I.K.G. Punjab Technical University

BBA- 304

SYLLABUS: Production and Operations Management

Course objective: The course aims at developing knowledge about various steps of product, design, development, plant location, storage, production planning and control.

Course Outcomes (COs): After completion of the course, the students shall be able to:

- CO1: Understand ever growing importance of Production and Operations management in uncertain business environment.
- CO2: Gain an in-depth understanding of resource utilization of an organization.
- CO3: Appreciate the unique challenges faced by firms in services and manufacturing. CO4: Understand the subject as a crucial part of functional management.
- CO5: Develop skills to operate competitively in the current business scenario.

UNIT I

Operations management: Concept, Functions. Product Design and development – Product design and its characteristics: Product development process (Technical): Product development techniques .Process selection- Project, job, Batch, Mass and Process types of Production Systems.

UNIT - II

Facility Location – importance, Factors in Location Analysis: Location Analysis Techniques. Facility Layout – Objectives: Advantages: Basic types of layouts. Capacity Planning – Concepts: Factors Affecting Capacity Planning, Capacity Planning Decisions. Production Planning & Control (PPC) –Concepts, Objectives, Functions.

UNIT – III

Introduction to modern productivity techniques – just in time, Kanban system. Total Quality Management & six sigma. Functions of Purchasing Management – Objectives, Functions: Methods: Procedure. Value analysis – Concepts. Stock control systems. Virtual factory concept.

UNIT – IV

Inventory Management – Concepts, Classification: Objectives: Factors Affecting Inventory Control Policy: Inventory costs: Basic EOQ Model: Re-order Level: ABC Analysis. Quality Management - Quality Concepts, Difference between Inspections, Quality Control, Quality Assurances, Total Quality Management: Control Charts: acceptance sampling.

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PRODUCTION AND OPERATION MANAGEMENT

Unit-1

OBJECTIVES

After studying this unit you will be able to

- Describe the concept of operations and production management
- Understand various levels of production management
- Appreciate the role of production manager.

➢ Meaning of Production Management:

- Production Management refers to the application of management principles to the production function in a factory. In other words, production management involves application of planning, organizing, directing and controlling the production process. I.e. the transformation of various resources into the value-added product, in an efficient manner.
- **Production management** refers to the management of activities related to the production of goods.
- In this process, the decision regarding the quality, quantity, price, packaging, design, etc. are taken by the production manager, so as to ensure that the output produced confirms the specifications

✓ Meaning of Operations Management

➢ Operations Management is understood as the process whereby resources (or) inputs are converted into more useful products or services. Operations management is more frequently used where various inputs are transformed into intangible services. Production management refers to transforming raw material in to finished goods, which are tangible in nature. However, we can see that production and operations departments go hand in hand. These two terms also used as synonyms in manufacturing units. But, we state that the 'Operations management' will cover such service organizations as banks, airlines, utilities, pollution control etc.

- Operations Management is that branch of management that deals with designing, implementing and controlling the production process, i.e. converting inputs into the output, using resources, in order to provide desired goods and services to customers while adhering to the policies stated by the management of the organisation.
- Its main objective is to utilize resources, to the extent possible so as to satisfy customer wants

BASIS FOR COMPARISON	PRODUCTION MANAGEMENT	OPERATIONS MANAGEMENT
Meaning	Production Management connotes the administration of the range of activities belonging to the creation of products.	Operations Management refers to the part of management concerned with the production and delivery of goods and services.
Decision Making	Related to the aspects of production.	Related to the regular business activities.
Found in	Enterprises where production is undertaken.	Banks, Hospitals, Companies including production companies, Agencies etc.
Objectives	To produce right quality goods in right quantity at right time and at least cost.	To utilize resources, to the extent possible so as to satisfy customer wants.

➢ MEANING OF PRODUCTION AND OPERATIONS MANAGEMENT

Production and Operations Management is defined as the process which transforms the inputs/resources of an organization into final goods (or services) through a set of defined, controlled and repeatable policies.

By policies, we refer to the rules that add value to the final output. The value added can be in different dimensions, but the industrial set-up is mostly concerned with the duo of ***quality*** **and** ***throughput***.

- **NATURE OR FEATURES OR CHARACTERISTICS OF PRODUCTION AND OPERATION MANAGEMENT**

1. **it's a transformational process**

The production and operation management is concerned with the conversion of raw material.

2. **Results into value addition**

In this at every successive level some value is added to the previous one. Example sand at sea shore does not add any value but sand used in construction adds to the value.

3. it's a system itself:

It's a complete step wise process i.e. a proper well defined sequence is followed in production and operation management.

4. **Carried out in part of organization:**

The production is not alone in the organization rather there are certain other acts also like finance, research and development etc.

5. **Inter relationship among the system**

No system can ever work in isolation and depends on others for certain help. So, there exists an interrelationship among different system.

➢ OBJECTIVES OF PRODUCTION AND OPERATION MANAGEMENT

- To attain maximum output with given set of resources (input).
- To produce maximum with lowest cost.
- To ensure optimum capacity utilization.
- To exercise inventory control.
- To control and reduce cost of operation.
- To ensure optimum utilization of resources.
- To ensure timely delivery of output.
- To ensure quality of products.
- To suggest changes in machinery and equipment.

➢ FUNCTIONS OF PRODUCTION AND OPERATION MANAGEMENT

1. Planning :

a) Product design and development:

- Deals with issues of converting market feedback on the requirements pertaining to the type of product to be produced into specifications and drawings that help in production.

b) Production Process Selection:

- Helps evaluate different process options possible to produce the type of product in terms of volumes and variety and other factors so as to select the best suited process.

c) Planning Facility Location:

- It deals in evaluating different possible locations for production.
- And selecting the most suitable one so that meets the organisational objectives of producing in required quantities at minimal costs.

d) Planning Facility Layout:

- Refers to studying various options in terms of plant and machinery layout that enables smooth flow of materials for smooth production.

e) Capacity Planning:

- Deals with the issues pertaining to planning the capacity for plant that enables cost competitive production even with certain degree of fluctuations in required volumes.

f) Production Planning:

- Helps effectively plan the production to meet the required quantities of products within the schedule time.

2. **Organizing:**

a) Work Study:

- Also known as time and motion study that aims at improving the cycle time required for producing product.

b) Material Management:

- Aims at establishing sources for the required materials in terms of input materials or consumables at the right time.
- So no delays in production occur and also unwanted inventories are not created.

c) Purchasing Management:

- It is responsible for making the input material available in time, at the right price and in the right quantity and quality.

3. Controlling:

a) Stores Management:

- Refers to managing the stores for input materials, consumables and finished stocks while avoiding over stock of materials.
- Stores are also accountable for recording the stock and consumption for these materials.

b) Value Analysis:

- This refers to process of obtaining the best possible combination between cost and required specifications of product by assigning a value to every operation of production process and identifying the function of product. So this helps in enhancing the value of the product.

c) Quality Control:

- It is responsible for monitoring the quality requirements of the product so that no defective parts passed on the consumers.
- For this, assess system associated with the processes assessed to improve them so that no defective parts are produced.

d) Maintenance Management:

- It is responsible for ensuring the continuous production in terms of machinery and other required infrastructure so that no breakdown occurs to hamper the production flow.

e) Inventory Management:

- It is responsible for maintaining minimum inventory for all critical materials so that ensuring no over stocking take place.

LEVELS OF PRODUCTION DECISIONS:

- **Corporate level**: Corporate level decision-making is concerned with broad issues, such as which types of business the company should be in. It explains overall direction in terms of its general attitude toward growth and the management of its various businesses and product lines. For example, the decision to enter or exit from a business- requires sound strategic analysis. These may fit within main categories of stability, growth and retrenchment. Thus,

diversification, expansion of product line is also depends upon the strategy adopted by the company.

- **Competitive level**: Business decisions deals with how production units able to produce competition in different markets. This usually occurs at the business unit level or product level. Policies are formulated which influence the allocation of resources to these units. Business strategies may fit within the overall categories of competitive or cooperative strategies.
- **Operational level:** Operational level decisions are taken at low level who contributes to day-to- day operations of the plant. The decisions are routine.

➢ **KEY FUNCTIONS OF AN OPERATIONS MANAGER INCLUDES**:

1. **Finance**

Finance plays a chief role in **operations management**. It is essential to ensure that the organization's finance has been utilized properly to carry out major functions such as the creation of goods or services so that the customer's needs could be satisfied.

2. **Operation**

This function in **operation management** is mainly concerned with planning, organising, directing and controlling all the activities of an organisation which helps in converting the raw materials and human efforts into valuable goods and services for satisfying customer needs.

3. **Strategy**

Strategy in **operation management** refers to planning tactics that could help them to optimise the resources and have a competitive edge over others. Business strategies imply to supply chain configuration, sales, capacity to hold money, optimum utilisation of human resources and many more.

4. **Design of the product**

Incorporating innovative technologies play a crucial role in the selling of a product. Thus it is the duty of **operations manager** to ensure that the product is designed catering to the market trends and needs

of the customers. The modern-day customers are more concerned about the quality of the product than its quantity. So, the **operation managers** focus on producing top-notch quality products.

5. **Forecasting**

Forecasting refers to the process of making an estimation regarding certain events that might occur in the future. In **operation management**, forecasting refers to the estimation of customer's demand so that production can be done accordingly. Through this, the manager gets to know what to produce, when to produce and how to produce in accordance with the customer's needs.

6. **Supply Chain Configuration**

The main motive of Supply Chain Configuration is to ensure effective management, monitoring and controlling of all the main activities that are held in a firm. The supply chain configuration starts from the supply of the raw materials and continues till the production of the final product and then their selling to the customers which will satisfy their needs and wants.

7. Managing the Quality

Quality management plays an imperative role in selling a product. The **operation managers** allocate the task of quality management to a team and then supervise their task. The managers identify project defects and rectify them to ensure quality. For this, certain systems are used that measure and maintain the quality of the product.

- **SCOPE OF PRODUCTION AND OPERATIONS MANAGEMENT FUNCTIONS**:

1. Location of facilities
2. Plant layouts and material handling
3. Product design
4. Process design
5. Production and planning control
6. Quality control
7. Materials management

8. Maintenance management.

1. LOCATION OF FACILITIES

Location of facilities for operations is a long-term capacity decision which involves a long term commitment about the geographically static factors that affect a business organization. It is an important strategic level decision-making for an organization. It deals with the questions such as 'where our main operations should be based?'

The selection of location is a key-decision as large investment is made in building plant and machinery. An improper location of plant may lead to waste of all the investments made in plant and machinery equipments. Hence, location of plant should be based on the company's expansion plan and policy, diversification plan for the products, changing sources of raw materials and many other factors. The purpose of the location study is to find the optimal location that will results in the greatest advantage to the organization.

2. PLANT LAYOUT AND MATERIAL HANDLING

Plant layout refers to the physical arrangement of facilities. It is the configuration of departments, work centers and equipment in the conversion process. The overall objective of the plant layout is to design a physical arrangement that meets the required output quality and quantity most economically.

According to **James Moore, "Plant layout** is a plan of an optimum arrangement of facilities including personnel, operating equipment, storage space, material handling equipments and all other supporting services along with the design of best structure to contain all these facilities".

'Material Handling' refers to the 'moving of materials from the store room to the machine and from one machine to the next during the process of manufacture'. It is also defined as the 'art and science of moving, packing and storing of products in any form'. Material handling devices increases the output, improves quality, speeds up the deliveries and decreases the cost of production. Hence, material handling is a prime consideration in the designing new plant and several existing plants.

3. PRODUCT DESIGN

Product design deals with conversion of ideas into reality. Every business organization has to design, develop and introduce new products as a survival and growth strategy. Developing the new products and launching them in the market is the biggest challenge faced by the organizations.

The entire process of need identification to physical manufactures of product involves three functions: marketing, product development, and manufacturing. Product development translates the needs of customers given by marketing into technical specifications and designing the various features into the product to these specifications. Manufacturing has the responsibility of selecting the processes by which the product can be manufactured. Product design and development provides link between marketing, customer needs and expectations and the activities required to manufacture the product.

4. PROCESS DESIGN

Process design is a macroscopic decision-making of an overall process route for converting the raw material into finished goods. These decisions encompass the selection of a process, choice of technology, process flow analysis and layout of the facilities. Hence, the important decisions in process design are to analyze the workflow for converting raw material into finished product and to select the workstation for each included in the workflow.

5. PRODUCTION PLANNING AND CONTROL:

Production planning and control can be defined as the process of planning the production in advance, setting the exact route of each item, fixing the starting and finishing dates for each item, to give production orders to shops and to follow up the progress of products according to orders.

