price below a certain level. Even when it is anxious to get a contract in order to keep the plant busy, it cannot quote price below marginal cost. On the other hand, if it raises its price above marginal cost, it increases its potential profit but reduces its chance of getting the contract.

PROBLEM NO. 2 :

Prompt Printers Ltd., uses a scheme of pricing based on cost plus. All the overheads are charged, based on direct labour and based on the total cost arrived at, the selling price is fixed.

The following figures are obtained from the Annual Budget for 2018 prepared by the company:

Particulars	Rs.
Sales	10,00,000
Direct material	1,80,000
Direct labour	3,20,000
Factory superintendent's salary	30,000
Commission paid on sales (5%)	50,000
Foreman's salaries	60,000
Insurance	10,000
Advertisement	20,000
Depreciation on assets	30,000
Administration expenses	90,000
Variable factory costs :	
Repairs and maintenance	60,000
Tools consumed	40,000
Miscellaneous supplies	10,000

The company has submitted a tender quoting Rs. 10,000 on a large order with a cost of Rs. 1,800 Direct materials and Rs. 3,200 Direct labour. The customer strikes the business at Rs. 8,900 on a 'take it or leave it' basis. If the company accepts the order, the total sales for 2018 would be Rs. 10,08,900. The company is reluctant to accept the order as it would be against its policy of accepting an order below cost.

Write a note to the Managing Director, recommending the acceptance of the order, substantiating your recommendation fully with supporting figures to explain that the price offered would not be below cost and a sizeable profit also would be made. Also comment on the pricing policy of the company.

PROBLEM NO. 3 :

Sellaway Ltd. manufactures and markets 2 products A and B, the demand in the market of which fluctuates with the prices quoted. As a result of the deliberations of its recent Sales Conference the following data was agreed upon as a working basis :-

Particulars	PRODUCT A			PRODUCT B		
Selling price per unit (Rs.)	32	30	28	22	20	18
Expected demand per month (Nos).	900	1,000	1,500	1,600	2,000	3,000

8 labour hours are required to produce product A and 4 labour hours to produce product B and the maximum capacity of the factory is restricted to 20,000 labour hours per month. The cost structure is as under per unit of production:-

Particulars	A (Rs.)	B (Rs.)
Direct Material	4	3
Direct Labour	6	5
Variable Overheads	6	10

Fixed Overheads are Rs. 32,400 per quarter.

You are required to compute a proper price mix for maximum profitability.

Also calculate such profit per month.

PROBLEM NO. 4 :

A firm furnishes the following information :

Capacity in Units	Unit Cost Rs.	Unit Price Rs.
2,000	40	100
3,000	35	95
4,000	34	94
5,000	32	--
6,000	31	--

At present the firm is operating at 4,000 units capacity and has received an order for 2,000 units from an export market at Rs. 28 per unit. Should the order be accepted?

PROBLEM NO. 5 :

Determine the selling price per unit to earn a return of 12% on capital employed (Net of Tax @ 40%). The cost of production and sales of 80,000 units per annum are :

Material	Rs. 4,80,000	Labour	Rs. 1,60,000
Variable overhead	Rs. 3,20,000	Fixed overhead	Rs. 5,00,000

The fixed portion of capital employed is Rs. 12 lacs and the varying portion is 50% of sales turnover.

PROBLEM NO. 6 :

Electromatic Excellers Ltd. specialises in the manufacture of novel transistors. They have recently developed a technology to design a new radio transistor, capable to being used as an emergency lamp also. They are quite confident of selling all of the 8,000 units that they would be making in a year. The capital equipment that would be required will cost Rs. 25 lakhs. It will have an economic life of 4 years and no significant terminal salvage value.

During each of the first four years, promotional expenses are planned as under:

Year	1	2	3	4
Advertisement (Rs.)	1,00,000	75,000	60,000	30,000
Other exps. (Rs.)	50,000	75,000	90,000	1,20,000

Variable costs of producing and selling the unit would be Rs. 250 per unit. Additional fixed operating costs incurred because of this new product are budgeted at Rs. 75,000 per year.

The company's profit goals call for a discounted rate of return of 15% after taxes on investments in new products. The income tax rate on an average works out to be 40%. You can assume that the straight line method of depreciation will be used for tax and reporting.

Work out an initial selling price per unit of the product that may be fixed for obtaining the desired rate of return on investment.

Present value of annuity of Re. 1 received or paid in a steady stream throughout 4 years in the future at 15% is 2.855.

PROBLEM NO. 7 : [ICAI Module]

The budgeted cost data of a product manufactured by Ayudhya Ltd. is furnished as below:

Budgeted units to be produced	2,00,000
Variable cost (₹)	32 per unit
Total Fixed cost (₹)	16 lacs

It is proposed to adopt cost plus pricing approach with a mark-up of 25% on full budgeted cost basis.

However, research by the marketing department indicates that demand of the product in the market is price sensitive. The likely market responses are as follows:

Selling price (₹ per unit)	44	48	50	56	60
Annual Demand (units)	1,68,000	1,52,000	1,40,000	1,28,000	1,08,000

Required :

ANALYSE the above situation and DETERMINE the best course of action.

The basic approach in most of the micro-economic theory (theory of the individual firm and its relation to other firms) defines the term optimum price as that price which yields the maximum profits (excess of total revenues over total costs).

Thus, the basic assumption of the pricing theory is that the firm's main objective is to maximise its profits. It also assumes that the firm takes into consideration the position of demand and cost functions and that the firm produces one product.

If a firm sells unlimited number of units, the total revenue line will be a **straight line** arrived at by

TR = mx (linear function)

Where,

TR = Total revenue line

m = quantity of units sold

x = price per unit.

Let's consider the following example of linear sales and cost function :

PROBLEM NO. 8 :

Sunshine Ltd. sales its product at a selling price of Rs. 100 per unit. It has a variable cost of Rs. 60 per unit. Total fixed cost is Rs. 40,000 per annum.

Present the above data in a graphical manner and ascertain BEP of the product.

Space for BEP Graph (Linear Function)

Non Linear Function :

However, in most of the market situations, additional units can be sold by reducing the price. This means that although the total sales revenue will increase as more and more units are sold, the increase in total revenue will decline gradually as sales increases. Then the revenue function becomes non-linear and the revenue line is not a straight line, but is represented by a curve. Let's consider the following example:

PROBLEM NO. 9 :

Chun Moon Ltd. is about to introduce a new product with the following estimates :

Price per unit (in rupees)	Demand (in '000 units)
39.00	240
37.50	280
36.00	315
34.50	340
33.00	360
31.50	380
30.00	400

Costs :

Direct material	Rs. 12 per unit
Direct labour	Rs. 3 per unit
Variable overhead	Rs. 3 per unit
Selling expenses	10% on sales
Fixed production overheads	Rs. 14,40,000
Administration expenses	Rs. 10,80,000

Judging from the estimates, determine the tentative price of the new product to earn maximum profit.

The above data can be graphically presented as follows.

Space for Non-Linear Graph

The reduction in the sales price per unit reflects a gradual reduction in the steepness of the total revenue curve as shown in the above figure. The total cost curve will however, register an increase in the steepness because as the volume increases, the cost also increases.

At point Q, the gap between the total cost line and total revenue is the maximum, thus Q is the point of optimum volume. Any attempt to increase the volume beyond this point will reduce the profit because the incremental cost will be more than the incremental revenue.

Profit Maximisation Model

Pricing model is a mathematical model which uses economic theory of pricing.

(i) As per economic theory of pricing, Profit is Maximum at a level of output where Marginal Revenue (MR) is equal to Marginal Cost (MC) i.e.

Marginal Revenue (MR) = Marginal Cost (MC)

This model determines the level of production up to which production can be continued.

(ii) The Basic Price equation, which is used to determine the Price where Profit is Maximum, is written as:

$P = a - bQ$

Where, P = Price where the profit is maximum

b = Slope of the Demand Curve, Calculated as

b = Change in Price / Change in Quantity

Q = Quantity Demanded

a = Price at Which Demand is Zero

(iii) The Marginal Revenue (Incremental revenue) equation is written as

Marginal Revenue (MR) = $a - 2bQ$

Question 10 : [ICAI Module]

Aditya Heavy Engineering Ltd. (AHEL) produces its only product 'A'. To manufacture a unit of 'A', variable cost of ₹ 2,20,000 is incurred. Market research has indicated that at a selling price of ₹ 5,10,000 no order will be received. But the demand for 'A' will be increased by two units with every ₹ 5,000 reduction in the unit selling price below ₹ 5,10,000.

You have to determine the unit selling price for 'A' that will maximize the profit of AHEL.

Solution 10 :

Let's assume that -

Selling Price per unit of 'A' is 'P', and Quantity demanded is 'Q'

The Marginal Cost i.e. variable cost of a unit of 'A' is ₹ 2,20,000

Price Equation for 'A'

$P = a - bQ$

$P = 5,10,000 - (5,000 / 2) \times Q$

$P = 5,10,000 - 2,500\ Q$

Marginal Revenue(MR) $= a - 2bQ$

$= 5,10,000 - 2 \times (5,000 / 2) \times Q$

$= 5,10,000 - 5,000\ Q$

Marginal Cost (MC) = 2,20,000 (i.e. variable cost)

Profit is Maximum where Marginal Revenue (MR) equals to Marginal Cost (MC)

Hence, $5,10,000 - 5,000\ Q = 2,20,000$

$5,10,000 - 2,20,000 = 5,000\ Q$

$Q = 58$ units

By Putting the Value of 'Q' in Price Equation, Value of 'P' is obtained as follows:

$P = 5,10,000 - 2,500\ Q$

$= 5,10,000 - 2,500 \times 58$ units

$= 3,65,000$

At Selling Price of ₹ 3,65,000 AHEL's Profit will be Maximum.