The principle of production planning and control lies in the statement 'First Plan Your Work and then Work on Your Plan'. Main functions of production planning and control includes planning, routing, scheduling, dispatching and follow-up.

Planning is deciding in advance what to do, how to do it, when to do it and who is to do it. Planning bridges the gap from where we are, to where we want to go. It makes it possible for things to occur which would not otherwise happen.

Routing may be defined as the selection of path which each part of the product will follow, which being transformed from raw material to finished products. Routing determines the most advantageous path to be followed from department to department and machine to machine till raw material gets its final shape.

Scheduling determines the program for the operations. Scheduling may be defined as 'the fixation of time and date for each operation' as well as it determines the sequence of operations to be followed.

Dispatching is concerned with the starting the processes. It gives necessary authority so as to start a particular work, which has already been planned under 'Routing' and 'Scheduling'. Therefore, dispatching is 'release of orders and instruction for the starting of production for any item in acceptance with the route sheet and schedule charts'.

The function of **follow-up** is to report daily the progress of work in each shop in a prescribed Performa and to investigate the causes of deviations from the planned performance.

6. QUALITY CONTROL

Quality Control (QC) may be defined as 'a system that is used to maintain a desired level of quality in a product or service'. It is a systematic control of various factors that affect the quality of the product. Quality control aims at prevention of defects at the source, relies on effective feedback system and corrective action procedure.

Quality control can also be defined as 'that industrial management technique by means of which product of uniform acceptable quality is manufactured'. It is the entire collection of activities which ensures that the operation will produce the optimum quality products at minimum cost.

The main objectives of quality control are:

- To improve the companies income by making the production more acceptable to the customers i.e., by providing long life, greater usefulness, maintainability, etc.
- To reduce companies cost through reduction of losses due to defects.
- To achieve interchangeability of manufacture in large scale production.
- To produce optimal quality at reduced price.
- To ensure satisfaction of customers with productions or services or high quality level, to build customer goodwill, confidence and reputation of manufacturer.
- To make inspection prompt to ensure quality control.
- To check the variation during manufacturing.

7. MATERIALS MANAGEMENT

Materials management is that aspect of management function which is primarily concerned with the acquisition, control and use of materials needed and flow of goods and services connected with the production process having some predetermined objectives in view.

The main objectives of materials management are:

- To minimize material cost.
- To purchase, receive, transport and store materials efficiently and to reduce the related cost.
- To cut down costs through simplification, standardization, value analysis, import substitution, etc.
- To trace new sources of supply and to develop cordial relations with them in order to ensure continuous supply at reasonable rates.
- To reduce investment tied in the inventories for use in other productive purposes and to develop high inventory turnover ratios.

8. MAINTENANCE MANAGEMENT

In modern industry, equipment and machinery are a very important part of the total productive effort. Therefore, their idleness or downtime becomes are very expensive. Hence, it is very important that the plant machinery should be properly maintained.

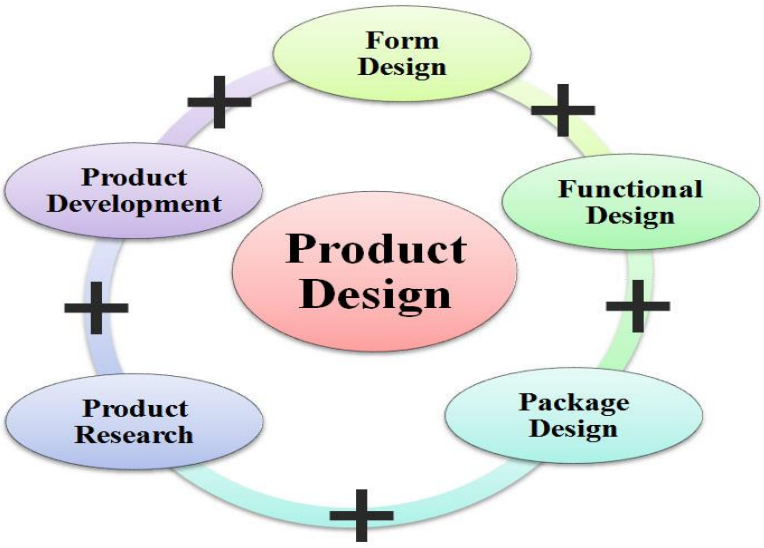
The main objectives of maintenance management are:

1. To achieve minimum breakdown and to keep the plant in good working condition at the lowest possible cost.
2. To keep the machines and other facilities in such a condition that permits them to be used at their optimal capacity without interruption.
3. To ensure the availability of the machines, buildings and services required by other sections of the factory for the performance of their functions at optimal return on investment.

PRODUCT DESIGN AND DEVELOPMENT

"**Product design** is the process of creating a new **product** to be sold by a **business** to its customers."

- **PRODUCT DESIGN INCLUDES THE FOLLOWING:**



1. Form design means the shape and appearance of the product.

2. Functional design means the working of the product. That is, how the product works. It is very important because the product will sell only if it works as expected.

Form design is less important because it adds nothing to the product's performance. However, it cannot be ignored because a product will not sell if it doesn't look good and is not appealing to buyers.

3. Package designing: An eye-catching attractive package lures customers to try a product; this increases sales.

4. Product research is done to discover new products.

5. Product development is done to improve the existing product.

- **CHARACTERISTICS OR FEATURES OF PRODUCT DESIGN**

1. **Innovative**.

A product design should not be without the possibility of innovation, meaning the product that will innovate the predecessor should also be considered as the one to be innovated once it hits past its prime. Innovation means that the product should be relatively new to the field, or contain some new

elements. Innovation should also include the added value, meaning it has to add something that will add value to the predecessor or current unit that wasn't introduced. For example, smart phones back then didn't have front-facing cameras, but the newer versions do now and have more powerful front-facing cams than the older unit's back camera. Getting business telephone systems with voicemail features can do wonders for your business.

2. **Makes a product useful**.

A good product needs to have both form and function. It needs to serve its function or functions. For example, hand dryers are convenient and found in all restaurants, and come in different sizes and features. They all look good and they all do only one thing: to dry hands. When a product lacks function, it also lacks in design because form follows function and function follows form. A product cannot also function properly if it wasn't formed well.

3. **Good design is aesthetic**.

Product designers cannot simply say that the product is designed that way in terms of aesthetic because it is artistic. A good design is aesthetic because it helps to generate a positive response from people, and aesthetics cover three fundamental human cravings: BALANCE, STRUCTURE, and COMPLETION. A product needs to look good and feel good, and has to be sturdy enough to withstand abuse. Case in point, the Gorilla Glass of the iPhone is an example of this current principle and principle #1 (innovation). The older iPhones had more fragile glasses and when it was dropped, the thing would shatter to a million pieces. The Gorilla Glass is both an aesthetic and innovative feature because it was made to improve an existing feature and it satisfies one human craving, which is STRUCTURE. Business telephone systems that look as good as they work can attract a lot of clients.

4. **Good design helps us to understand a product**.

Product design is not like painting on a canvass, where people have to guess what it means. A good product design should be able to tell how the product functions simply through how it looks. **For example**: hand dryer. It's a relatively simple product but comes with sleek designs. The

commonalities of the designs of hand dryers are its air vent and the one button that disperses the heat. These two alone should be able to tell an individual how it works minus the complicated manuals.

5. **Good design is durable**.

A good product needs to be durable. **For example** what good is a television if it short circuits easily? Oftentimes, product designers add more durability to a new product when the older version lacks durability.

6. Good design is honest

It does not make a product more innovative, powerful or valuable than it really is. It does not attempt to manipulate the consumer with promises that cannot be kept.

7. **Good design is concerned with the environment**.

Once a product is no longer of use to us, we immediately discard it as junk and throw it away. When it's mixed with the trash, some parts are actually considered as pollutants and maybe harmful to the environment. A good product design should be environment-friendly, like how the foam cups of coffee shops are now biodegradable or how an appliance is able to consume less electricity compared to its older predecessors. Pioneers of these kinds of technology are LG and Samsung, both of which are currently marketing their GREEN or eco-friendly appliances.

8. Profitability: Product design should make economic sense as to deliver value to customer and sustainability to the organization.

9. Differentiable: A good product design should enable product to be differentiate among its competition. This can be achieved by attractive packaging and also by providing additional service on the product

10. Producible: Product design should enable effective production of product through available production methods.

➢ FACTORS AFFECTING PRODUCT DESIGN

A successful product design is combination factors as follows:

1. Correct Team Selection: This is very essential to get the correct team in place which has expert designers who are not only aware and comfortable with technology but also understanding of customer expectation.

2. Customer Involvement: Involvement of customer in product design and testing can provide insight into the direction of the project

3. Prototyping and testing: Product design is high risk concept as it involves commitment of capital and man-power; therefore, it is imperative that extensive prototyping and testing are done with customer and market.

4. Raw Material: It is essential that raw material to be used in the production meets the quality standards of the end product. Furthermore, procurement system needs to be in place to ensure continuous, cost effective supply.

5. Production method and process layout: Feasibility of production method and process layout determines future success of the product.

6. External Factors: Environmental and government regulations plays an important part in product design. And these norms are updated from time to time, so product design should have the flexibility to adapt.

- **PRODUCT DEVELOPMENT:**

It is the process of finding out the possibilities of producing a product. It includes the decisions such as — whether it would be feasible or not to produce the product.

- ✓ Some scholars are of the view that product development includes the changes in the size, design, characteristics, color and packing, etc., of the product.

- ✓ Thus, product development includes the following — addition of a new product line to the product mix of the enterprise, elimination of a running product line from this product mix, addition of new product items to a product line, elimination of some existing product items from a product line, changes in the size, color, design, packing, form, quality, characteristics and price of a product, and discontinuation of an unprofitable product etc.

- ✓ **The aim of product development is to:**

1. Provide the goods the market demands in time.
2. Adjust with the variation in quantity required.
3. Charge the price which the consumer is willing to pay after ensuring reasonable profits for the organization.

➢ ELEMENTS OF PRODUCT DEVELOPMENT

The main elements of product developments are as follows:

1. To discover the feasibility of the production of product.

2. To develop qualities and characteristics of products.

3. To develop different models and designs of products.

4. To select the best model or design.

5. To decide about packing, color, size, form, etc., of the product.
6. Expansion and contraction of product mix.

7. Discontinuation of unprofitable product.

8. Improvement in products.

➢ ADVANTAGES OF PRODUCT DEVELOPMENT

Product development has become an important function of every enterprise. It provides several advantages to the enterprise. Some important advantages of product development are as follows:

1. Product development helps in producing the goods and services of best quality.
2. It provides maximum possible satisfaction to the consumers.

3. It helps in expanding the market for the products.

4. It helps in achieving stability in the demand of the products.
5. It minimizes the possibilities of obsolescence of products.

6. It helps in facing competition successfully and effectively.

7. It increases the goodwill of the organization.

8. It increases profit earning possibilities of the organization

- **PRODUCT DEVELOPMENT PROCESS**

1. Idea Generation

The first stage of the New Product Development is the idea generation. Ideas come from everywhere, can be of any form, and can be numerous. This stage involves creating a large pool of ideas from various sources, which include

- **Internal sources** – many companies give incentives to their employees to come up with workable ideas.
- **SWOT analysis** – Company may review its strength, weakness, opportunities and threats and come up with a good feasible idea.

- **Market research** – Companies constantly reviews the changing needs, wants, and trends in the market.
- **Customers** – Sometimes reviews and feedbacks from the customers or even their ideas can help companies generate new product ideas.
- **Competition** – Competitors SWOT analysis can help the company generate ideas.

2. Idea Screening

Ideas can be many, but good ideas are few. This second step of new product development involves finding those good and feasible ideas and discarding those which aren't. Many factors play a part here, these include –

- Company's strength,
- Company's weakness,
- Customer needs,
- Ongoing trends,
- Expected ROI,
- Affordability, etc.

3. Concept Development & Testing

The third step of the new product development includes concept development and testing. A concept is a detailed strategy or blueprint version of the idea. Basically, when an idea is developed in every aspect so as to make it presentable, it is called a concept.

All the ideas that pass the screening stage are turned into concepts for testing purpose. You wouldn't want to launch a product without its concept being tested.

The concept is now brought to the target market. Some selected customers from the target group are chosen to test the concept. Information is provided to them to help them visualize the product. It is followed by questions from both sides. Business tries to know what the customer feels about the concept. Does the product fulfil customer's need or want? Will they buy it when it's actually launched?

Their feedback helps the business to develop the concept further.

4. Business Strategy Analysis & Development

The testing results help the business in coming up with the final concept to be developed into a product.

Now that the business has a finalized concept, it's time for it to analyse and decide the marketing, branding, and other business strategies that will be used. Estimated product profitability, marketing mix, and other product strategies are decided for the product.
Other important analytics includes

- Competition of the product
- Costs involved
- Pricing strategies
- Breakeven point, etc.

5. Product Development

Once all the strategies are approved, the product concept is transformed into an actual tangible product. This development stage of new product development results in building up of a prototype or a limited production model. All the branding and other strategies decided previously are tested and applied in this stage.

6. Test Marketing

Unlike concept testing, the prototype is introduced for research and feedback in the test marketing phase. Customers feedback are taken and further changes, if required, are made to the product. This process is of utmost importance as it validates the whole concept and makes the company ready for the launch.

7. Commercialization

The product is ready, so should be the marketing strategies. The marketing mix is now put to use. The final decisions are to be made. Markets are decided for the product to launch in. This stage involves briefing different departments about the duties and targets. Every minor and major decision is made before the final introduction stage of the new product development.

- **PROCESS SELECTION**

Process Selection refers to the way an organization chooses to produce its good or services. It takes into account selection of technology, capacity planning, layout of facilities, and design of work systems. Process selection is a natural extension after selection of new products and services.

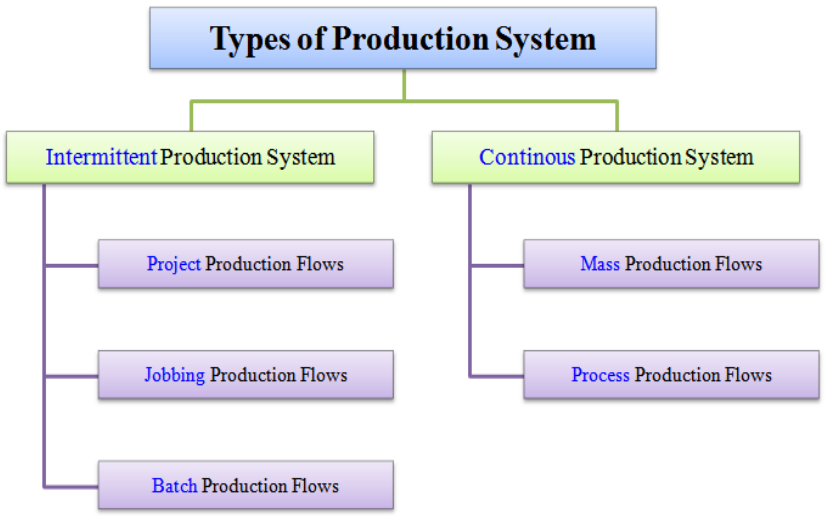
➢ PRODUCTION SYSTEM:

The production system of an organization is that part, which produces products of an organization. It is that activity whereby resources, flowing within a defined system, are combined and transformed in a controlled manner to add value in accordance with the policies communicated by management.

✓ The production system has the following characteristics:

1. Production is an organized activity, so every production system has an objective.
2. The system transforms the various inputs to useful outputs.
3. It does not operate in isolation from the other organization system.
4. There exists a feedback about the activities, which is essential to control and improve system performance.

✓ CLASSIFICATION OF PRODUCTION SYSTEM



➢ The types of production system are grouped under two categories viz.,

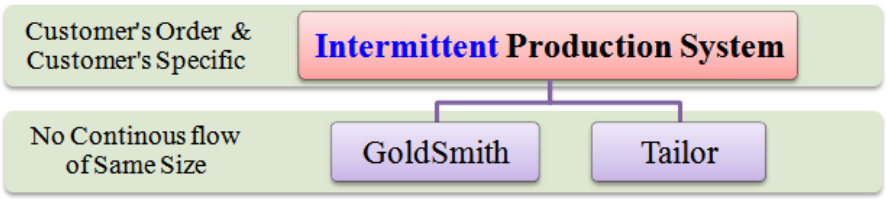
1. Intermittent production system, and

2. Continuous production system

1. INTERMITTENT PRODUCTION SYSTEM

Intermittent means something that starts (initiates) and stops (halts) at irregular (unfixed) intervals (time gaps).

In the intermittent production system, goods are produced based on customer's orders. These goods are produced on a small scale. The flow of production is intermittent (irregular). In other words, the flow of production is not continuous. In this system, large varieties of products are produced. These products are of different sizes. The design of these products goes on changing. It keeps changing according to the design and size of the product. Therefore, this system is very flexible.

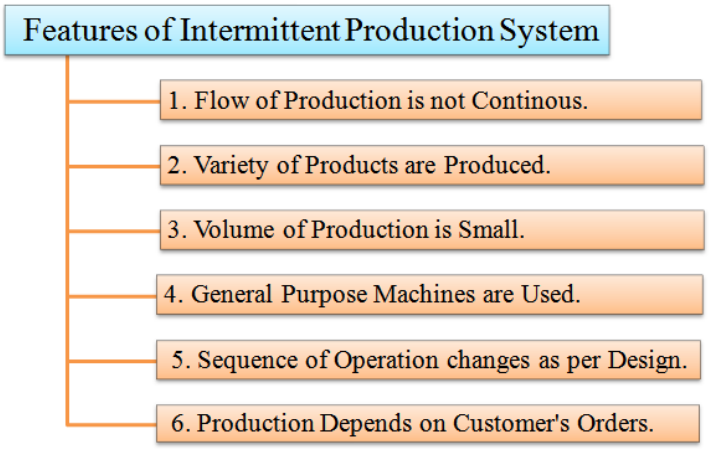


Following are examples on the intermittent production system. Please refer above chart while reading examples given below.

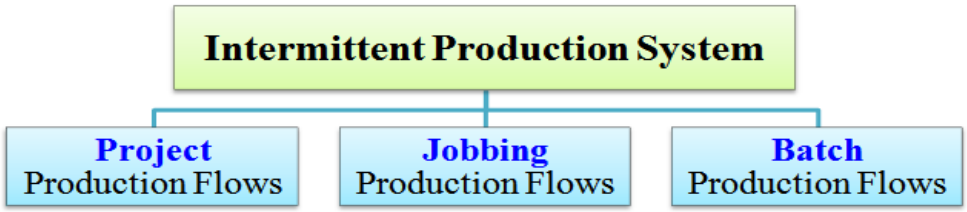
The work of a goldsmith is purely based on the frequency of his customer's orders. The goldsmith makes goods (ornaments) on a small-scale basis as per his customer's requirements. Here, ornaments are not done on a continuous basis.

Similarly, the work of a tailor is also based on the number of orders he gets from his customers. The clothes are stitched for every customer independently by the tailor as per one's measurement and size. Goods (stitched clothes) are made on a limited scale and is proportional to the number of orders received from customers. Here, stitching is not done on a continuous basis.

The features of an intermittent production system are depicted below



- **Types of intermittent production system**



The types of an intermittent production system include:

1.Project production flows,

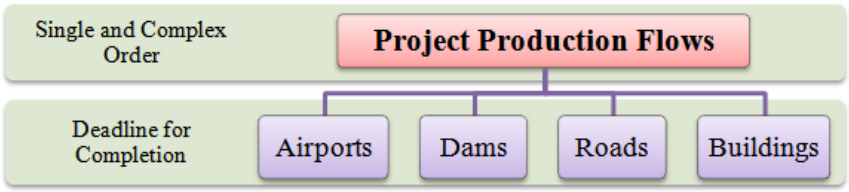
2.Jobbing production flows, and

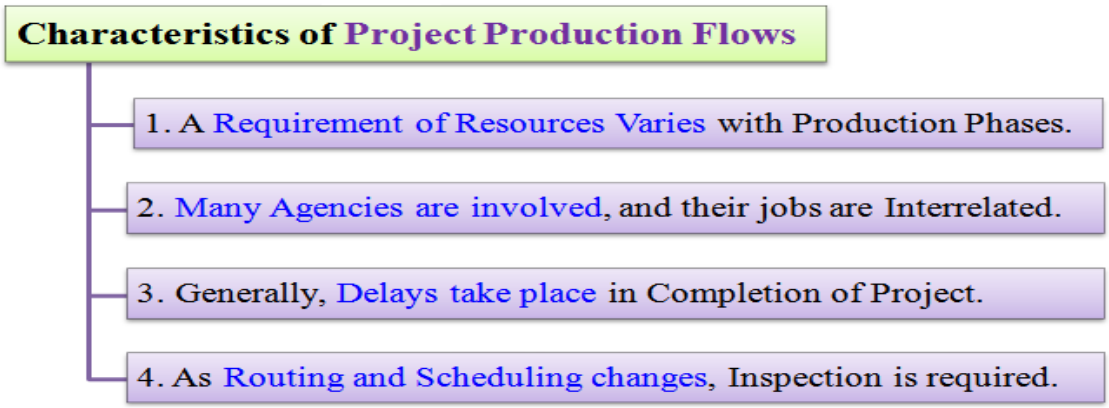
3.Batch production flows.

1. **Project production flows:**

In the project production flows, company accepts a single, complex order or contract. The order must be completed within a given period of time and at an estimated cost.

Examples of project production flows mainly include construction of airports, dams, roads, buildings, shipbuilding, etc.





1. The requirement of resources is not same (it varies). Generally, the resource requirement at the beginning is low. Then in mid of production, the requirement increases. Finally, it slows down when the project is near its completion phase.

2. Many agencies are involved in the project. Each agency performs specialized jobs. Here, coordination between agencies is important because all jobs are interrelated.

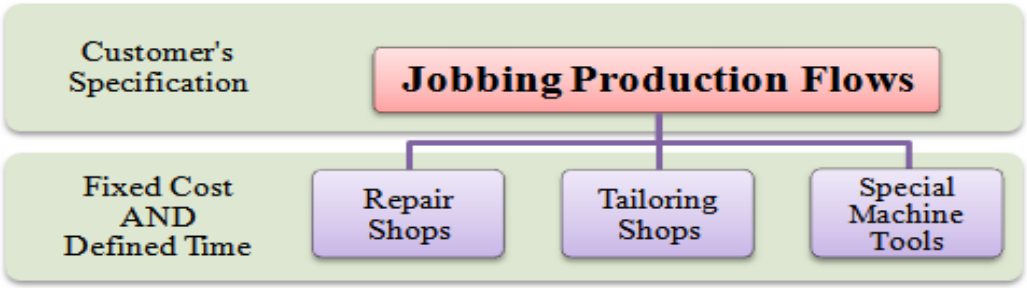
3. Delays take place in completion of projects due to its complexity and massiveness.

4. As routing and scheduling changes with fresh orders, proper inspection is required at each stage of production.

2. Jobbing production flows

Here, in jobbing production flows, company accepts a contract to produce either one or few units of a product strictly as per specifications given by the customer. The product is produced within a given period and at a fixed cost. This cost is fixed at the time of signing the contract.

Examples of such jobbing production flows include, services given by repair shops, tailoring shops, manufacturer of special machine tools, etc.



1. The production of items takes place in small lots. Sometimes only one product is produced at one time.

2. The items are manufactured strictly as per customer's specifications.

3.Highly skilled labour is required to perform specialized jobs.

4. There is disproportionate manufacturing cycle time. For e.g. the time needed to design the product may be more than the manufacturing time.

✓ **Advantages**

Following are the advantages of job shop production:

1. Because of general purpose machines and facilities variety of products can be produced.
2. Operators will become more skilled and competent, as each job gives them learning opportunities.

3. Full potential of operators can be utilized.
4. Opportunity exists for creative methods and innovative ideas.

✓ **Limitations**

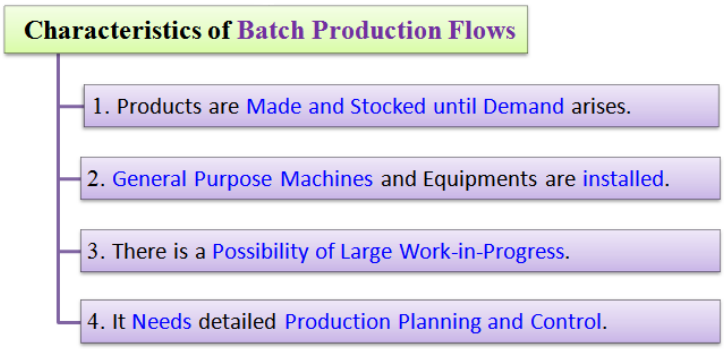
Following are the limitations of job shop production:

1. Higher cost due to frequent set up changes.
2. Higher level of inventory at all levels and hence higher inventory cost.
3. Production planning is complicated.
4. Larger space requirements

3. Batch production flows

In batch production flows, the production schedule is decided according to specific orders or are based on the demand forecasts. Here, the production of items takes place in lots or batches. A product is divided into different jobs. All jobs of one batch of production must be completed before starting the next batch of production.