Crosscheck :

If we try to sell 59 units, then the selling price p.u. shall be = 3,65,000 – 2,500 = 3,62,500

Total sales revenue for 59 units shall be = 59 x 3,62,500 = 2,13,87,500

Total sales revenue for 58 units @ 3,65,000 shall be = 2,11,70,000

Marginal Revenue (MR) = 2,13,87,500 – 2,11,70,000 = 2,17,500

Marginal Cost (MC)= 2,20,000. Which is higher than the marginal revenue and hence, there is no marginal profit left further. We should stop at 58 units @ ₹ 3,65,000.

If we try to sell 57 units, then the selling price p.u. shall be = 3,65,000 + 2,500 = 3,67,500

Total sales revenue for 57 units shall be = 57 x 3,67,500 = 2,09,47,500

Marginal Revenue (MR) = 2,11,70,000 - 2,09,47,500 = 2,22,500

It means, if we move from 57 to 58 units, then incremental revenue is 2,22,500 and incremental cost is 2,20,000. It will lead to an incremental profit of Rs. 2,500.

Question 11 : [**Jan. 2021 Exam - 5** Marks]

Bharat Heavy Machinery Ltd produces engines for the cars. Variable cost per engine is ₹ 4,200. Market research has indicated that at a selling price of ₹ 7,400, no order will be received, but the demand for the engines will be increased by two units for every ₹ 400 reduction in the unit selling price below 7,400.

You are required to DETERMINE the unit selling price per engine that will maximize the profit of the company.

Answer 11 :

P	= a – bQ
	= 7,400 – (400/2) x Q = 7,400 - 200Q
Marginal Revenue (MR)	= a – 2bQ
	= 7,400 – 2 x (400/2) x Q
	= 7,400 – 400 Q
Marginal Cost (MC)	= 4,200

Profit is Maximum where Marginal Revenue (MR) equals to Marginal Cost (MC)

7,400 – 400 Q	= 4,200
Q	= **8 units**

By Putting the Value of 'Q' in Price Equation, Value of 'P' is obtained.

P	= 7,400 – 200Q
	= 7,400 – (200 x 8 units)
	= **₹ 5,800**

At Selling Price of ₹ 5,800 Profit will be Maximum.

Pricing Under Different Market Structures

The determination of optimal price can be considered under the following market structures, using the fundamental rule. The optimum price is one, where Marginal Revenue (MR) becomes equal to Marginal Cost (MC). However, the price elasticity of demand may vary under each of the market structures explained below:

(a) Monopoly :

It is a business situation which is characterised by :

(i) one seller of a particular goods or services and

(ii) competition from the producers of substitutes is almost insignificant.

Due to above characteristics, a monopolist can raise the price of its product without frightening away all his customers. How much he can raise from his customers, depends upon the elasticity of demand for his particular product. Under monopolistic condition, consumers may buy more at a lower price than at higher price. The profit can be maximised by equating marginal revenue with marginal cost.

(b) Monopolistic Competition :

It is a situation which arises after the Monopolistic trend. Here we will see that substitute firms who sell similar products enter the market and because of differentiation of products by sellers, monopolistic competition arises. The excess profits earned by monopolistic situation attracts new competitors. This will have a long-run effect on the excess profits, which will tend to diminish because of the price competition with close substitutes. The company will, however, have to compare marginal cost and marginal revenue in maximising its profits.

(c) Oligopoly :

If in a market there are a few large sellers occupying a major share of the market, the situation is called oligopoly. If the oligopolistic seller finds that his competitors also increase their prices with his decision to increase or decrease their prices with his decision to decrease, then his revenue curve will have the same shape as that of the market as a whole. If the competitors, however, do not follow suit, the shift in the sales will be sensitive. If one seller increases his price while the others do not, the consumers will start buying from the competitors and the sales of the seller who increased his price will start falling off. Thus each firm will study the potential reaction before increasing or decreasing the selling price.

(d) Perfect Competition :

Under this situation, there are large number of sellers selling a homogeneous product. Perfect competition allows free entry and exit of firms into and out of the industry.

Under pure competition a firm has no pricing policy of its own, as it has to accept the prevalent market price and at this price, it can sell all of its production if it so desires. But at any higher price it can sell nothing. There is no control over market price which will equate the quantities available with the quantities which the buyers are willing to buy. The firm has to take a decision in favour of the quantity to sell. The firm can continue to produce so long as its marginal cost is less than or equal to its selling price. Upto the point at which the marginal cost is equal to price, increase in output will add to profit and thereafter the increase will add to loss.

Non - Price Strategies:

Non – price competition is the favoured strategy for oligopolists, because price competition can lead to destructive price wars and won't help anyone. Hence, instead of reducing the sales price, one can adopt the following practices:

- Try to improve quality of goods and after sales services, offer extended warranty etc.
- Spend money on advertisement, sponsorships, product placements etc.
- Conduct special sales promotion campaigns like buy one get one free, festival offers and gifts, foreign tours, lucky draw schemes etc.
- Have a loyalty reward schemes, to retain the existing customers etc.

Pricing in the Periods of Recession:

In periods of recession, a firm may sell its articles at a price less than the total cost but above the marginal cost for a limited period.

The advantages of this practice are:

- The firm can continue to produce and use the services of skilled employees who are well trained and will be difficult to re-employ later if discharged.
- Plant and machinery can be prevented from deterioration through idleness.
- The business would be ready to take advantage of improved business conditions later.
- This strategy prevents you from the competition and the business is secured.

One thing to remember here is that a situation like this should not lead to a drastic price cutting and the orders accepted should not cover a long period extending over the production facilities of a period when business conditions improve.

Pricing Below Marginal Cost:

Firm may also be justifiable to sell the product at a price below marginal cost for a limited period, if the following conditions prevail:

- Where materials are of perishable nature.
- Where stocks have been accumulated in large quantities and the market prices have fallen. This will save the carrying cost of stocks.
- To popularize a new product. Example – Reliance Jio.
- Where such reduction enables the firm to boost the sales of other products having larger profit margin. Example – Inkjet printer and ink cartridge.

Strategic Pricing of New Products

The pricing of new product poses a bigger problem because of the uncertainty involved in the estimation of their demand. In order to overcome this difficulty experimental sales are conducted in different markets using different prices to see which price is suitable.

A company may, for example, choose three different markets and by using the same amount of sales promotional activities, ascertain what the right price is. In such circumstances, it may even prove that the highest price yielding the largest unit contributory margin need not necessarily maximise the profits. A lower price may well go to maximise the total profits. But at the same time if a product is priced very low to attract more demand, it may be difficult in the future to raise the price as it may not be acceptable to the consumers. So, pricing of a new product is very critical issue which should be decided after a thorough market study and consumer behavior analysis.

A new product is analysed into three categories for the purpose of pricing:

(1) Revolutionary Product :

A product is said to be revolutionary when it is new for the market and has the potential to create its own value. This type of product has revolutionary impact on the market and consumer behaviour. It replaces the existing method or technology and the approach to doing a work is quite different and unique. These products enjoy the benefit of product differentials and have the potential of being market leader.

Revolutionary product may enjoy the premium price as a reward for its innovation and taking first initiative.

(2) Evolutionary Product :

A product introduces upgraded version of revolutionary product, with few additional characteristics of the product is known as evolutionary product.

The evolutionary product may be priced taking cost-benefit analysis, competition, total demand in the market etc. Generally, it is priced a little above the revolutionary product, because it provides some more features and benefits over the earlier revolutionary product. This strategy is based on the principles of True Economic Value (TEV) pricing.

(3) Me - too Product :

A product is said to be me-too product when its emergence is a result of success of a revolutionary product. These types of products are very similar i.e. imitations of the revolutionary or evolutionary products of other firms. The firm while producing me-too products, generally follows the similar production process and technology that is used by the other firms. These are known as market followers.

Me – too products are price takers as the price is determined by the market mainly by the competitive forces. Hence, competitive pricing strategy is adopted to sell these products.

Market - Entry Strategies :

While preparing to enter the market with a new product, management must decide whether to adopt a skimming or penetration pricing strategy. These are -

a) Skimming Pricing :

It is a policy of high price during the early period of a product's existence. This can be synchronised with high promotional expenditure and in the later years the prices can be gradually reduced. The reasons for following such a policy are :-

1) The demand is likely to be **inelastic** in the earlier stages till the product is established in the market.
2) The charge of high price in the initial periods serves to skim the cream of the market that is relatively insensitive to price. The gradual reduction in price in the later years will tend to increase the sales, because by then the market starts responding to the change in price.
3) This method is preferred in the beginning because in the initial periods when the demand for the product is not known the prices covers the initial cost of production.
4) High initial capital outlays, needed for manufacturing result in high cost of production. Added to this, the manufacturer has to incur huge promotional expenses resulting in increased costs. High initial prices will be able to finance the cost of production particularly when uncertainties block the usual sources of capital.

b) Penetration Pricing :

This policy is in favour of using a low price as the principal instrument for penetrating mass market at an early stage and then slowly increasing the price. It is opposite to skimming price. The low price policy is introduced for the sake of long-term survival and profitability and hence it has to receive careful consideration before implementation. This needs an analysis of the scope for market expansion and hence considerable amount of research and forecasting are necessary before determining the price.

Penetrating pricing, means a pricing suitable for penetrating mass market as quickly as possible through lower price offers. This method is also used for pricing a new product. In order to popularise a new product penetrating pricing policy is used in initial stage. Later on, the price may be increased as and when the demand picks up. Penetrating pricing policy can also be adopted at any stage of the product life cycle for products whose market is approached with low initial price. The use of this policy by the existing concerns will discourage the new concerns to enter the market. This pricing policy is also known as "stay-out-pricing". The three circumstances in which penetrating pricing policy can be adopted are as under :

1. When demand of the product is **elastic** to price. In other words, the demand of the product increases when price is low.
2. When there are substantial savings on large scale production. Hence increase in demand is sustained by the adoption of low pricing policy.
3. When there is the threat of competition. The prices are fixed at such a low level that it acts as entry barrier to the prospective competitors.

PROBLEM NO. 12 :

6,000 pen drives of 2 GB to be sold in a perfectly competitive market to earn ₹ 1,06,000 profit, whereas in a monopoly market only 1,200 units are required to be sold to earn the same profit. The fixed costs for the period are ₹ 74,000. The contribution per unit in the monopoly market is as high as three fourth its variable cost. Determine the target selling price per unit under each market condition.

PROBLEM NO. 13 :

State the pricing strategy that you would advise in the following situations which are independent of each other:

(i) A new product is to be launched. It has had high promotional expenditure and its demand in the market is not known.

(ii) A new product is to be launched. It is to be mass manufactured and faces stiff competition.

(iii) A product which has an external market demand is to be transferred to another division of the same company. For the external market, variable selling costs of 10 per unit and fixed selling costs amounting to ₹10 lakhs p.a. are incurred. These costs are not applicable to divisional transfers. The divisional transfer can take up only 20% of the output produced.

(iv) A special one-time order for the use of idle capacity is offered. This order will not impact the existing sales of the company. The product has competition in the market.

(v) There is stock of a discontinued product. It has severe competition and the product is perishable.

PROBLEM NO. 14 :

State the pricing policy most suitable in each of the following independent situations:

(i) The company makes original equipments and does defence contract work. There are other companies which also undertake such projects.

(ii) The product made by a company is new to the market. It is expected to enjoy a long-term demand. Competition is expected very soon, since the product will be desirable to most customers.

(iii) Stock of processed ready-to-eat products, whose shelf-life will soon be over in the next 2 months. The product is going to be discontinued.

(iv) A company sells a homogeneous product in a highly competitive market.

PROBLEM NO. 15 :

State the appropriate pricing policy in each of the following independent situations :

(i) 'A' is a new product for the company and the market and meant for large scale production and long term survival in the market. Demand is expected to be elastic.

(ii) 'B' is a new product for the company, but not for the market. B's success is crucial for the company's survival in the long term.

(iii) 'C' is a new product to the company and the market. It has an inelastic market. There needs to be an assured profit to cover high initial costs and the usual sources of capital has uncertainties blocking them.

(iv) 'D' is a perishable item, with more than 80% of its shelf life over.

PROBLEM NO. 16 : [Nov. 2020 Exam]

State the most appropriate pricing policy to be adopted in the following independent situations :

(Situations need not be copied. Only policy name is required.)

(i) The company manufactures original equipment and does railways contract work. Other companies are also there in the market who also undertake similar projects.

(ii) Patented Drug for Covid 19 is ready to be launched in the market.

(iii) A bike manufacturer is launching an innovative, technologically advanced bike in the highly priced segment.

(iv) A company making a variant of sanitizers, trying to enter the market. The same varieties of sanitizers are already successfully capturing the market.

(v) A successful mobile manufacturing company has built into it's latest tablet, an additional sliding screen and improved processing capabilities so that the tablet is almost a laptop.

Question 17 - [May 2019 Exam]

(i) Name any two competition-based pricing methods. **(2 Marks)**

(ii) RECOMMEND the Pricing Strategy to be adopted with reference to the following situations. You are not required to explain the reasons for your answer.

a. Star Coffee Shop follows the practice of keeping the price of its coffee or service artificially high in order to encourage favourable perceptions among buyers, based solely on the price.
b. Sky TV gave away their satellite dishes for free in order to set up a market for them.
c. Princeton Hotels Ltd. follows a competitive pricing method under which it tries to keep its price at an average level charged by the Industry.
d. Eddisson Enterprises has piled up stocks in large quantities and the market price has fallen.
e. Aqua LLP follows a new product pricing strategy through which company makes profitable sales by selling out few units.
f. X Ltd. produces Product X a revolutionary product and as a reward for innovation and for taking first initiative which pricing strategy should X Ltd. adopt?
g. An established company has recently entered the stationery market segment and launched quality paper for printing at home and office.
h. D is a perishable item, with more than 80% of its shelf life is over. **(1 x 8 = 8 Marks)**

Answer 17 :

(i) Competition Based Pricing Methods – Going Rate Pricing and Sealed Bid Pricing

(ii)
a. Premium Pricing
b. Penetration Pricing
c. Going Rate Pricing
d. Pricing Below Marginal Cost
e. Skimming Pricing
f. Premium Pricing
g. Market Price
h. Any Cash Realizable Value

Question 18 : [Nov. 2018 Exam]

Sun Chemicals Co., is engaged in manufacturing many chemical products. It is using many chemicals, some of which are fast moving, some are slow moving and few are in non-moving category. The company has a stock of 10 units of one non-moving toxic chemical. Its book value is ₹ 2,400; realisable value is ₹ 3,500 and replacement cost is ₹ 4,200.

One of the customers of the company asks to supply 10 units of a product which needs all the 10 units of the non-moving chemical as an input. The other costs associated with the production of the product are :

Allocated overhead expenses ₹ 16 per unit

Out of pocket expenses ₹ 50 per unit

Labour cost ₹ 40 per hour. For each unit two hours are required.

Other material cost ₹ 80 per unit.

The labour force required for the production of the product will be deployed from among the permanent employees of the company. This temporary deployment will not lead to any loss of contribution.

Required :

(i) Recommend the minimum unit price to be charged to the customer without any loss to the company. [4 Marks]

(ii) Analyse with reasons for the inclusion or exclusion of each of the cost associated with the production of the product. [4 Marks]

(iii) Advice a pricing policy to be followed by Sun Chemical in perfect competition. [2 Marks]

Solution 18 :

(i) Calculation of Minimum Price :

Particulars	₹
(a) Realizable value of non moving chemical	3,500
(b) Out of pocket expenses [50 per unit x 10 units]	500
(c) Other material cost [80 per unit x 10 units]	800
(d) Total relevant cost [a + b + c]	4,800
(e) Minimum unit price [4,800 / 10 units]	480

(ii) Reasons for inclusion or exclusion of each item of cost :

(a) Non-moving toxic chemical : It is already in stock and hence book value is a sunk cost and irrelevant. We don't need it and hence replacement cost is also irrelevant. However, if we don't need it, then we can sale it and realize ₹ 3,500. However, if we use it in the production, we will lose an opportunity to earn ₹ 3,500, hence it is a relevant cost of manufacture.

(b) Allocated overheads : Allocated overheads means common or general overheads charged as per absorption costing policy. There will not be any additional cost due to extra production, hence irrelevant.

(c) Out of pocket expenses : It is an incremental cost, hence relevant.

(d) Labour cost : These are permanent employees and their temporary deployment will not lead to any loss of contribution. Hence, there is no incremental cost of production and no opportunity cost, hence irrelevant.

(e) Other material cost : It is an incremental cost, hence relevant.

(iii) Pricing Policy under Perfect Competition :

Under perfect competition conditions, Sun Chemicals cannot have pricing policy of its own. In such case, sellers are price takers and not the price deciders. It cannot increase its price beyond the current market price. In short, in such case, the company should follow 'Going Rate' pricing strategy. It can keep its selling price at the average level of price charged by the industry.

The company should keep on selling the goods as long as the marginal cost is recovered. However, if the marginal cost exceeds the selling price, then the firm starts incurring losses. Selling at the prevailing market prices (i.e. going rate pricing), would yield a fair return on investment to the firm as per industry standard. It would also help the firm to attract a fair market share under the competitive conditions.

Question 19 : [ICAI Module]

Baithway India Ltd. (BIL) is an ISO 9001:2008, a premier multi-discipline company. BIL manufactures a diverse range of products viz. Pressure Vessels, Wagons, Steel Castings etc. To manufacture Wagons, BIL undertake structural fabrication jobs and manufacturing, retrofitting of EOT crane. It is presently the flagship company of the Baithway Group comprising of renowned companies such as Krishna Agriculture, Chiang Phosphate Etc. The Group was launched with the idea of one virtual company with diversified businesses, and is based on four fundamental principles - Collaboration, Sustainability, Inclusiveness and being Global.

Baithway India Ltd. has two divisions namely, Bogie Division (BD) and Wagon Division (WD) for manufacturing of Wagon. BD manufactures Bogies and WD manufactures various types of Wagons like Freight Wagon, Tank Wagon, Special Wagon etc. To manufacture a wagon, WD needs 4 Bogies. BD is the only manufacturer of the Bogies and supplies both WD and outside customers. Details of BD and WD for the coming financial year 2018-19 are as follows :

Particulars	BD	WD
Fixed Costs (₹)	9,20,20,000	16,45,36,000
Variable Cost per unit (₹)	2,20,000	*4,80,000
Capacity per month (units)	320	12

* excluding transfer costs

Market research has indicated that the demands in the market for Baithway India Ltd.'s products at different quotations are as follows :

For Bogies : At quotation price of ₹ 3,20,000; no tender will be awarded, but demand will increase by 30 Bogies with every ₹ 10,000 reduction in the unit quotation price below ₹ 3,20,000.

For Wagons : At quotation price of ₹ 17,10,000; no tender will be awarded, but demand will increase by 2 Wagons with every ₹ 50,000 reduction in the unit quotation price below ₹ 17,10,000.

Further, BD is the only manufacturer of Bogies but due to increased demand, competitors are entering the market. The division is reviewing its pricing policy and carrying out some market research. After the market research, the division BD has decided to introduce new type of 'E' Class Bogies in the market and to obtain the patent right for such unique Bogies. High growth in future characterizes this class.

Required :

(i) Calculate the unit quotation price of the Wagon that will maximise Baithway India Ltd.'s profit for the financial year 2018-19.