Examples of batch production flows include, manufacturing of drugs and pharmaceuticals, medium and heavy machineries, etc.



1. The products are made and kept in stock until their demand arises in the market.

2. General purpose machines and handling equipments, which can do many different jobs quickly are installed. This is because large varieties of items are to be produced.

3. There is a possibility of large work-in-progress due to many reasons.

4. There is a need for detailed production planning and control.

5. When there is shorter production runs.

6. When plant and machinery are flexible.

7. When plant and machinery set up is used for the production of item in a batch and change of set up is required for processing the next batch.

8. When manufacturing lead time and cost are lower as compared to job order production.

✓ **Advantages**

Following are the advantages of batch production:

1. Better utilization of plant and machinery.
2. Promotes functional specialization.
3. Cost per unit is lower as compared to job order production.
4. Lower investment in plant and machinery.
5. Flexibility to accommodate and process number of products.
6. Job satisfaction exists for operators.

✓ **Limitations**

Following are the limitations of batch production:

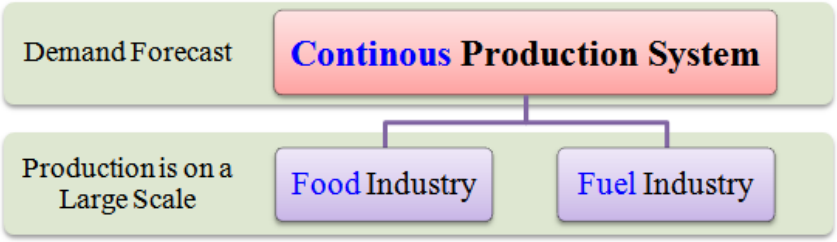
1. Material handling is complex because of irregular and longer flows.
2. Production planning and control is complex.
3. Work in process inventory is higher compared to continuous production.
4. Higher set up costs due to frequent changes in set up.

2. CONTINUOUS PRODUCTION SYSTEM

Continuous means something that operates constantly without any irregularities or frequent halts.

In the continuous production system, goods are produced constantly as per demand forecast. Goods are produced on a large scale for stocking and selling. They are not produced on customer's orders. Here, the inputs and outputs are standardized along with the production process and sequence.

Following chart highlights the concept of a continuous production system.

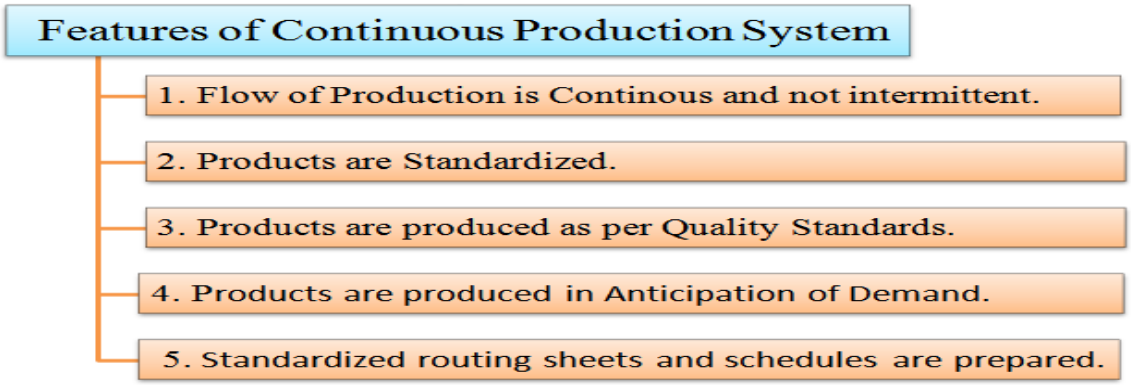


Following are **examples** on the continuous production system. Please refer above chart while reading examples given below.

The production system of a food industry is purely based on the demand forecast. Here, a large-scale production of food takes place. It is also a continuous production.

Similarly, the production and processing system of a fuel industry is also purely based on, demand forecast. Crude oil and other raw sources are processed continuously on a large scale to yield usable form of fuel and compensate global energy demand.

- **The features of a continuous production system are depicted below**.



- **The types of continuous production system include**:

1. Mass production flows, and

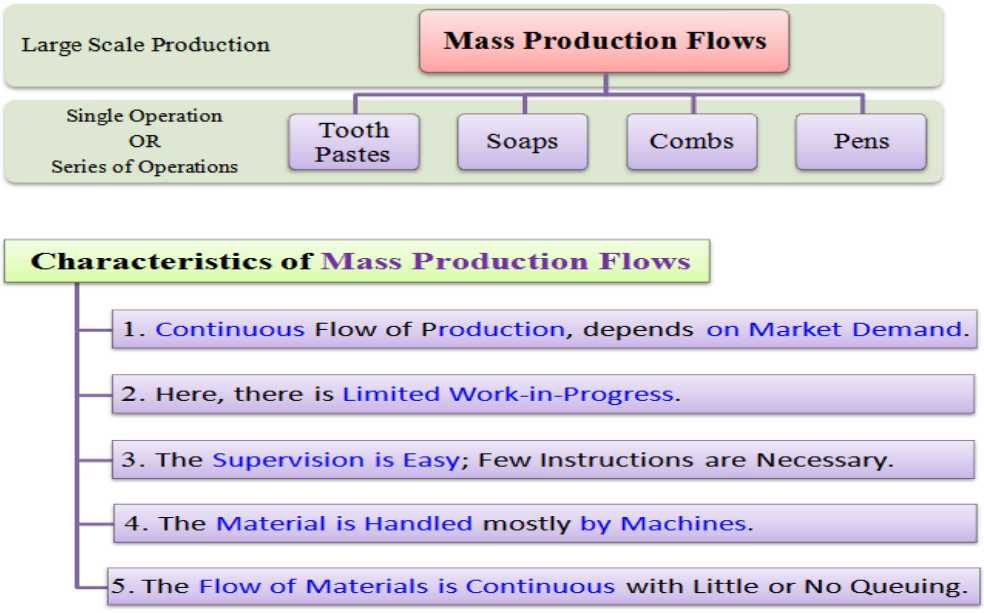
2. Process production flows.

1. Mass production flows

Here, company produces different types of products on a large-scale and stock them in warehouses until they are demanded in the market.

The goods are produced either with the help of a single operation or uses a series of operations.

E.g. of mass production is the production of toothpastes, soaps, pens, etc.



1. There is a continuous flow of production. However, this depends on the demand in the market.

2. Here, there is limited work-in-progress.

3. Supervision is easy because only few instructions are necessary.

4. The material handling is done mostly by machines, i.e. conveyors and automatic transfer machines.

5. The flow of materials is continuous. There is little or no queuing at any stage of production.

6. Standardization of product and process sequence.
7. Dedicated special purpose machines having higher production capacities and output rates.
8. Large volume of products.
9. Shorter cycle time of production.
10. Production planning and control is easy.

✓ **Advantages**

Following are the advantages of mass production:

1. Higher rate of production with reduced cycle time.
2. Higher capacity utilization due to line balancing.
3. Less skilled operators are required.
4. Low process inventory.
5. Manufacturing cost per unit is low.

✓ **Limitations**

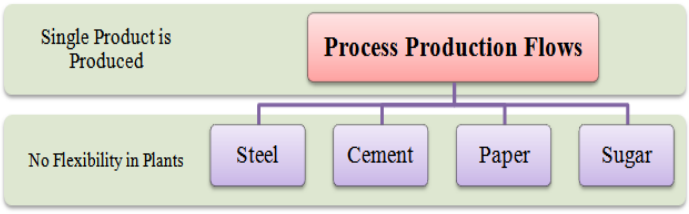
Following are the limitations of mass production:

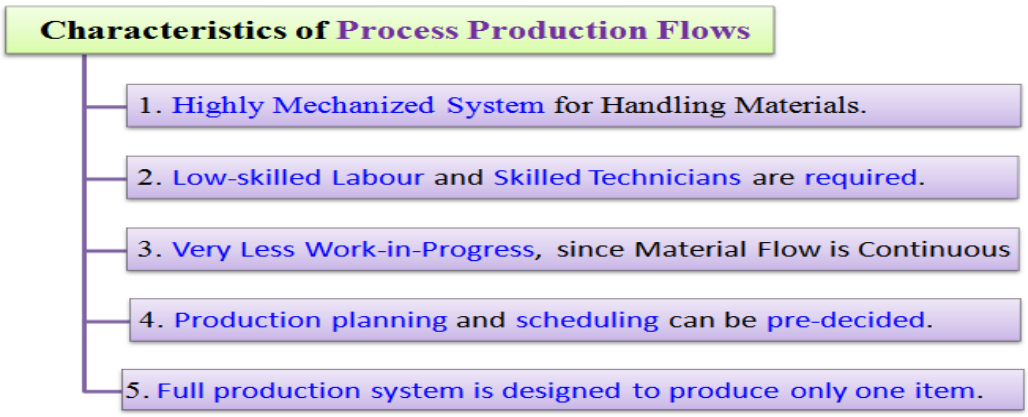
1. Breakdown of one machine will stop an entire production line.
2. Line layout needs major change with the changes in the product design.
3. High investment in production facilities.
4. The cycle time is determined by the slowest operation

2. Process production flows

Here, a single product is produced and stocked in warehouses until it is demanded in the market. The flexibility of these plants is almost zero because only one product can be produced.

Examples of these plants include, steel, cement, paper, sugar, etc.





1. There is a highly mechanized system for handling materials. Conveyors and automatic transfer machines are used to move the materials from one stage to another.

2. Low-skilled labour and skilled technicians are required.

3. There is very less work-in-progress because material flow is continuous.

4. The production planning and scheduling can be decided well in advance.

5. The full production system is designed to produce only one specific type of item.

✓ **Advantages**

Following are the advantages of continuous production:

1. Standardization of product and process sequence.
2. Higher rate of production with reduced cycle time.
3. Higher capacity utilization due to line balancing.
4. Manpower is not required for material handling as it is completely automatic.
5. Person with limited skills can be used on the production line.
6. Unit cost is lower due to high volume of production.

✓ **Limitations**

Following are the limitations of continuous production:

1. Flexibility to accommodate and process number of products does not exist.
2. Very high investment for setting flow lines.

3. Product differentiation is limited.

UNIT-II

FACILITY LOCATION

- **INTRODUCTION:**

Location of an industry is an important management decision. It is a two-step decision: first, choice of general area or region and second, the choice of site within the area selected. Location decision is based on the organizations long-term strategies such as technological, marketing, resource availability and financial strategies.

The objective of plant location decision-making is to minimize the sum of all costs affected by location.

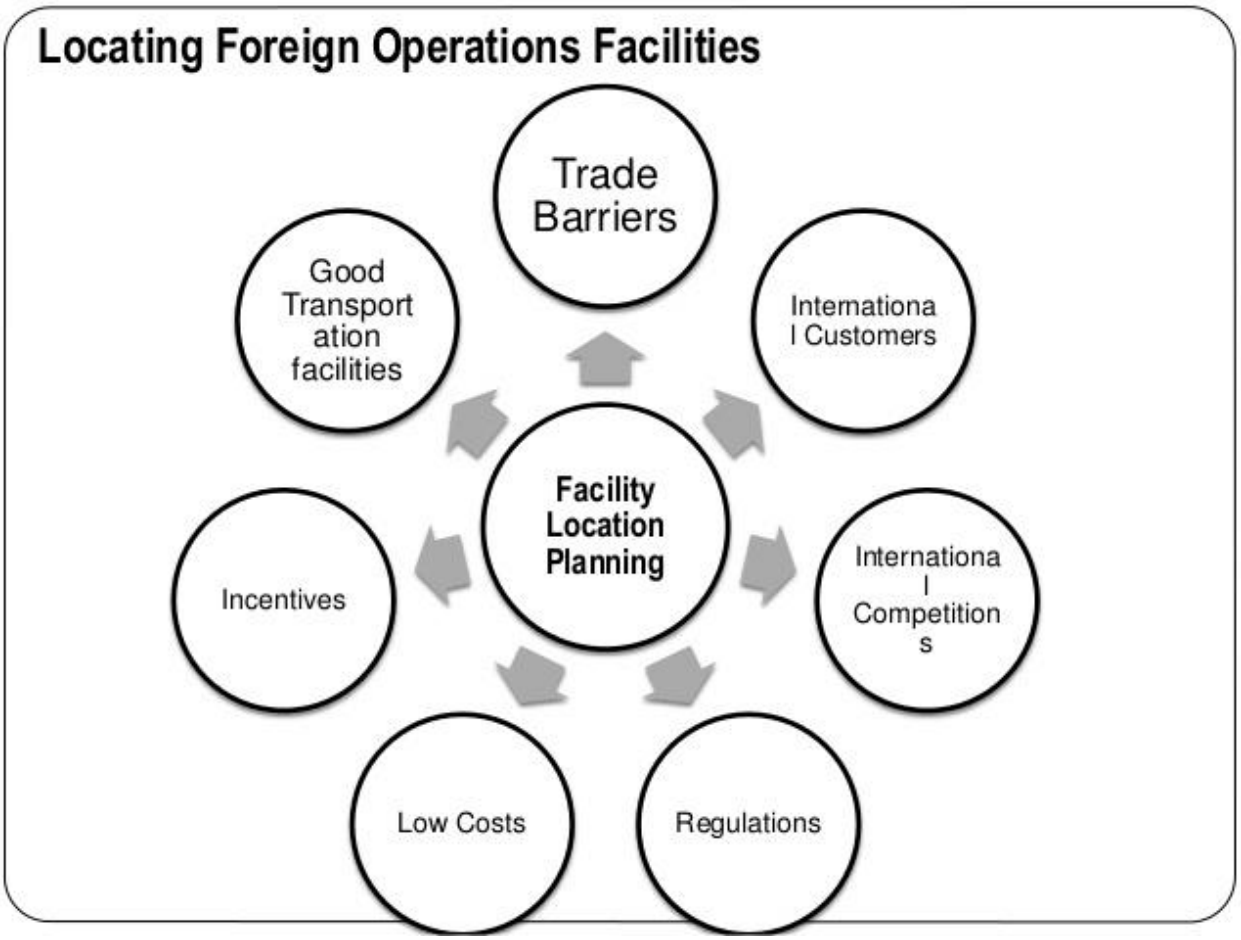
- **MEANING:**

Facility location may be defined as a place where the facility will be set up for producing goods or services. The need for location selection may arise under any of the following conditions: a. When a business is newly started.

b. When the existing business unit has outgrown its original facilities and expansion is not possible; hence a new location has to be found.

c. When the volume of business or the extent of market necessitates the establishment of branches.

d. When the lease expires and the landlord does not renew the lease.



- **IMPORTANCE OF FACILITY LOCATION PLANNING**

Location planning is important because it affects the cost, selling price, and demand of the product. It is a one time and non-recurring heavy expenditure.

1. Expansion : If the company wants to expand and diversify its activities, it will have to search for a new-location for setting up its new business unit. In this case, it will need a location planning.

2. Cost advantages : If an existing plant is not near a market place, it will increase the transport cost. This will also increase the cost of the product. So, to avoid this, the company will search for a new plant location which is near the market. Such location of plant must be convenient to the employees and must have a regular supply of water and electricity. Overall, this will result in reduction of the cost of production.

3. Discovery of raw-material : Generally, a plant must be located at a place where raw-material is available. For example, if oil and gas are found at some place, then a new petrochemical plant has to be set up there for processing purpose.

4. Additional facilities : Plant location-related decisions will have to be taken if the organization wants additional facilities. New facilities may be necessary to improve the quality of work, to meet rising demands, etc.

5. Mergers : Mergers, joint-ventures, and Amalgamations may lead to start a new unit at a new-location. It may even require closure of an existing plant unit. In mergers, production is mostly started at a new place as per the new-agreement.

6. Political and social changes : Each political party has its own philosophy. Political changes can lead to changes in economic policies of the government. This may make the existing location

unattractive for doing business. Social changes may require production of eco-friendly goods. This may require a change in location.

7. Increasing product demand : Demand for the company's product may increase at other places, especially in abroad countries. So, the company will have to start a branch in another state or in foreign countries. This would lead to a search for new location of plant.

8. Avail tax benefits: Government may announce some tax benefits for starting a business in rural areas. This may motivate entrepreneurs to start their business units in remote areas.

➢ FACTORS INFLUENCING PLANT LOCATION

1. Proximity to markets:

Every company is expected to serve its customers by providing goods and services at the time needed and at reasonable price organizations may choose to locate facilities close to the market or away from the market depending upon the product. When the buyers for the product are concentrated, it is advisable to locate the facilities close to the market. Locating nearer to the market is preferred if

a) The products are delicate and susceptible to spoilage.

b) After sales services are promptly required very often.

c) Transportation cost is high and increase the cost significantly.

2. Availability of Raw Materials:

One of the most important considerations involved in selection of industrial location has been the availability of raw materials required. The biggest advantage of availability of raw material at the location of industry is that it involves less cost in terms of ‘transportation cost.

If the raw materials are perishable and to be consumed as such, then the industries always tend to locate nearer to raw material source. Steel and cement industries can be such examples. In the case of

small- scale industries, these could be food and fruit processing, meat and fish canning, jams, juices and ketchups, etc.

3. Infrastructure availability:

The basic infrastructure facilities like power, water and waste disposal, etc., become the prominent factors in deciding the location. Certain types of industries are power hungry e.g., aluminum and steel and they should be located close to the power station or location where uninterrupted power supply is assured throughout the year. The non-availability of power may become a survival problem for such industries. Process industries like paper, chemical, cement, etc., require continuous. Supply of water in large amount and good quality, and mineral content of water becomes an important factor. A waste disposal facility for process industries is an important factor, which influences the plant location.

4. Government Policy:

In order to promote the balanced regional development, the Government also offers several incentives, concessions, tax holidays for number of years, cheaper power supply, factory shed, etc., to attract the entrepreneurs to set up industries in less developed and backward areas. Then, other factors being comparative, these factors become the most significant in deciding the location of an industry.

5. Availability of Manpower and prevailing wage rate:

Availability of required manpower skilled in specific trades may be yet another deciding factor for the location of skill- intensive industries. As regards the availability of skilled labour, the existence of technical training institutes in the area proves useful. Besides, an entrepreneur should also study labour relations through turnover rates, absenteeism and liveliness of trade unionism in the particular area.

Such information can be obtained from existing industries working in the area. Whether the labour should be rural or urban; also assumes significance in selecting the location for one's industry. Similarly, the wage rates prevalent in the area also have an important bearing on selection of location decision.

6. Local Laws, Regulations and Taxes:

Laws prohibit the setting up of polluting industries in prone areas particularly which are environmentally sensitive. Air (Prevention and Control of Pollution) Act, 1981 is a classical example of such laws prohibiting putting up polluting industries in prone areas.

7. Ecological and Environmental Factors:

In case of certain industries, the ecological and environmental factors like water and air pollution may turn out to be negative factor in deciding enterprise location. For example, manufacturing plants apart from producing solid waste can also pollute water and air. Moreover, stringent waste disposal laws, in case of such industries, add to the manufacturing cost to exorbitant limits.

In view of this, the industries which are likely to damage the ecology and environment of an area will not be established in such areas. The Government will not grant permission to the entrepreneurs to establish such industries in such ecologically and environmentally sensitive areas

8. Competition:

In case of some enterprises like retail stores where the revenue of a particular site depends on the degree of competition from other competitors' location nearby plays a crucial role in selecting the location of an enterprise. The areas where there is more competition among industries, the new units will not be established in these areas. On the other hand, the areas where there is either no or very less competition, new enterprises will tend to be established in such areas.

9. Climatic Conditions:

Climatic conditions vary from place to place in any country including India. And, climatic conditions affect both people and manufacturing activity. It affects human efficiency and behaviour to a great extent. Wild and cold climate is conducive to higher productivity. Likewise, certain industries require specific type of climatic conditions to produce their goods. **For example,** jute and textiles manufacturing industries require high humidity.

10. Political Conditions:

Political stability is essential for industrial growth. That political stability fosters industrial activity and political upheaval derails industrial initiates is duly confirmed by political situations across the countries and regions within the same country. The reason is not difficult to seek.

The political stability builds confidence and political instability causes lack of confidence among the prospective and present entrepreneurs to venture into industry which is filled with risks. Community attitudes such as the "Sons of the Soil Feeling" also affect entrepreneurial spirits and may not be viable in every case.

- **TECHNIQUES**

1. Factor Rating Method: A location method that instills objectivity into the process of identifying hard to evaluate costs. It is a Popular method because a wide variety of factors can be included in the analysis. It includes **six steps**

–Develop a list of relevant factors called key success factors
–Assign a weight to each factor
–Develop a scale for each factor
–Score each location for each factor
–Multiply score by weights for each factor for each location
–Recommend the location with the highest point score

2**. Location Break Even Analysis**

• It is used to determine which location provides the lowest cost. It involves Three Steps
–Determine the fixed and variable cost for each location
–Plot the cost for each location
–Select location with the lowest total cost for expected production volume.

3. Center of Gravity Method

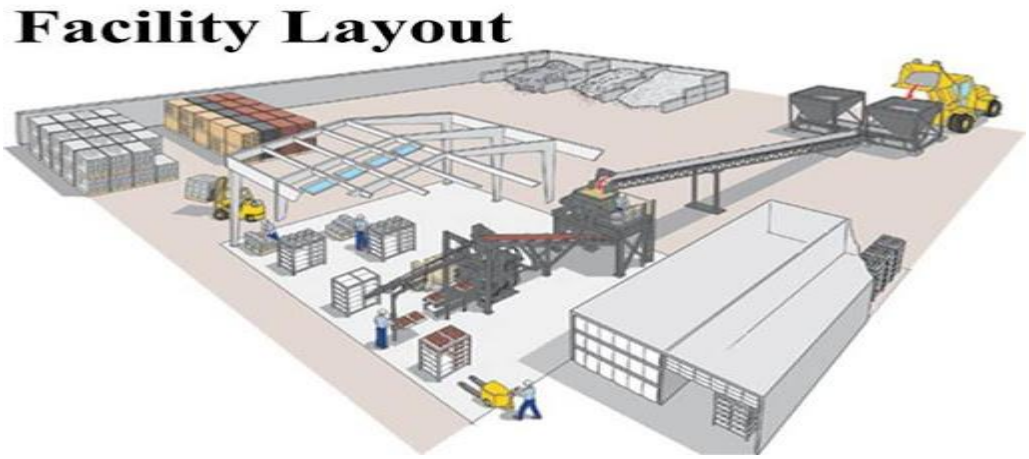
- It Finds location of distribution center that minimizes distribution costs
- This method takes into account the Location of markets.
- Volume of goods shipped to those markets
- Shipping Costs for distribution center

4. Transportation Model

- Finds an initial feasible solution and then makes step bystep improvements until an optimal solution is reached.
- Solutions will minimize total production and shipping costs

FACILITY LAYOUT

It is an arrangement of different aspects of manufacturing in an appropriate manner as to achieve desired production results. **Facility layout** considers available space, final product, safety of users and facility and convenience of operations.



➢ **Objectives/Advantages of Plant Layout:**

Following are the objectives/advantages of plant layout:

(i) Streamline flow of materials through the plant

(ii) Minimize material handling

(iii) Facilitate manufacturing progress by maintaining balance in the processes

(iv) Maintain flexibility of arrangements and of operation

(v) Maintaining high turnover of in-process inventory

(vi) Effective utilisation of men, equipment and space

(vii) Increase employee morale

(viii) Minimise interference (i.e. interruption) from machines

(ix) Reduce hazards affecting employees

(x) Hold down investment (i.e. keep investment at a lower level) in equipment.

- **PRINCIPLES OF PLANT/ FACILITY LAYOUT:**

While designing the plant layout, the following principles must be kept in view:

(i) Principle of Minimum Movement:

Materials and labour should be moved over minimum distances; saving cost and time of transportation and material handling.

(ii) Principle of Space Utilization:

All available cubic space should be effectively utilized – both horizontally and vertically.

(iii) Principle of Flexibility:

Layout should be flexible enough to be adaptable to changes required by expansion or technological development.

(iv) Principle of Interdependence:

Interdependent operations and processes should be located in close proximity to each other; to minimize product travel.

(v) Principle of Overall Integration:

All the plant facilities and services should be fully integrated into a single operating unit; to minimize cost of production.

(vi) Principle of Safety:

There should be in-built provision in the design of layout, to provide for comfort and safety of workers.

(vii) Principle of Smooth Flow:

The layout should be so designed as to reduce work bottlenecks and facilitate uninterrupted flow of work throughout the plant.

(viii) Principle of Economy:

The layout should aim at effecting economy in terms of investment in fixed assets.

(ix) Principle of Supervision:

A good layout should facilitate effective supervision over workers.

(x) Principle of Satisfaction:

A good layout should boost up employee morale, by providing them with maximum work satisfaction.