(ii) Calculate the unit quotation price of the Wagon that is likely to emerge if the divisional managers of BD and WD both set quotation prices calculated to maximise divisional profit from sales to outside customers and the transfer price is set at market selling (quotation) price. [Note : If P = a - bQ then MR = a - 2bQ]

(iii) Recommend appropriate pricing strategy while introducing the E class bogies.

Solution 19 :

(i) Calculation of Price per unit of the Wagon to maximise BIL's Profit :

The Basic Price equation, which is used to determine the Price where Profit is Maximum, is written as:

$P = a - bQ$

Where, P = Price where the profit is maximum

b = Slope of the Demand Curve, Calculated as

b = Change in Price / Change in Quantity

Q = Quantity Demanded

a = Price at Which Demand is Zero

Profit is maximum when -

Marginal Revenue (MR) = Marginal Cost (MC)

Marginal Cost = Variable cost per unit of Wagon

= Variable cost of 4 Bogies + Incremental cost of WD

= (2,20,000 x 4) + 4,80,000 = ₹ 13,60,000

Marginal Revenue (MR) = a – 2bQ

= 17,10,000 - [2 x (50,000 / 2) x Q]

= 17,10,000 - 50,000Q

MR = MC, hence -

17,10,000 - 50,000Q = ₹ 13,60,000

17,10,000 - 13,60,000 = 50,000Q

Hence, Q = 7 units

Substituting Q = 7 in the equation of price we get -

P = a – bQ

P = 17,10,000 - [(50,000 / 2) x 7]

= 17,10,000 - 1,75,000 = ₹ 15,35,000

Conclusion : BIL should sell 7 Wagons @ ₹ 15,35,000 each.

(ii) Calculation of Price per unit of the Wagon considering divisional transfer :

First we need to calculate the internal transfer price of a Bogie at the same selling price at which it sells to outside customers, to earn maximum total profit.

Marginal Cost of Bogie = ₹ 2,20,000 (given)

Marginal Revenue (MR) = a – 2bQ

= 3,20,000 - [2 x (10,000 / 30) x Q]

= 3,20,000 - (2,000/3 x Q)

MR = MC, hence -

3,20,000 - (2,000/3 x Q) = 2,20,000

3,20,000 - 2,20,000 = (2,000 / 3 x Q)

1,00,000 x 3 / 2,000 = Q

Hence, Q = 150 units

Substituting Q = 150 in the equation of price we get -

P = a – bQ

P = 3,20,000 - [(10,000 / 30) x 150]

= 3,20,000 - 50,000 = ₹ 2,70,000 per Bogie

Conclusion : Division BD should sell 150 Bogies @ ₹ 2,70,000 each.

Using the above quotation of Bogie in the equation of Wagon we get -

Marginal Cost = Variable cost per unit of Wagon

= Variable cost of 4 Bogies + Incremental cost of WD

= (2,70,000 x 4) + 4,80,000 = ₹ 15,60,000

Marginal Revenue (MR) = a – 2bQ

= 17,10,000 - [2 x (50,000 / 2) x Q]

= 17,10,000 - 50,000Q

MR = MC, hence -

17,10,000 - 50,000Q = ₹ 15,60,000

17,10,000 - 15,60,000 = 50,000Q

Hence, Q = 3 units

Substituting Q = 3 in the equation of price we get -

P = a – bQ

P = 17,10,000 - [(50,000 / 2) x 3]

= 17,10,000 - 75,000 = ₹ 16,35,000 per Wagon

Conclusion : WD should sell 3 Wagons @ ₹ 16,35,000 each, if it gets the internal transfer of Bogies @ ₹ 2,70,000.

(iii) Appropriate pricing strategy while introducing the E class bogies :

Whenever a new product is launched into the market, management can adopt either Skimming Pricing or Penetration Pricing Policy.

The idea behind Skimming Pricing Strategy is to intentionally keep a higher price in the beginning to recover high cost of R&D and marketing expenses associated with a new product.

Penetration Pricing Strategy works when we are entering into an already competitive market and our product doesn't have any special features to offer. This policy works well if the demand in the market is elastic. Under this policy, a very low price is charged initially to drive away the competitors and then the prices are increased gradually.

BD has decided to introduce new type of 'E' Class Bogies in the market and to obtain the patent right for such unique Bogies. BD is the only manufacturer of Bogies at present and hence the demand is inelastic. Hence, BD can use Skimming Pricing Strategy while launching E class bogies.

As this product is expected to witness high growth in future and competition is expected in the future, BD can gradually reduce the price of E class bogies to take care of such competition and to encash high growth potential. Thus Skimming Pricing will work well in this situation.

Price Adjustment Policies

Having set prices, often companies will need to adjust their basic prices to account for various customer differences and changing situations. Companies, therefore, need to establish price adjustment policies. It is also called as price discrimination, which is opposite to uniform pricing policy. It can be broadly classified in two types as follows:

(1) Discount Policy

(a) Distributor Discounts

(b) Quantity Discounts

(c) Cash Discounts

(2) Price Discrimination Policy

(a) Clock Time Differential

(b) Calendar Time Differential

(c) Geographical Price Differential

(d) Consumer Category Price Differential

Let's discuss each one of the above in little more details:

Distributor's Discounts

It means price deductions that systematically make the net price vary according to buyer's position in the chain of distribution. These discounts are given to various distributors in the trade channel e.g., wholesalers, dealers and retailers. As these discounts creates differential prices for different customers on the basis of marketing functions performed by them, so these are also called as functional discounts.

Quantity Discounts

Quantity discounts are price reductions related to the quantities purchased. It may take several forms. It may be related to the size of the order which is being measured in terms of physical units of a particular commodity. This is practicable where the commodities are homogeneous or identical in nature, or where they may be measured in terms of truck-loads. However, this method is not applicable in the case of heterogeneous commodities as it is difficult to add them in terms of physical units or truck loads e.g. textile and drug industry. Quantity discounts are useful in the marketing of materials and supplies but are rarely used for marketing equipment and components.

Cash Discounts

Cash discounts are price reductions based on promptness of payment. It is a convenient device to identify and overcome bad credit risks. In those trades where credit risk is high, the percentage of cash discount given is also high. If a buyer decides to purchase goods on credit, he has to pay a higher price by foregoing the cash discount.

Price Differentials: Charging different prices on the basis of time is another kind of price discrimination. Under price differentials the objective of the seller is to take advantage of the fact that buyer's demand elasticities vary over time. Price differentials can be classified under the following heads :

(i) Clock-time differentials : The price differentials are known as clock-time differentials when different prices are charged for the same service or commodity at different times within a 24 hours period. Common examples of these are, the differences between the day and night rates on trunk calls; difference between the rates charged in morning and regular shows in cinema houses etc.

(ii) Calendar-time differentials : Here price differences are based on a period longer than 24 hours. For example; seasonal price rate variations in the case of winter clothing or hotel accommodation at a hill station and a tourist resort. The main objective here is to exploit the time preferences of the buyers.

(iii) Geographical price differentials : It refers to price differentials based on buyers location. The objective here is to exploit the differences in transport-cost, due to the varying distances between the locations of the plants and customers. For example, the price of petrol is highest in Nagpur in entire India due to it's central location.

(iv) Consumer category price differentials : Price discriminations is frequently practised according to consumer categories in the case of public utilities, e.g. electricity, transportation, etc. Electricity companies charge different rates for residential consumers and industrial consumers. Similarly water charges are based on the type of consumer etc.

Cost should not always be considered as an important determinant of price. The tendency should be to lower the price in such a way so as to choose a right combination of price and output to maximise profits. The important determinants of price, therefore, are competitive situations prevailing in the market and elasticities of demand.

Taking the standard products into consideration, the pricing principles are much the same whether the product is a new one or the one already well established in the market. However, the environmental situation and information base are different.

To arrive at a right price, the following important points to be kept in the mind:

Price Customization :

Pricing of a product is some time customized keeping taste, preference and perceived value of a consumer into consideration. Price customization is done in various ways:

- Based on product line: Based on the requirement of the consumer, products can be customized and accordingly the prices. For example, some may like to have a smartphone with 32 GB over 64 GB. In this case pricing for the product can be based on memory specification.
- Based on customer's past behaviour: A customer with good payment record may be given more discounts than the others.
- Based on demographics: Different pricing may be adopted based on age or social status. For example, railway fare concession for senior citizens and concessional price tickets for military personnel.
- Based on time differential: Pricing for a product or service is also done on the basis of time differential i.e. different price for different time period. For example, discounted price for data usage provided by a broadband service provider if subscription paid for six months at a time.

Price Sensitivity :

It measures the customer's behaviour to the change in price of a product. **Thomas Nagle** has identified nine factors that contribute to price sensitivity. These factors are:

- Unique Value Effect - More unique the product, lower is the price sensitivity.
- Substitute Awareness Effect - If the buyers are aware of substitutes and these perform the same function, then the buyer's price sensitivity will be high.
- Difficult Comparison Effect - Price sensitivity will be low if the buyer has difficulty comparing two alternatives.
- Total Expenditure Effect - If total expenditure on the product represents a low proportion of the consumer income, the price sensitivity will be less visible for such a product. In short, more affordability leads to low sensitivity.
- End Benefit Effect - Buyers are less price sensitive where the expenditure on the input product is low compared to the total cost of the end product.
- Shared Cost Effect - If the cost of the product is shared by another party, the buyer will be less prone to price sensitivity.
- Sunk Investment Effect - Price sensitivity is low in products which are used along with assets previously bought.
- Price Quality Effect - Higher the perceived quality of the product, lower the price sensitivity.
- Inventory Effect - If the product cannot be stored, the buyer will be less price sensitive.