- **TYPES OF FACILITY LAYOUT:**

Two basic plans of the arrangement of manufacturing facilities are – product layout and process layout. The only other alternative is a combination of product and process layouts, in the same plant.

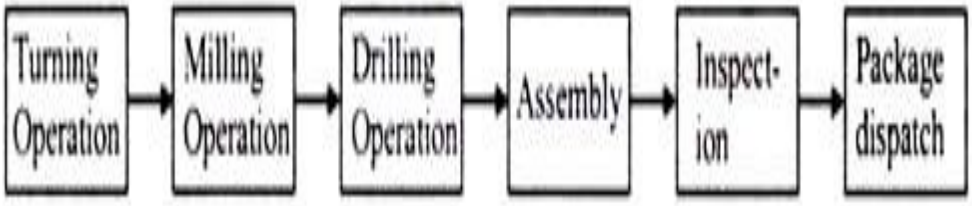
- **Following is an account of the various types of plant layout:**

(a) Product Layout (or Line Layout):

In this type of layout, all the machines are arranged in the sequence, as required to produce a specific product. It is called line layout because machines are arrange in a straight line. The raw materials are fed at one end and taken out as finished product to the other end.

Special purpose machines are used which perform the required jobs (i.e. functions) quickly and reliably.

Product layout is depicted below:



- **ADVANTAGES:**

1. Reduced material handling cost due to mechanized handling systems and straight flow

2. Perfect line balancing which eliminates bottlenecks and idle capacity.

3. Short manufacturing cycle due to uninterrupted flow of materials

4. Simplified production planning and control; and simple and effective inspection of work.

5. Small amount of work-in-progress inventory

6. Lesser wage cost, as unskilled workers can learn and manage production.

- **DISADVANTAGES:**

1. Lack of flexibility of operations, as layout cannot be adapted to the manufacture of any other type of product.

2. Large capital investment, because of special purpose machines.

3. Dependence of whole activity on each part; any breakdown of one machine in the sequence may result in stoppage of production.

4. Same machines duplicated for manufacture of different products; leading to high overall operational costs.

5. Delicate special purpose machines require costly maintenance / repairs.

- **Suitability of product layout:**

Product layout is suitable in the following cases:

1. Where one or few standardized products are manufactured.

2. Where a large volume of production of each item has to travel the production process, over a considerable period of time.

3. Where time and motion studies can be done to determine the rate of work.

4. Where a possibility of a good balance of labour and equipment exists.

5. Where minimum of inspection is required, during sequence of operations.

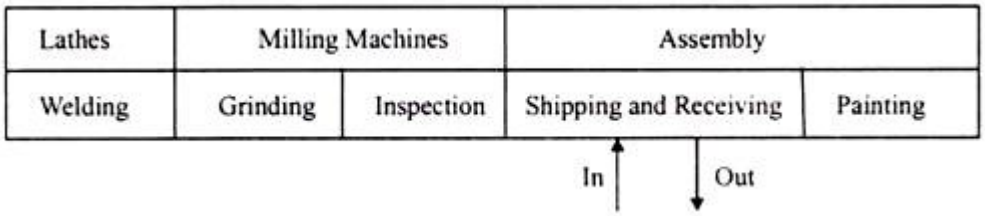
6. Where materials and products permit bulk or continuous handling by mechanical parts.

7. Where minimum of set-ups are required.

(b) Process Layout (or Functional Layout):

In this type of layout, all machines performing similar type of operations are grouped at one location i.e. all lathes, milling machines etc. are grouped in the shop and they will be clustered in like groups.

A typical process layout is depicted below:



Advantages:

1. Greater flexibility with regard to work distribution to machinery and personnel. Adapted to frequent changes in sequence of operations.

2. Lower investment due to general purpose machines; which usually are less costly than special purpose machines.

3. Higher utilisation of production facilities; which can be adapted to a variety of products.

4. Variety of jobs makes the work challenging and interesting.

5. Breakdown of one machine does not result in complete stoppage of work.

Disadvantages:

1. Backtracking and long movements occur in handling of materials. As such, material handling costs are higher.

2. Mechanisation of material handling is not possible.

3. Production planning and control is difficult

4. More space requirement; as work-in-progress inventory is high-requiring greater storage space.

5. As the work has to pass through different departments; it is quite difficult to trace the responsibility for the finished product.

- **Suitability of process layout:**

Process layout is suitable in the following cases, where:

1. Non-standardised products are manufactured; as the emphasis is on special orders.

2. It is difficult to achieve good labour and equipment balance.

3. Production is not carried on a large scale.

4. It is difficult to undertake adequate time and motion studies.

5. It is frequently necessary to use the same machine or work station for two or more difficult operations.

6. During the sequence of operations, many inspections are required.

7. Process may have to be brought to work, instead of **"vice-versa"**; because materials or products are too large or heavy to permit bulk or continuous handling by mechanical means.

(c) Combination Layout:

In practice, plants are rarely laid out either in product or process layout form. Generally a combination of the two basic layouts is employed; to derive the advantages of both systems of layout. For example, refrigerator manufacturing uses a combination layout.

Process layout is used to produce various operations like stamping, welding, heat treatment being carried out in different work centres as per requirement. The final assembly of the product is done in a product type layout.

(d) Fixed Position Layout:

It is also called stationary layout. In this type of layout men, materials and machines are brought to a product that remains in one place owing to its size. Ship-building, air-craft manufacturing, wagon building, heavy construction of dams, bridges, buildings etc. are typical examples of such layout.

CAPACITY PLANNING

Capacity planning is the process of determining the production capacity needed by an organization to meet changing demands for its products. In the context of capacity planning, design capacity is the maximum amount of work that an organization is capable of completing in a given period.

- Capacity planning is an integral part of the overall production planning for an enterprise. Capacity planning and control is the process of establishing, measuring, monitoring and adjusting the levels of capacity in order to execute all manufacturing plans and schedules in the best possible manner.
- Capacity planning involves the following questions.

1. What type of capacity is required?
2. How much capacity is required?
3. When the capacity is required?

➢ **The following concepts of capacity are involved in capacity planning**:

a. Design Capacity: It refers to the maximum output that can possibly be produced in a given period of time. It is the ideal situation.

b. Effective Capacity: Refers to the maximum possible output, given the changes in product mix, machine maintenance, scheduling and operating problems, labour problems, etc. It is usually less than the design capacity.

c. Actual Output: It is the rate of output actually achieved. It cannot exceed effective capacity due to machine breakdowns, labour absenteeism, irregular supply of raw materials, unusual delay in supply of equipment, power breakdown, etc.

- **DETERMINANTS OF EFFECTIVE CAPACITY OR FACTORS AFFECTING CAPACITY PLANNING:**

1. Facilities

The design of production facilities is the most important determinant of effective capacity. Design includes the size and also the provision for expansion of the facilities. Design facilities should be such that the employees should feel comfortable at their work place. Location factors such as distance from the market, supply of labour, transport costs, energy sources are also important. Layout of the work area determines how smoothly the work can be performed. Environmental factors such as lighting, ventilation, etc., influence the effectiveness with which employees can perform the assigned work.

2. Products or Services

Design of the company's products or services exerts a significant influence on capacity utilization. When more uniform is the output, greater can be the standardization of materials and methods and greater can be the utilization of capacity. For instance, a restaurant that offers a limited menu, can prepare and serve meals at a faster rate. Product mix should also be considered because different products have different rates of output.

3. Process

Quantity capacity of a process is the obvious determinant of effective capacity. But if quantity of output does not meet the quality standards, the rate of output is reduced due to the need for inspection and rework activities.

4. Human factors

Job design (tasks that comprise a job), nature of the job (variety of activities involved), training and experience required to perform the job, employee motivation, manager's leadership style, rate of absenteeism and labor are the main human factors influencing the rate of output.

5. Operational Factors

Materials management, scheduling, quality assurance, maintenance policies and equipment breakdowns are important determinants of effective capacity. Late delivery and low acceptability of materials will reduce effective capacity. Inventory problems are a major hurdle in a capacity utilization. Similarly, when the alternative equipment have different capabilities there may be scheduling problems.

6. External Factors

Product standards (minimum quality and performance standards), pollution control regulations, safety requirements and trade union attributes exercise tremendous influence on effective capacity. Generally, the external factors act as constraints in capacity utilization.

➢ IMPORTANCE OF CAPACITY PLANNING

Capacity planning is important due to the following reasons:

1. Capacity limits the rate of output. Therefore, capacity planning determines the ability of an enterprise to meet future demand for its products and services.

2. Capacity influences the operating costs. Capacity is determined on the basis of estimated demand. Actual demand is often different from estimated demand. As a result, there arises excess capacity or under capacity. Excess or idle capacity increases the cost per unit of output. Whereas under capacity results in the loss of sales.

3. Capacity decisions leave a direct impact on the amount of fixed investment made initially.

4. Capacity decisions result in long-term commitment of funds. Such long-term decisions cannot be reversed except at major costs.

➢ PROCEDURE FOR CAPACITY PLANNING

1. Assessment of Existing Capacity

Capacity of a unit can be measured in terms of output or inputs. Output measure is appropriate in case of manufacturing concerns, e.g., automobile plant (number of cars), iron and steel plant (tons of steel), brewery (barrels of bear), cannery (tons of food), power company, (megawatts of electricity), etc. Service concerns like hospitals (number of beds), airlines (number of seats), theatres (number of seats), restaurants (number of tables), university (number of students), warehouse (cubic feet of space), etc., can measure capacity in terms of inputs.

2. Forecasting Future Capacity Needs

Short term capacity requirements can be estimated by forecasting product demand at different stages of the product life cycle. It is more difficult to anticipate long-term capacity requirements due to uncertainties of market and technology. Capacity forecast helps to determine the gap between the existing capacity and estimated capacity so that necessary adjustments may be made. For example, a company engaged in manufacturing two products may find that one product has a low demand in summer (e.g. coffee or tea) while another product has low demand in winter (e.g. cold drink).

3. Identifying Alternative ways of Modifying Capacity

In case where the existing capacity is inadequate to meet the forecast demand capacity, the expansion is required to meet the shortage. Additional shifts may be employed to expand the capacity. Expansion will provide economies of scale and help in meeting the forecast demand. But it involves additional investment and danger of fall in forecast demand in future.

When the existing capacity exceeds forecast capacity, there is a need for reduction of excess capacity. Developing new products, selling of existing facilities, layout of workers or getting work from other firms are the methods of overcoming it.

4. Evaluation of Alternatives

Various alternatives for capacity expansion or reduction are evaluated from economic, technical and other viewpoints. Reactions of employees and local community should also be considered. Cost Benefit analysis, Decision theory and Queuing theory are the main techniques of evaluating alternatives.

5. Choice of Suitable Course of Action

After performing the cost-benefit analysis of various alternatives to expand or reduce the capacity, the most appropriate alternative is selected.

➢ PRODUCTION PLANNING AND CONTROL

Meaning:

Production planning and control is an important task of Production Manager. It has to see that production process is properly decided in advance and it is carried out as per the plan. Production is related to the conversion of raw materials into finished goods. This conversion process involves a number of steps such as deciding what to produce, how to produce, when to produce, etc. These decisions are a part, of production planning. Merely deciding about the task is not sufficient.

The whole process should be carried out in a best possible way and at the lowest cost. Production Manager will have to see that the things proceed as per the plans. This is a control function and has to be carried as meticulously as planning. Both planning and control of production are necessary to produce better quality goods at reasonable prices and in a most systematic manner.

Production planning is the function of looking ahead, anticipating difficulties to be faced and the likely remedial steps to remove them. It may be said to be a technique of forecasting ahead every step

in the long process of production, taking them at a right time and in the right degree and trying to complete the operations at maximum efficiency.

Production control guides and directs flow of production so that products are manufactured in a best way and conform to a planned schedule and are of the right quality. Control facilitates the task of manufacturing and sees that everything goes as per the plans.

- **OBJECTIVES OF PRODUCTION PLANNING AND CONTROL:**

Planning of production precedes control. Whatever is planned needs to be controlled. The ultimate objective of both planning and control is to use various inputs in an efficient way and to have a proper control over various targets and schedules fixed earlier.

- ✓ **Production Planning:**

1. To determine the requirements for men, materials and equipment.

2. Production of various inputs at a right time and in right quantity.

3. Making most economical use of various inputs.

4. Arranging production schedules according to the needs of marketing department.

5. Providing for adequate stocks for meeting contingencies.

6. Keeping up-to-date information processes.

- ✓ **Production Control:**

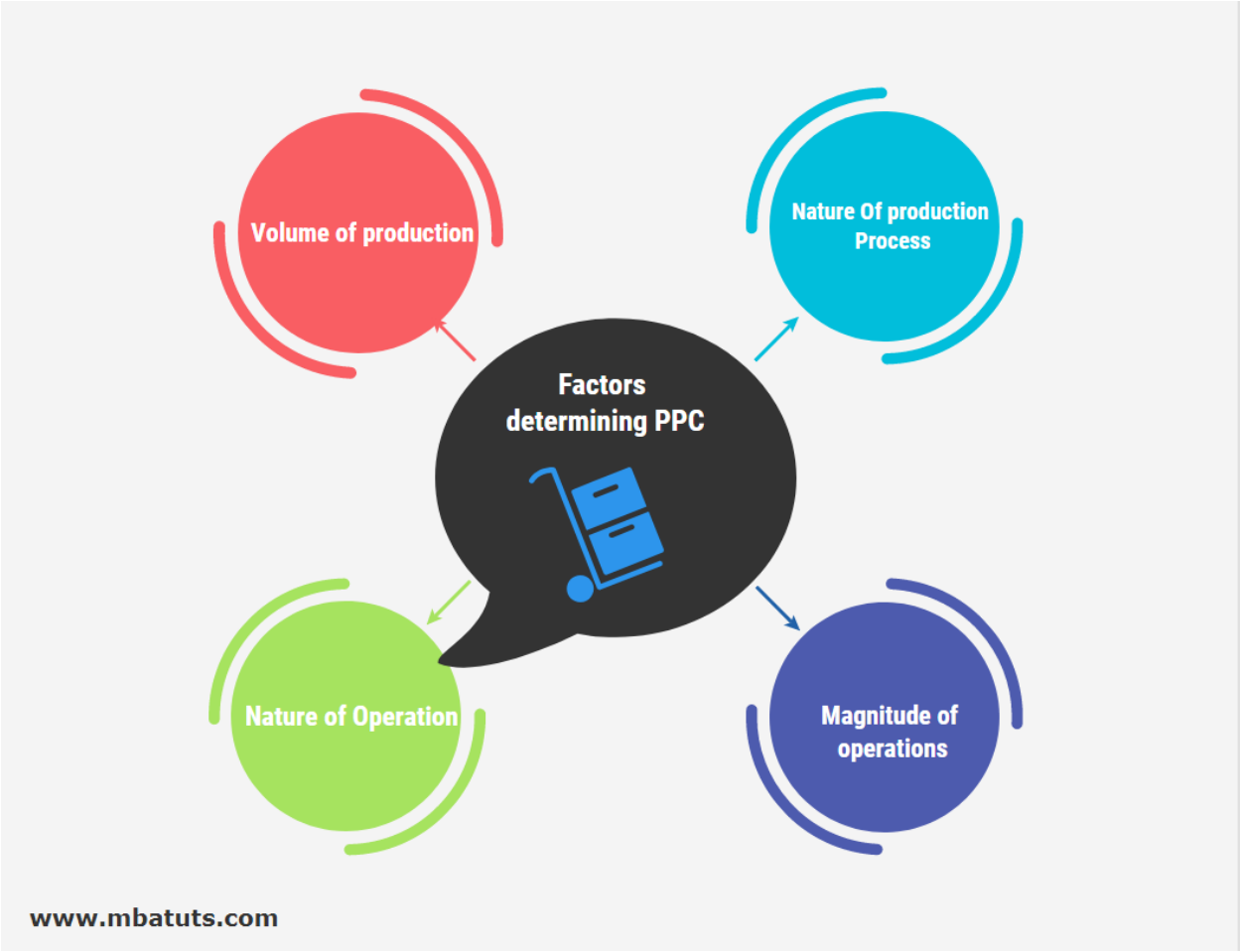
1. Making efforts to adhere to the production schedules.

2. Issuing necessary instructions to the staff for making the plans realistic.

3. To ensure that goods produced according to the prescribed standards and quality norms.

4. To ensure that various inputs are made available in right quantity and at proper time.

5. To ensure that work progresses according to the predecided plans.



➢ **Main elements of Production Planning & Control**

The following are main elements of Production Planning and Control.

1. Routing

It is about selection of path or route through which raw materials pass in order to make it into a finished product. The points to be noted while routing process are – full capacity of machines, economical and short route and availability of alternate routing. Setting up time for the process for each stage of route is to be fixed. Once overall sequence are fixed, then the standard time of operations are noted using work measurement technique.

2. Loading and scheduling

Loading and Scheduling are concerned with preparation of workloads and fixing of starting and completing date of each operation. On the basis of the performance of each machine, loading and scheduling tasks are completed.

3. Dispatching

Dispatching is the routine of setting productive activities in motion through the release of orders and instructions, in accordance with previously planned time and sequence, embodied in route sheet and schedule charts. It is here the orders are released.

4. Expediting / Follow-up

It is a control tool which brings an idea on breaking up, delay, rectifying error etc., during the progress of work.

5. Inspection

Inspection is to find out the quality of executed work process.

6. Corrective

At evaluation process, a thorough analysis is done and corrective measures are taken in the weaker spots.

➢ STAGES OF PRODUCTION PLANNING & CONTROL

Production Planning & Control is done in three stages namely,

1. Pre-planning
2. Planning
3. Control.

Stage 1: Pre-Planning

Under this phase of production planning, basic ground work on the product design, layout design and work flow are prepared. The operations relating to the availability scope and capacity of men, money materials, machines, time are estimated.

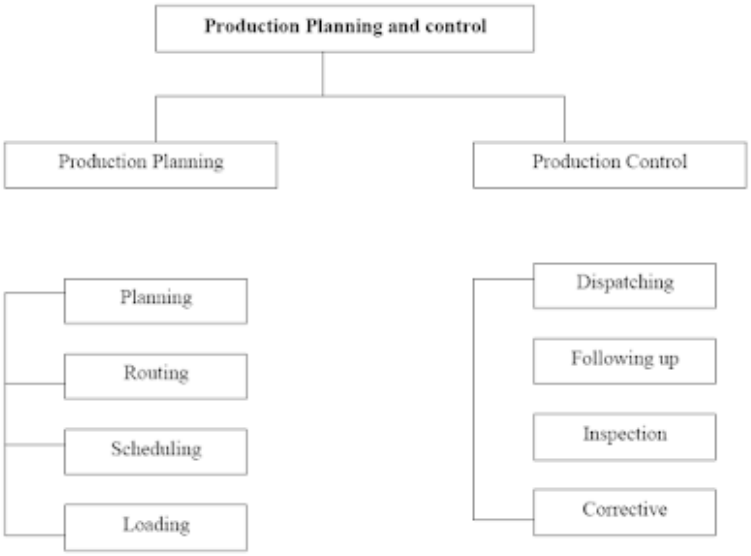
Stage 2: Planning

This is a phase where a complete analysis on routing, estimating and scheduling is done. It also tries to find out the areas of concern for short time and long time so that prominent planning can be prepared.

Stage 3: Control

Under this phase, the functions included are dispatching, follow up, inspection and evaluation. It tries to analyze the expedition of work in progress. This is one of the important phases of the Production Planning and Control

- **FUNCTIONS OF PRODUCTION PLANNING AND CONTROL :**



1. **Materials Function**:

Raw materials, finished parts and bought out components should be made available in required quantities and at required time to ensure the correct start and end for each operation resulting in uninterrupted production. The function includes the specification of materials (quality & quantity) delivery dates, variety reduction (standardization) procurement and make or buy decisions.

2. Machines and Equipment:

This function is related with the detailed analysis of available production facilities, equipment down time, maintenance policy procedure and schedules. Concerned with economy of jigs and fixtures,

equipment availability. Thus the duties include the analysis of facilities and making their availability with minimum down time because of breakdowns.

3. Methods:

This function is concerned with the analysis of alternatives and selection of the best method with due consideration to constraints imposed. Developing specifications for processes is an important aspect of PPC and determination of sequence of Operations.

4. Process Planning (Routing):

It is concerned with selection of path or route which the raw should follow to get transformed in to finished product

The duties include:

(a) Fixation of path of travel giving due consideration to layout.

(b) Breaking don of operations to define each operation in detail.

(c) Deciding the set up time and process time for each operation.

5. Estimating:

Once the overall method and sequence of operations is fixed and process sheet for each operation is available, then the operations times are estimated. This function is carried out using extensive analysis of operations along with methods and routing and standard times for operation are established using work measurement techniques.

6. Loading and Scheduling:

Scheduling is concerned with preparation of machine loads and fixation of Starting and completion dates for each of the operations. Machines have to be loaded according to their capability of performing the given task and according to their capacity.

Thus, the duties include:

(a) Loading the machines as per their capability and capacity.

(b) Determining the start and completion times for each operation.

(c) To Co-ordinate with sales department regarding delivery schedules.

7. Dispatching:

This is the execution phase of planning. It is the process of setting production activities in motion through release of orders and instructions. It authorises the start of Production activities by releasing materials, components, tools, fixtures and instruction sheets to the operator.

The activities involved are:

(a) To assign definite work to definite machines, work centres and men.

(b) To issue required materials from stores.

(c) To issue jigs, fixtures and make them available at correct point of use.

(d) Release necessary work orders, time tickets etc. to authorize timely start of operations.

(e) To record start and finish time of each job on each machine or by each man.

8. Expediting:

This is the control tool that keeps a close observation on the progress of the work. It is a logical step after dispatching which is called “follow-up” or “Progress”. It co-ordinates extensively to execute the production plan. Progressing function can be divided in to three parts, i.e. follow up of materials, follow up of work in process and follow up of assembly.

The duties include:

1. Identification of bottlenecks and delays and interruptions because of which the production schedule may be disrupted.

2. To devise action plans (remedies) for correct the errors.

3 To see that production rate is in line with schedule.

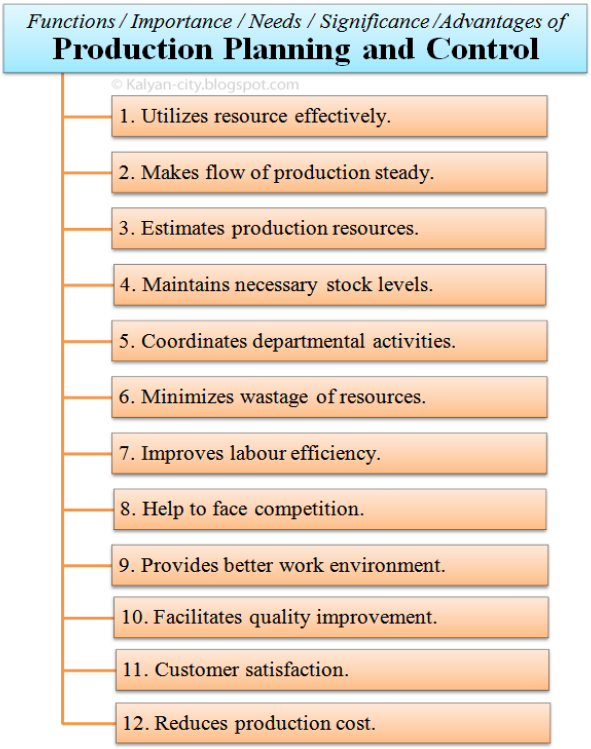
9. Inspection:

It is a measure control tool. Though the aspects of quality control are the separate function, this is of very much important to PPC both for the execution of the current plans and in scope for future planning. This forms the basis for knowing the limitations with respects to methods, processes etc. which is very much useful for evaluation phase.

10. Evaluation:

This stage though neglected is a crucial to the improvement of productive efficiency. A thorough analysis of all the factors influencing the production planning and control helps to identify the weak spots and the corrective action with respect to preplanning and planning will be effected by a feed back. The success of this step depends on the communication, Data and information gathering and analysis.

- **NEED SIGNIFICANCE ADVANTAGES OF PPC**



1. Utilizes resources effectively

Production planning and control result in effective utilization of plant capacity, equipment and resources.

It results in low-cost and high-returns for the organization.

2. Makes flow of production steady

Production planning and control ensure a regular and steady flow of production. All machines are put to their optimum use.This helps in achieving a continuous production of goods.This also helps to provide a regular supply of goods to consumers.

3. Estimates production resources

Production planning and control help to estimate the resources like men, materials, machines, etc.The estimate is made based on sales forecast.So, production is planned to meet sales requirements

4. Maintains necessary stock levels

Production planning and control prevent over-stocking and under-stocking of materials.

Necessary stocks are maintained. Stock of raw-material is maintained at a proper level in order to meet production demands. Stock of finished goods is also maintained to meet regular demands from customers.