One of the methods more commonly used for measuring price sensitivity is controlled experimentation. In this method, customers are offered different brands at different prices and customer's responses are obtained. Then the company's brand prices are changed and customer's response at each price level is recorded. The price at which demand for the product starts declining is the level where price sensitivity begins and based on the response level, sensitivity can be measured. It depends on the nature of the product and buyer characteristics.

Pricing of Services : Issues

- When services are uniquely tailored to each customer's needs, the pricing cannot be easy. Each service transaction is likely to have distinct pricing structure.
- In certain services customer's participation is essential. The customer may have to incur certain intangible costs over and above monetary cost while making use of a service. The pricing decision in such services should accommodate the intangible costs that a customer may have to bear with.
- Some of the services like health care, education, communication, transport, etc. fall within the larger domain of government. Therefore, price of those services tends to be regulated.
- For some services, pricing is determined in a collective manner. Trade association, professional bodies, or other institutions may impose broad guidelines for fixing the price.

Sensitivity Analysis in Pricing Decision :

Sensitivity analysis is very significant in making pricing decisions and striking the right balance in which the price is good-looking enough to generate enough sales, yet is also profitable for the firm. Sometimes, simple analysis of past data may not be enough to take proper pricing decision. In such case, we need to do sensitivity analysis by projecting future cost and profit data under various market conditions.

Product pricing decisions must be balanced against costs and competitive market conditions. Sensitivity analysis is required to determine how sales and costs will respond to changes in the market conditions.

Sensitivity analysis is performed by choosing the critical parameters upon which our future computations are based, and systematically changing them to assess how the changes will affect the overall outcome. Some of these factors are external, and change according to the market and economy. Some of the factors are typically internal, and in these cases sensitivity analysis is valuable in making important decisions within the company.

Some examples of **external** factors are :

- Market demand & competition
- Changes in market driven prices
- Exchange rate fluctuation etc.

Some examples of **internal** factors are :

- Initial outlay e.g. R & D expenses
- Production cost
- Marketing costs
- Product launching dates
- Product prices etc.

PROBLEM NO. 20 : [ICAI Module]

Bosch Ltd. has developed a special product. Details are as follows:

The product will have a life cycle of 5,000 units. It is estimated that market can absorb first 4,500 units at ₹ 64 per unit and then the product will enter the "decline" stage of its life cycle.

The company estimates the following cost structure:

Direct Labour..... ₹ 6 per hour

Other variable costs.....₹ 19 per unit

Fixed costs will be ₹ 40,000 over the life cycle of the product. The 'labour rate' and both of these costs will not change throughout the product's life cycle.

The first batch of 100 units will take 1,000 labour hours to produce. There will be an 80% learning curve that will continue until 2,500 units have been produced. Batches after this level will each take the same amount of time as the 25th batch. The batch size will always be 100 units.

Required :

CALCULATE average selling price of the final 500 units that will allow the company to earn a total profit of ₹ 80,000 from the product, over its lifetime.

Assume that average time for 24 batches is 359.40 hours.

(Note: Learning coefficient is – 0.322 for learning rate of 80%).

The values of Logs have been given for calculation purpose:

log 2 = 0.30103; log3 = 0.47712; log5 = 0.69897;

antilog of 2.534678 = 342.51; antilog of 2.549863 = 354.70;

antilog of 2.555572 = 359.40; antilog of 2.567698 = 369.57

PROBLEM NO. 21 :

State whether and why the following are valid or not for Learning Curve Theory:

(i) Learning Curve Theory applies to a Division of a Company which is fully automated.

(ii) Learning Curve Theory helps in setting standards.

(iii) Learning Curve helps in Pricing Decisions.

(iv) Experienced workmen are more prone to Learning Effect.

PROBLEM NO. 22 :

What are the limitations of the learning curve theory?

Solution 22 :

1. All activities are not subject to learning effect. The activities involving human skill and efforts are only subject to learning effect.
2. All the workers may not observe the same learning ratio. The speed of learning for a new worker and an experienced worker would be different. It means, learning curve ratio shall be different for different workers.
3. Different activities or different operations may also have different learning effect because the difficulty and complexity level of each work will be different.
4. It is correct that learning effect does take place and average time taken is likely to reduce. But in practice it is highly unlikely that there will be a regular and consistent rate of decrease, as stated earlier, so any cost predictions based on learning curves should be viewed with caution.
5. Considerable difficulty arises in obtaining a valid data for computation of learning effect.
6. Even a slight change in the circumstances, process of production, labour turnover etc. will quickly render the learning curve obsolete.
7. Research & Development project do not observe any learning effect. Production carried out on highly automated machines, do not observe the learning effect. In short, the learning curve theory has a limited utility.
8. It is also difficult to estimate the length of time for which the learning effect will continue.

PROBLEM NO. 23 :

Bring out the main applications of Learning Curve.

Solution 23 :

The main applications or uses of learning curve are as follows:

- CVP Analysis: It helps to analyze CVP relationship during familiarization phase of product or process and thus it is very useful for cost estimates.
- Budgeting and profit planning: Learning curve provides scientific ideas and sophistication for budgeting and profit planning.
- Pricing Decisions: Cost data adjusted for learning effect helps in proper pricing decisions.
- Product Design: It helps design engineers in making decisions based upon expected rates of improvement.
- Contract negotiations: It is very useful to Government in negotiations about contracts. Government receives full advantage of the decreasing unit cost in establishing the contract price.
- Setting Standards : The learning curve is useful in setting standards in Learning phase.

PROBLEM NO. 24 :

Explain the concept of learning curve and discuss its relevance to pricing decisions.

Solution 24 :

In estimating the price of a product it is found that changes in the efficiency of the labour force may render past performance unsuitable for predicting the future labour costs. Such a situation will arise when workers become more familiar with the tasks they perform such that less labour time is required for production of each unit. This phenomenon is known as learning effect.

In pricing decisions, the main impact of learning curve is providing better cost predictions to enable price quotations to be prepared for potential orders. A forecast of cost reduction due to learning curve will enable suitable price reduction to secure more orders. In the case of new orders, learning curve effect will provide unbeatable lead over competitors because reduction in price based on learning curve effect will further increase the volume and market share.

PROBLEM NO. 25 :

State whether the learning curve theory can be applied to the following independent situations briefly justifying your decision :

(i) A labour intensive sculpted product is carved from the metal provided to the staff. The metal is sourced from different suppliers since it is scarce. The alloy composition of the input metal is quite different among the suppliers.

(ii) Pieces of hand-made furniture are assembled by the company in a far off location. The labours do not know anything about the final product which utilizes their work. As a matter of further precaution, rotation of labour is done frequently.

(iii) Skilled workers have been employed for a long time. The company has adequate market for the craft pieces done by these experts.

(iv) A company finds that it always has an adverse usage of indirect material. It wants to apply learning curve theory to improve the way standards have been set.

PROBLEM NO. 26 :

A Company manufacturing small tools has completed the first order of 10 units of special tool at a contract price of Rs. 5,000 and has received an enquiry for another 30 units of the special tool.

The cost details of the first order are –

Particulars	Per unit (Rs.)
Material Cost	50
Wages	300
Tools	10
Variable overheads	80
Fixed overheads	20
Total cost	460
Profit	40
Selling Price	500

The company expects 80% learning curve in respect of labour and variable overheads. But material costs, labour cost and variable overheads will rise by 10% in future.

The company wants 25% profit on cost.

The amount of Rs. 100 spent on tools will not be required for this order.

Fixed overheads for the second order will be Rs. 229.20.

You are required to ascertain the contract price for repeat order.

*****

Annexure 1 - Logarithm

A logarithm often just called a log, is an exponent representing the power to a particular number. The two most commonly used base numbers are 10 and e. Where e is a special number having a value of 2.71828. Its logs as follows :

$\text{Log}_{10}25$ = 1.3979 (the log of 25 with base 10)
$\text{Log}_{e}25$ = 3.2189 (the log of 25 with base e)

We can verify these results as follows :
$10^{1.3979}$ = 25
$2.71828^{3.2189}$ = 25

Logs using base 10 are referred to as common logs, while logs using base e are called natural logs. The log tables are available for common logs with base 10, however, in finance we make use of natural logs more often.

Here are some important rules regarding logs:

- The log of a positive number is a positive number.
- The log of a negative number is undefined.
- The log of zero is undefined.
- The log of 1 is zero.
- The log of a number between zero and one is negative.

Laws of Logarithm :
There are four laws of logarithms that make operations such as multiplication and division of numbers easy.

1. $\log (m \times n) = \log m + \log n$ [multiplication is converted into addition]
2. $\log (m/n) = \log m - \log n$ [division is converted into subtraction]
3. $\log (m^n) = n \log m$
4. $\log_a m = \log_x m / \log_x a$ $x \neq 0$, and x is a positive real number

the fourth law gives the facility for the change of base.
Thus $\log_{10} 100 = \log_e 100 / \log_e 10 = \text{Ln } 100 / \text{Ln}10$

As mentioned earlier, logarithmic tables for standard bases are available. So if we are given any base, we can change the base to the standard bases with the above law and proceed with the calculations.

How to determine logarithm of a given number?
If x is a positive real number then log x can be written as
Log x = characteristic of x + mantissa of x.
Characteristic of x is an integer that can be either positive or negative depending on whether $x > 1$ or $0 < x < 1$. Mantissa of x has to be read from the log tables.

How to determine the characteristic of a number:
If $x > 1$, then count the digits on the left of the decimal point; if the number of digits is y, then the characteristic is $(y - 1)$.
If $0 < x < 1$, then count the number of zeroes appearing in the right side of the decimal point; if the number of zeros is z, then the characteristic is $(z + 1)$ bar.

How to determine the mantissa of a number:
As mentioned earlier, the mantissa has to be read from a standard log table. Log tables consist of rows that go from 10, 11, upto 99. The columns have values 0, 1, 2, upto 9. Beyond 9^{th} column, there is another column which is known as the mean difference. For determining the mantissa, a particular row has to be read of and the mean difference has to be added from the table.

The following has to be remembered :

- Mantissa usually consist of a four digit number, and it comes after the decimal point.
- While determining the mantissa, the decimal point of the number has to be ignored.
- Most of the log tables give values of mantissa up to four digits only. For more than a four digit mantissa, we have to round off the last digit.

Example 1 : Find the log of 500.2

Characteristic = (3 – 1) = 2.

For mantissa, read from the table a number 5002 ignoring decimal. From the rows, choose 50, and read off from the number under the column 0. The number given in the log tables is 6990. Now read, in the same row, the mean difference under 2. This number is given as 2.

Mantissa = 6990 + 2 = 6992.

Thus log 500.2 = Characteristic of 500.2 + Mantissa of 500.2
= 2 + 0.6992
= 2.6992.

Example 2 : Find the log of 0.0009887

Characteristic = 4 bar i.e. - 4.

For mantissa, read from the table a number 9887. From the rows, choose 98, and read off from the number under the column 8. The number given in the log tables is 9948. Now read, in the same row, the mean difference under 7. This number is given as 3.

Mantissa = 9948 + 3 = 9951.

Thus log 0.0009887 = Characteristic of 0.0009887 + Mantissa of 0.0009887
= - 4 + 0.9951 = - 3.0049

Antilogarithm :

Antilogarithm is the exact opposite of logarithm of a number.
If log b = x, then antilog x = b.

Antilog table for base 10 is readily available. Antilog tables are used for determining the inverse value of the mantissa. From the characteristic, the position of the decimal point can be determined.

Antilog tables consist of rows that go from .00, .01, up to .99. The columns have values 0, 1, 2, up to 9. Beyond the 9^{th} column, there is another column which is known as the mean difference. For determining the antilog of the numbers after the decimal point, a particular row has to be read off and the mean difference has to be added from the table.

Antilogarithm Rules :

a. You find antilog of mantissa only.

b. The characteristic is used to place the decimal to left or right of the number you get from the antilog table.

c. If the characteristic is x, and x is > = 0, (means x is a positive number) then place the decimal at x + 1^{th} place to the right treating the first digit as the zero position.

d. If the characteristic is x, and x is < 0, (means x is a negative number) then place the decimal at x + 1^{th} place to the left treating the first digit as the zero position.

Example 3 : Find the antilog of 2.6992

The number before the decimal point is 2, so the decimal point will be after the first 3 digits. (Here x is > 0, place decimal at 2 + 1 i.e. 3rd position to right).

From the antilog table, read off the row for .69 and column of 9; the number given in the table is 5000. the mean difference in the same row and under the column 2 is 2. To get the inverse of mantissa add 5000 + 2 = 5002.

Now place a decimal point after the first 3 digits and you get the number 500.2.
Thus antilog 2.6992 = 500.2

Example 4 : Find the antilog of - 3.0049

The number – 3.0049 should be re-written as 4 bar + 0.9951 = - 4 + 0.9951
The number before the decimal point is - 4, (Here x is < 0, place decimal at - 4 + 1 i.e. 3rd position to the left)

From the antilog table, read off the row for .99 and column of 5; the number given in the table is 9886. The mean difference in the same row and under the column 1 is 2. To get the inverse of mantissa add 9886 + 2 = 9888.

Now place a decimal point at the 3rd position to the left and you get the number 0.0009888
Thus antilog - 3.0049 = 0.0009888

Applications :

We will now see how logarithms and antilogarithms of numbers are useful for calculations which are complicated or have very large / small numbers.

Example 5 : Find 80.92 x 19.45.

Let x = 80.92 x 19.45
Use the log function on both the sides.
Log x = log (80.92 x 19.45)
Log (80.92 x 19.45) = log 80.92 + log 19.45 (from the laws of logarithms)
From the log tables we get log 80.92 = 1.9080, log 19.45 = 1.2889
Thus log (80.92 x 19.45) = 1.9080 + 1.2889 = 3.1969
i.e. Log x = 3.1969

Now use antilog functions on both the sides.
Hence, antilog 3.196 = x
From the antilog tables we see that the antilog of 3.1969 is 1573

Example 6 : Find 251 x $10^{-0.3219}$

Let x = 251 x $10^{-0.3219}$
Take log functions on both the sides.
Log x = log 251 + (-0.3219) log 10 (from the laws of logarithms)
Log x = log 251 – (0.3219 x 1) (since $\log_{10}10 = 1$)
Now log (251) = 2.3997
Therefore, log x = 2.3997 - 0.3219 = 2.0778

Now use antilog functions on both the sides -
Therefore x = Antilog (2.0778)
Thus x = 119.60

Logarithms Table

	0	1	2	3	4	5	6	7	8	9	Mean Difference								
											1	2	3	4	5	6	7	8	9
10	0000	0043	0086	0128	0170	0212	0253	0294	0334	0374	4	8	12	17	21	25	29	33	37
11	0414	0453	0492	0531	0569	0607	0645	0682	0719	0755	4	8	11	15	19	23	26	30	34
12	0792	0828	0864	0899	0934	0969	1004	1038	1072	1106	3	7	10	14	17	21	24	28	31
13	1139	1173	1206	1239	1271	1303	1335	1367	1399	1430	3	6	10	13	16	19	23	26	29
14	1461	1492	1523	1553	1584	1614	1644	1673	1703	1732	3	6	9	12	15	18	21	24	27
15	1761	1790	1818	1847	1875	1903	1931	1959	1987	2014	3	6	8	11	14	17	20	22	25
16	2041	2068	2095	2122	2148	2175	2201	2227	2253	2279	3	5	8	11	13	16	18	21	24
17	2304	2330	2355	2380	2405	2430	2455	2480	2504	2529	2	5	7	10	12	15	17	20	22
18	2553	2577	2601	2625	2648	2672	2695	2718	2742	2765	2	5	7	9	12	14	16	19	21
19	2788	2810	2833	2856	2878	2900	2923	2945	2967	2989	2	4	7	9	11	13	16	18	20
20	3010	3032	3054	3075	3096	3118	3139	3160	3181	3201	2	4	6	8	11	13	15	17	19
21	3222	3243	3263	3284	3304	3324	3345	3365	3385	3404	2	4	6	8	10	12	14	16	18
22	3424	3444	3464	3483	3502	3522	3541	3560	3579	3598	2	4	6	8	10	12	14	15	17
23	3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	2	4	6	7	9	11	13	15	17
24	3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	2	4	5	7	9	11	12	14	16
25	3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	2	3	5	7	9	10	12	14	15
26	4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	2	3	5	7	8	10	11	13	15
27	4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	2	3	5	6	8	9	11	13	14
28	4472	4487	4502	4518	4533	4548	4564	4579	4594	4609	2	3	5	6	8	9	11	12	14
29	4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	1	3	4	6	7	9	10	12	13
30	4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	1	3	4	6	7	9	10	11	13
31	4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	1	3	4	6	7	8	10	11	12
32	5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	1	3	4	5	7	8	9	11	12
33	5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	1	3	4	5	6	8	9	10	12
34	5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	1	3	4	5	6	8	9	10	11
35	5441	5453	5465	5478	5490	5502	5514	5527	5539	5551	1	2	4	5	6	7	9	10	11
36	5563	5575	5587	5599	5611	5623	5635	5647	5658	5670	1	2	4	5	6	7	8	10	11
37	5682	5694	5705	5717	5729	5740	5752	5763	5775	5786	1	2	3	5	6	7	8	9	10
38	5798	5809	5821	5832	5843	5855	5866	5877	5888	5899	1	2	3	5	6	7	8	9	10
39	5911	5922	5933	5944	5955	5966	5977	5988	5999	6010	1	2	3	4	5	7	8	9	10
40	6021	6031	6042	6053	6064	6075	6085	6096	6107	6117	1	2	3	4	5	6	8	9	10
41	6128	6138	6149	6160	6170	6180	6191	6201	6212	6222	1	2	3	4	5	6	7	8	9
42	6232	6243	6253	6263	6274	6284	6294	6304	6314	6325	1	2	3	4	5	6	7	8	9
43	6335	6345	6355	6365	6375	6385	6395	6405	6415	6425	1	2	3	4	5	6	7	8	9
44	6435	6444	6454	6464	6474	6484	6493	6503	6513	6522	1	2	3	4	5	6	7	8	9
45	6532	6542	6551	6561	6571	6580	6590	6599	6609	6618	1	2	3	4	5	6	7	8	9
46	6628	6637	6646	6656	6665	6675	6684	6693	6702	6712	1	2	3	4	5	6	7	7	8
47	6721	6730	6739	6749	6758	6767	6776	6785	6794	6803	1	2	3	4	5	5	6	7	8
48	6812	6821	6830	6839	6848	6857	6866	6875	6884	6893	1	2	3	4	4	5	6	7	8
49	6902	6911	6920	6928	6937	6946	6955	6964	6972	6981	1	2	3	4	4	5	6	7	8
50	6990	6998	7007	7016	7024	7033	7042	7050	7059	7067	1	2	3	3	4	5	6	7	8
51	7076	7084	7093	7101	7110	7118	7126	7135	7143	7152	1	2	3	3	4	5	6	7	8
52	7160	7168	7177	7185	7193	7202	7210	7218	7226	7235	1	2	2	3	4	5	6	7	7
53	7243	7251	7259	7267	7275	7284	7292	7300	7308	7316	1	2	2	3	4	5	6	6	7
54	7324	7332	7340	7348	7356	7364	7372	7380	7388	7396	1	2	2	3	4	5	6	6	7
55	7404	7412	7419	7427	7435	7443	7451	7459	7466	7474	1	2	2	3	4	5	5	6	7

	0	1	2	3	4	5	6	7	8	9	Mean Difference								
											1	2	3	4	5	6	7	8	9
56	7482	7490	7497	7505	7513	7520	7528	7536	7543	7551	1	2	2	3	4	5	5	6	7
57	7559	7566	7574	7582	7589	7597	7604	7612	7619	7627	1	2	2	3	4	5	5	6	7
58	7634	7642	7649	7657	7664	7672	7679	7686	7694	7701	1	1	2	3	4	4	5	6	7
59	7709	7716	7723	7731	7738	7745	7752	7760	7767	7774	1	1	2	3	4	4	5	6	7
60	7782	7789	7796	7803	7810	7818	7825	7832	7839	7846	1	1	2	3	4	4	5	6	6
61	7853	7860	7868	7875	7882	7889	7896	7903	7910	7917	1	1	2	3	4	4	5	6	6
62	7924	7931	7938	7945	7952	7959	7966	7973	7980	7987	1	1	2	3	3	4	5	6	6
63	7993	8000	8007	8014	8021	8028	8035	8041	8048	8055	1	1	2	3	3	4	5	5	6
64	8062	8069	8075	8082	8089	8096	8102	8109	8116	8122	1	1	2	3	3	4	5	5	6
65	8129	8136	8142	8149	8156	8162	8169	8176	8182	8189	1	1	2	3	3	4	5	5	6
66	8195	8202	8209	8215	8222	8228	8235	8241	8248	8254	1	1	2	3	3	4	5	5	6
67	8261	8267	8274	8280	8287	8293	8299	8306	8312	8319	1	1	2	3	3	4	5	5	6
68	8325	8331	8338	8344	8351	8357	8363	8370	8376	8382	1	1	2	3	3	4	4	5	6
69	8388	8395	8401	8407	8414	8420	8426	8432	8439	8445	1	1	2	2	3	4	4	5	6
70	8451	8457	8463	8470	8476	8482	8488	8494	8500	8506	1	1	2	2	3	4	4	5	6
71	8513	8519	8525	8531	8537	8543	8549	8555	8561	8567	1	1	2	2	3	4	4	5	5
72	8573	8579	8585	8591	8597	8603	8609	8615	8621	8627	1	1	2	2	3	4	4	5	5
73	8633	8639	8645	8651	8657	8663	8669	8675	8681	8686	1	1	2	2	3	4	4	5	5
74	8692	8698	8704	8710	8716	8722	8727	8733	8739	8745	1	1	2	2	3	4	4	5	5
75	8751	8756	8762	8768	8774	8779	8785	8791	8797	8802	1	1	2	2	3	3	4	5	5
76	8808	8814	8820	8825	8831	8837	8842	8848	8854	8859	1	1	2	2	3	3	4	5	5
77	8865	8871	8876	8882	8887	8893	8899	8904	8910	8915	1	1	2	2	3	3	4	4	5
78	8921	8927	8932	8938	8943	8949	8954	8960	8965	8971	1	1	2	2	3	3	4	4	5
79	8976	8982	8987	8993	8998	9004	9009	9015	9020	9025	1	1	2	2	3	3	4	4	5
80	9031	9036	9042	9047	9053	9058	9063	9069	9074	9079	1	1	2	2	3	3	4	4	5
81	9085	9090	9096	9101	9106	9112	9117	9122	9128	9133	1	1	2	2	3	3	4	4	5
82	9138	9143	9149	9154	9159	9165	9170	9175	9180	9186	1	1	2	2	3	3	4	4	5
83	9191	9196	9201	9206	9212	9217	9222	9227	9232	9238	1	1	2	2	3	3	4	4	5
84	9243	9248	9253	9258	9263	9269	9274	9279	9284	9289	1	1	2	2	3	3	4	4	5
85	9294	9299	9304	9309	9315	9320	9325	9330	9335	9340	1	1	2	2	3	3	4	4	5
86	9345	9350	9355	9360	9365	9370	9375	9380	9385	9390	1	1	2	2	3	3	4	4	5
87	9395	9400	9405	9410	9415	9420	9425	9430	9435	9440	0	1	1	2	2	3	3	4	4
88	9445	9450	9455	9460	9465	9469	9474	9479	9484	9489	0	1	1	2	2	3	3	4	4
89	9494	9499	9504	9509	9513	9518	9523	9528	9533	9538	0	1	1	2	2	3	3	4	4
90	9542	9547	9552	9557	9562	9566	9571	9576	9581	9586	0	1	1	2	2	3	3	4	4
91	9590	9595	9600	9605	9609	9614	9619	9624	9628	9633	0	1	1	2	2	3	3	4	4
92	9638	9643	9647	9652	9657	9661	9666	9671	9675	9680	0	1	1	2	2	3	3	4	4
93	9685	9689	9694	9699	9703	9708	9713	9717	9722	9727	0	1	1	2	2	3	3	4	4
94	9731	9736	9741	9745	9750	9754	9759	9763	9768	9773	0	1	1	2	2	3	3	4	4
95	9777	9782	9786	9791	9795	9800	9805	9809	9814	9818	0	1	1	2	2	3	3	4	4
96	9823	9827	9832	9836	9841	9845	9850	9854	9859	9863	0	1	1	2	2	3	3	4	4
97	9868	9872	9877	9881	9886	9890	9894	9899	9903	9908	0	1	1	2	2	3	3	4	4
98	9912	9917	9921	9926	9930	9934	9939	9943	9948	9952	0	1	1	2	2	3	3	4	4
99	9956	9961	9965	9969	9974	9978	9983	9987	9991	9996	0	1	1	2	2	3	3	3	4

Anti – Logarithm Table

	0	1	2	3	4	5	6	7	8	9	Mean Difference								
											1	2	3	4	5	6	7	8	9
.00	1000	1002	1005	1007	1009	1012	1014	1016	1019	1021	0	0	1	1	1	1	2	2	2
.01	1023	1026	1028	1030	1033	1035	1038	1040	1042	1045	0	0	1	1	1	1	2	2	2
.02	1047	1050	1052	1054	1057	1059	1062	1064	1067	1069	0	0	1	1	1	1	2	2	2
.03	1072	1074	1076	1079	1081	1084	1086	1089	1091	1094	0	0	1	1	1	1	2	2	2
.04	1096	1099	1102	1104	1107	1109	1112	1114	1117	1119	0	1	1	1	1	2	2	2	2
.05	1122	1125	1127	1130	1132	1135	1138	1140	1143	1146	0	1	1	1	1	2	2	2	2
.06	1148	1151	1153	1156	1159	1161	1164	1167	1169	1172	0	1	1	1	1	2	2	2	2
.07	1175	1178	1180	1183	1186	1189	1191	1194	1197	1199	0	1	1	1	1	2	2	2	2
.08	1202	1205	1208	1211	1213	1216	1219	1222	1225	1227	0	1	1	1	1	2	2	2	3
.09	1230	1233	1236	1239	1242	1245	1247	1250	1253	1256	0	1	1	1	1	2	2	2	3
.10	1259	1262	1265	1268	1271	1274	1276	1279	1282	1285	0	1	1	1	1	2	2	2	3
.11	1288	1291	1294	1297	1300	1303	1306	1309	1312	1315	0	1	1	1	2	2	2	2	3
.12	1318	1321	1324	1327	1330	1334	1337	1340	1343	1346	0	1	1	1	2	2	2	2	3
.13	1349	1352	1355	1358	1361	1365	1368	1371	1374	1377	0	1	1	1	2	2	2	3	3
.14	1380	1384	1387	1390	1393	1396	1400	1403	1406	1409	0	1	1	1	2	2	2	3	3
.15	1413	1416	1419	1422	1426	1429	1432	1435	1439	1442	0	1	1	1	2	2	2	3	3
.16	1445	1449	1452	1455	1459	1462	1466	1469	1472	1476	0	1	1	1	2	2	2	3	3
.17	1479	1483	1486	1489	1493	1496	1500	1503	1507	1510	0	1	1	1	2	2	2	3	3
.18	1514	1517	1521	1524	1528	1531	1535	1538	1542	1545	0	1	1	1	2	2	2	3	3
.19	1549	1552	1556	1560	1563	1567	1570	1574	1578	1581	0	1	1	1	2	2	3	3	3
.20	1585	1589	1592	1596	1600	1603	1607	1611	1614	1618	0	1	1	1	2	2	3	3	3
.21	1622	1626	1629	1633	1637	1641	1644	1648	1652	1656	0	1	1	2	2	2	3	3	3
.22	1660	1663	1667	1671	1675	1679	1683	1687	1690	1694	0	1	1	2	2	2	3	3	3
.23	1698	1702	1706	1710	1714	1718	1722	1726	1730	1734	0	1	1	2	2	2	3	3	4
.24	1738	1742	1746	1750	1754	1758	1762	1766	1770	1774	0	1	1	2	2	2	3	3	4
.25	1778	1782	1786	1791	1795	1799	1803	1807	1811	1816	0	1	1	2	2	2	3	3	4
.26	1820	1824	1828	1832	1837	1841	1845	1849	1854	1858	0	1	1	2	2	3	3	3	4
.27	1862	1866	1871	1875	1879	1884	1888	1892	1897	1901	0	1	1	2	2	3	3	3	4
.28	1905	1910	1914	1919	1923	1928	1932	1936	1941	1945	0	1	1	2	2	3	3	4	4
.29	1950	1954	1959	1963	1968	1972	1977	1982	1986	1991	0	1	1	2	2	3	3	4	4
.30	1995	2000	2004	2009	2014	2018	2023	2028	2032	2037	0	1	1	2	2	3	3	4	4
.31	2042	2046	2051	2056	2061	2065	2070	2075	2080	2084	0	1	1	2	2	3	3	4	4
.32	2089	2094	2099	2104	2109	2113	2118	2123	2128	2133	0	1	1	2	2	3	3	4	4
.33	2138	2143	2148	2153	2158	2163	2168	2173	2178	2183	0	1	1	2	2	3	3	4	4
.34	2188	2193	2198	2203	2208	2213	2218	2223	2228	2234	1	1	2	2	3	3	4	4	5
.35	2239	2244	2249	2254	2259	2265	2270	2275	2280	2286	1	1	2	2	3	3	4	4	5
.36	2291	2296	2301	2307	2312	2317	2323	2328	2333	2339	1	1	2	2	3	3	4	4	5
.37	2344	2350	2355	2360	2366	2371	2377	2382	2388	2393	1	1	2	2	3	3	4	4	5
.38	2399	2404	2410	2415	2421	2427	2432	2438	2443	2449	1	1	2	2	3	3	4	4	5
.39	2455	2460	2466	2472	2477	2483	2489	2495	2500	2506	1	1	2	2	3	3	4	5	5
.40	2512	2518	2523	2529	2535	2541	2547	2553	2559	2564	1	1	2	2	3	4	4	5	5
.41	2570	2576	2582	2588	2594	2600	2606	2612	2618	2624	1	1	2	2	3	4	4	5	5
.42	2630	2636	2642	2649	2655	2661	2667	2673	2679	2685	1	1	2	2	3	4	4	5	6
.43	2692	2698	2704	2710	2716	2723	2729	2735	2742	2748	1	1	2	3	3	4	4	5	6
.44	2754	2761	2767	2773	2780	2786	2793	2799	2805	2812	1	1	2	3	3	4	4	5	6
.45	2818	2825	2831	2838	2844	2851	2858	2864	2871	2877	1	1	2	3	3	4	5	5	6
.46	2884	2891	2897	2904	2911	2917	2924	2931	2938	2944	1	1	2	3	3	4	5	5	6
.47	2951	2958	2965	2972	2979	2985	2992	2999	3006	3013	1	1	2	3	3	4	5	5	6
.48	3020	3027	3034	3041	3048	3055	3062	3069	3076	3083	1	1	2	3	4	4	5	6	6
.49	3090	3097	3105	3112	3119	3126	3133	3141	3148	3155	1	1	2	3	4	4	5	6	6
.50	3162	3170	3177	3184	3192	3199	3206	3214	3221	3228	1	1	2	3	4	4	5	6	7

	0	1	2	3	4	5	6	7	8	9	Mean Difference								
											1	2	3	4	5	6	7	8	9
.51	3236	3243	3251	3258	3266	3273	3281	3289	3296	3304	1	2	2	3	4	5	5	6	7
.52	3311	3319	3327	3334	3342	3350	3357	3365	3373	3381	1	2	2	3	4	5	5	6	7
.53	3388	3396	3404	3412	3420	3428	3436	3443	3451	3459	1	2	2	3	4	5	6	6	7
.54	3467	3475	3483	3491	3499	3508	3516	3524	3532	3540	1	2	2	3	4	5	6	6	7
.55	3548	3556	3565	3573	3581	3589	3597	3606	3614	3622	1	2	2	3	4	5	6	7	7
.56	3631	3639	3648	3656	3664	3673	3681	3690	3698	3707	1	2	3	3	4	5	6	7	8
.57	3715	3724	3733	3741	3750	3758	3767	3776	3784	3793	1	2	3	3	4	5	6	7	8
.58	3802	3811	3819	3828	3837	3846	3855	3864	3873	3882	1	2	3	4	4	5	6	7	8
.59	3890	3899	3908	3917	3926	3936	3945	3954	3963	3972	1	2	3	4	5	5	6	7	8
.60	3981	3990	3999	4009	4018	4027	4036	4046	4055	4064	1	2	3	4	5	6	6	7	8
.61	4074	4083	4093	4102	4111	4121	4130	4140	4150	4159	1	2	3	4	5	6	7	8	9
.62	4169	4178	4188	4198	4207	4217	4227	4236	4246	4256	1	2	3	4	5	6	7	8	9
.63	4266	4276	4285	4295	4305	4315	4325	4335	4345	4355	1	2	3	4	5	6	7	8	9
.64	4365	4375	4385	4395	4406	4416	4426	4436	4446	4457	1	2	3	4	5	6	7	8	9
.65	4467	4477	4487	4498	4508	4519	4529	4539	4550	4560	1	2	3	4	5	6	7	8	9
.66	4571	4581	4592	4603	4613	4624	4634	4645	4656	4667	1	2	3	4	5	6	7	9	10
.67	4677	4688	4699	4710	4721	4732	4742	4753	4764	4775	1	2	3	4	5	7	8	9	10
.68	4786	4797	4808	4819	4831	4842	4853	4864	4875	4887	1	2	3	4	6	7	8	9	10
.69	4898	4909	4920	4932	4943	4955	4966	4977	4989	5000	1	2	3	5	6	7	8	9	10
.70	5012	5023	5035	5047	5058	5070	5082	5093	5105	5117	1	2	4	5	6	7	8	9	11
.71	5129	5140	5152	5164	5176	5188	5200	5212	5224	5236	1	2	4	5	6	7	8	10	11
.72	5248	5260	5272	5284	5297	5309	5321	5333	5346	5358	1	2	4	5	6	7	9	10	11
.73	5370	5383	5395	5408	5420	5433	5445	5458	5470	5483	1	3	4	5	6	8	9	10	11
.74	5495	5508	5521	5534	5546	5559	5572	5585	5598	5610	1	3	4	5	6	8	9	10	12
.75	5623	5636	5649	5662	5675	5689	5702	5715	5728	5741	1	3	4	5	7	8	9	10	12
.76	5754	5768	5781	5794	5808	5821	5834	5848	5861	5875	1	3	4	5	7	8	9	11	12
.77	5888	5902	5916	5929	5943	5957	5970	5984	5998	6012	1	3	4	5	7	8	10	11	12
.78	6026	6039	6053	6067	6081	6095	6109	6124	6138	6152	1	3	4	6	7	8	10	11	13
.79	6166	6180	6194	6209	6223	6237	6252	6266	6281	6295	1	3	4	6	7	9	10	11	13
.80	6310	6324	6339	6353	6368	6383	6397	6412	6427	6442	1	3	4	6	7	9	10	12	13
.81	6457	6471	6486	6501	6516	6531	6546	6561	6577	6592	2	3	5	6	8	9	11	12	14
.82	6607	6622	6637	6653	6668	6683	6699	6714	6730	6745	2	3	5	6	8	9	11	12	14
.83	6761	6776	6792	6808	6823	6839	6855	6871	6887	6902	2	3	5	6	8	9	11	13	14
.84	6918	6934	6950	6966	6982	6998	7015	7031	7047	7063	2	3	5	6	8	10	11	13	15
.85	7079	7096	7112	7129	7145	7161	7178	7194	7211	7228	2	3	5	7	8	10	12	13	15
.86	7244	7261	7278	7295	7311	7328	7345	7362	7379	7396	2	3	5	7	8	10	12	13	15
.87	7413	7430	7447	7464	7482	7499	7516	7534	7551	7568	2	3	5	7	9	10	12	14	16
.88	7586	7603	7621	7638	7656	7674	7691	7709	7727	7745	2	4	5	7	9	11	12	14	16
.89	7762	7780	7798	7816	7834	7852	7870	7889	7907	7925	2	4	5	7	9	11	13	14	16
.90	7943	7962	7980	7998	8017	8035	8054	8072	8091	8110	2	4	6	7	9	11	13	15	17
.91	8128	8147	8166	8185	8204	8222	8241	8260	8279	8299	2	4	6	8	9	11	13	15	17
.92	8318	8337	8356	8375	8395	8414	8433	8453	8472	8492	2	4	6	8	10	12	14	15	17
.93	8511	8531	8551	8570	8590	8610	8630	8650	8670	8690	2	4	6	8	10	12	14	16	18
.94	8710	8730	8750	8770	8790	8810	8831	8851	8872	8892	2	4	6	8	10	12	14	16	18
.95	8913	8933	8954	8974	8995	9016	9036	9057	9078	9099	2	4	6	8	10	12	15	17	19
.96	9120	9141	9162	9183	9204	9226	9247	9268	9290	9311	2	4	6	8	11	13	15	17	19
.97	9333	9354	9376	9397	9419	9441	9462	9484	9506	9528	2	4	7	9	11	13	15	17	20
.98	9550	9572	9594	9616	9638	9661	9683	9705	9727	9750	2	4	7	9	11	13	16	18	20
.99	9772	9795	9817	9840	9863	9886	9908	9931	9954	9977	2	5	7	9	11	14	16	18	20

हार नहीं होती

लहरों से डरकर नौका पार नहीं होती,
कोशिश करने वालों की कभी हार नहीं होती ।।

नन्हीं चींटी जब दाना लेकर चलती है,
चढती दिवारों पर सौ-सौ बार फिसलती है।
मन का उत्साह, रगों में साहस भरता है,
चढकर गिरना, गिरकर चढना न अखरता है।
आखिर उसकी मेहनत बेकार नहीं होती,
कोशिश करने वालों की कभी हार नहीं होती।।

डुबकियाँ सिंधु में गोताखोर लगाता है,
जा-जाकर खाली हाथ लौटकर आता है।
मिलते न सहज ही मोती गहरे पानी में,
बढता दुना उत्साह इसी हैरानी में।
मुट्ठी उसकी खाली हर बार नहीं होती,
कोशिश करने वालों की कभी हार नहीं होती।।

असफलता एक चुनौती है, स्वीकार करो,
क्या कमी रह गयी, देखो और सुधार करो।
जब तक सफल न हो, नींद चैन की त्यागो तुम,
संघर्षों का मैदान छोड़ मत भागो तुम।
कुछ किये बिना ही जय-जयकार नहीं होती,
कोशिश करने वालों की कभी हार नहीं होती।।