5. Coordinates departmental activities

Production planning and control helps to co-ordinate the activities of different departments. Consider, for an example, the marketing department co-ordinates with production department to sell the goods.This results in profit to the organization.

6. Minimizes wastage of resources

Production planning and control ensure proper inventory of raw-materials and effective handling of materials. This helps to minimize the wastage of raw materials. It also ensures production of quality goods. This results in minimal rejects and minimum wastage.

7. Improves labor efficiency

There is maximum utilization of manpower.Training is provided to the workers.

The profits are shared with the workers in form of increased wages and other incentives.

Workers are motivated to perform their best. This results in improved labor efficiency.

8. Helps to face competition

Production planning and control help to give delivery of goods to customers in time.

This is because of regular flow of quality production. So, the company can face competition effectively, and it can capture the market.

9. Provides better work environment

Production planning and control provide a better work environment to workers.

They get better work facilities, proper working hours, leave and holidays, increased wages and other incentives.

10. Facilitates quality improvement

Production planning and control facilitate quality improvement because the production is checked regularly.

Quality consciousness is developed among the employees through training, suggestion schemes, quality circles, etc.

11. Customer satisfaction

Production planning and control help to give a regular supply of goods and services to consumers at competitive market price. This results in customer satisfaction.

12. Reduces production costs

Production planning and control make optimum utilization of resources, and it minimizes wastage. It also maintains an optimal level of inventories. Overall, this reduces the production costs.

UNIT-III

INTRODUCTION TO MODERN PRODUCTIVITY TECHNIQUES

➢ JUST IN TIME (JIT)

- ✓ **Just in Time (JIT**), as the name suggests, is a management philosophy that calls for the production of what the customer wants, when they want it, in the quantities requested, where they want it, without it being delayed in inventory.
- ✓ The just-in-time (JIT) inventory system is a management strategy that minimizes inventory and increases efficiency.
- ✓ Just-in-time (JIT) manufacturing is also known as the Toyota Production System (TPS) because the car manufacturer Toyota adopted the system in the 1970s.
- ✓ The success of the JIT production process relies on steady production, high-quality workmanship, no machine breakdowns, and reliable suppliers.
- ✓ JIT production systems cut inventory costs because manufacturers do not have to pay storage costs. Manufacturers are also not left with unwanted inventory if an order is canceled or not fulfilled.
- ✓ JIT is generally accepted as being a concept **invented by Taiichi Ohno of Toyota**; after World War2 resources were very scarce in Japan so using them to create something that the customer did not actually want right now was not a good idea.

On a visit to the US the management team of Toyota were inspired by, of all things, how they saw a supermarket (Piggly Wiggly) handle their inventory. Only what was removed from the shelves by the customers was actually replenished and ordered from suppliers. In this way shelves never became empty, nor did they end up overflowing with excessive inventory.

✓ JIT REMOVES SEVEN TYPES OF WASTES:

- Waste from overproduction.
- Waste of waiting time.
- Transportation waste.
- Processing waste.

- Inventory waste.
- Waste of motion.
- Waste from product defects.

✓ **THE BENEFITS OF A JIT SYSTEM**

1. **Reduction in the order to payment timeline**; cash, as they say is king in business. Many businesses will suffer with cash flow problems as they will often have to purchase large amounts of raw materials prior to manufacturing and subsequent payment by the customer. Often this gap is many months. Through implementing JIT you are able to considerably reduce that time period.
2. **Reduction in Inventory costs**; one of the main aims with any JIT implementation is to improve stock turns and the amount of stock being held. Along with the reduction in the stock come many other associated benefits like increase in profits.
3. **Reduction in space required**; by removing large amounts of stock from the system and moving processes closer together there will be a significant reduction in the amount of floor space being used.
4. **Reduction in handling equipment and other costs**; if there is no need to move large batches there is less need for complex machinery to move them and all of the associated labor and training.
5. **Lead time reductions**: lead times means the total time required to manufacture an item, including order preparation time, queue time, setup time, run time, move time, inspection time, and put-away time. For make-to-order products, it is the time taken from release of an order to production and shipment. For make-to-stock products, it is the time taken from the release of an order to production and receipt into finished goods inventory one of the most significantly impacted areas is that of the time it takes for products to flow through the process. Instead of weeks or months most JIT implementations result in lead times of hours or a few days.
6. **Reduced planning complexity**; the use of simple pull systems such as Kanban, even with the suppliers, can significantly reduce the need for any form of complex planning. With many implementations the only planning is the final shipping process.

7. **Improved Quality**; the removal of large batch manufacturing and reduction in handling often results in significant quality improvements;
8. **Productivity increases**; to achieve JIT there are many hurdles that must be overcome with regards to how the process will flow. These will often result in productivity improvements of 25% upwards.
9. **Problems are highlighted quicker**; often this is cited as being a negative aspect of JIT in that any problems will often have an immediate impact on your whole production process. However this is the perfect way to ensure that problems are highlighted and solved immediately when they occur.
10. **Employee empowerment**; one requirement of JIT as with most other aspects of Lean manufacturing is that employees are heavily involved in the design and application of the system.

✓ **DISADVANTAGES OF JIT:**

- There is little room for mistakes as minimal stock is kept for re-working faulty product
- Production is very reliant on suppliers and if stock is not delivered on time, the whole production schedule can be delayed
- There is no spare finished product available to meet unexpected orders, because all product is made to meet actual orders – however, JIT is a very responsive method of production

➢ **KANBAN SYSTEM:**

- The term Kanban is a Japanese word whose English translation means signboard or visual signal. A well-timed Kanban system works exactly like a traffic signal in managing the flow of traffic and meeting the real time needs of customers by sending clears signals on when to start, slow down, and stop production. Each Kanban signal also carries valuable information about the volume and sequencing of the production. Toyota originally used cards attached to different supply containers to communicate what materials in the production line were needed,
- Kanban is a Japanese manufacturing regulation system which makes use of an instruction manual to control the flow of work, usually the production line in a business. It is also sometimes called as lean manufacturing system.

- Kanban is a Japanese term which translates to 'billboard' or 'signboard'. It is a management tool which is used by companies to regulate the smooth running of activities.
- Kanban runs alongside with a just in time (JIT) system. Where JIT is the work approach under which producing right amount of goods at the right time is the key aim, kanban is a tracking system which keeps a trail of work to be started, work still in process (WIP) and the completed tasks.
- In a kanban system, **kanban cards** are a vital part. These cards are the main tool which indicate the progress of work for a company, movement of inventory for a manufacturing line and personals assigned to a task or service etc. It maintains the tasks which form the part of a specific operation of the company. All the related resources and employees are continuously informed about the progress that can trigger or delay the activities based upon the levels of completion. A basic kanban card consists of following heads:

Backlog	To Do Task	In Progress	Completed
Tasks not yet prioritized	Work items	Work items	Work items
Tasks not ready to be worked on	Work Items	Work Items	Work Items
Brainstorming cues	Work Items	Work Items	Work Items

"Backlog" of a kanban card highlights all the tasks that are yet to be started. These are either tasks that are not scheduled or the task force has not done necessary arrangements to commence these tasks in the first place.

"To Do Task" head of the card shows the tasks that are being started.

"In Progress" shows the tasks which the task force is currently working upon.

"Completed" as the heading reads highlights the tasks that have been completed. A company can add or remove headings and invent its own kanban cards based upon the own unique nature of business and work requirements.

These headings enable the team to prioritize the tasks and plan their work accordingly. Work in progress limits are set which enable the work to be consistent and smooth.

✓ BENEFITS OF THE KANBAN SYSTEM:

- **Better managed inventory levels.** Too much inventory can result in cash flow problems by adding overhead expenses for storage, insurance, and security. On the other side, too little inventory can damage the reputation of the business for being unreliable, resulting in lost sales and dissatisfied customers. The Kanban system combined with good inventory practices smoothes out inventory levels and eliminates carrying costs.

- **Smoother manufacturing flow**. Because the Kanban system focuses on current conditions, production levels are calculated to take into account downtime, scrap, and changeover time of equipment to ensure that the production schedule is met.

- **Overproduction elimination.** As a demand pull system, Kanban is less likely to result in overproduction because of the need to create buffer inventory to address unexpected delays resulting from quality problems with suppliers or minor disruptions in the transportation network.

- **Reduced risk of Inventory obsolescence.** Many products have a shelf life or product lifecycle that can expire unless the product reaches the consumer in a timely manner. In these changing economic times, brand loyalty has faded and can no longer save a company that does not deliver its goods on time.

➢ DEMERITS OF KANBAN SYSTEM

1. Less Effective in Shared-Resource Situations

Infrequent orders may render the kanban process ineffective. For instance, if your upward production line made many parts, your requests to make more parts required by the downstream line will require a buffer to ensure that the downstream line does not run out. This is because each production line requires a separate signaling card.

2. Product Mix or Demand Changes May Cause Problems

The kanban system assumes stable, repetitive production plans. The kanban concept implies that the warehouse or the supplier should deliver components to the production line as and when they are needed. Fluctuations in demand and products may affect the functioning of the kanban system. Therefore, the system is less suited to industries where product volumes and mixes fluctuate.

3. The Kanban System Does Not Eliminate Variability

The kanban system may produce poor-quality items that need to be reworked or scrapped if production is disrupted with lengthy and unpredictable down times. Kanban is structured like a traffic signal, to manage the flow of traffic to meet customer needs by signaling when to start, stop or slow down production. Any variability or unpredictability will affect the functioning of the system, making it send confused, mixed and wrong signals with regard to the optimal production levels.

4. Production Flow Problems

Kanban is not suited for manufacturing environments with poor-quality products, short production runs, a multitude of product types and highly variable product demands. The Kanban system requires planned weekly and monthly production schedules coupled with day-to-day flexibility. This may not be possible in a manufacturing environment with multiple product types; variable production demands and long production runs, thus reducing the overall efficiency of the production line.

- **TOTAL QUALITY MANAGEMENT:**

✓ **Quality:**

Quality refers to a parameter which decides the superiority or inferiority of a product or service. Quality can be defined as an attribute which differentiates a product or service from its competitors. Quality plays an essential role in every business. Business marketers need to emphasize on quality of their brands over quantity to survive the cut throat competition.

✓ **Total Quality management**

It is defined as a continuous effort by the management as well as employees of a particular organization to ensure long term customer loyalty and customer satisfaction. Total quality management ensures that every single employee is working towards the improvement of work culture, processes, services, systems and so on to ensure long term success.

✓ **Total Quality management can be divided into four categories:**

- Plan
- Do
- Check
- Act

1. Planning Phase

Planning is the most crucial phase of total quality management. In this phase employees have to come up with their problems and queries which need to be addressed. They need to come up with the various challenges they face in their day to day operations and also analyze the problem's root cause. Employees are required to do necessary research and collect relevant data which would help them find solutions to all the problems.

2. Doing Phase

In the doing phase, employees develop a solution for the problems defined in planning phase. Strategies are devised and implemented to overcome the challenges faced by employees. The effectiveness of solutions and strategies is also measured in this stage.

3. Checking Phase

Checking phase is the stage where people actually do a comparison analysis of before and after data to confirm the effectiveness of the processes and measure the results.

4. Acting Phase

In this phase employees document their results and prepare themselves to address other problems.

✓ ELEMENTS OF TQM

1. Customer-focused: The customer ultimately determines the level of quality. No matter what an organization does to foster quality improvement—training employees, integrating quality into the design process, or upgrading computers or software—the customer determines whether the efforts were worthwhile.

2. Total employee involvement: All employees participate in working toward common goals. Total employee commitment can only be obtained after fear has been driven from the workplace, when empowerment has occurred, and when management has provided the proper environment. High-performance work systems integrate continuous improvement efforts with normal business operations. Self-managed work teams are one form of empowerment.

3. Process-centered: A fundamental part of TQM is a focus on process thinking. A process is a series of steps that take inputs from suppliers (internal or external) and transforms them into outputs that are delivered to customers (internal or external). The steps required to carry out the process are defined, and performance measures are continuously monitored in order to detect unexpected variation.

4. **Strategic and systematic approach:** A critical part of the management of quality is the strategic and systematic approach to achieving an organization's vision, mission, and goals. This process, called strategic planning or strategic management, includes the formulation of a strategic plan that integrates quality as a core component.

5. Continual improvement:

Total Quality Management is not something that can be done once and then forgotten. It's not a management "phase" that will end after a problem has been corrected. Real improvements must occur frequently and continually in order to increase customer satisfaction and loyalty

6. Fact-based decision making: In order to know how well an organization is performing, data on performance measures are necessary. TQM requires that an organization continually collect and analyze data in order to improve decision making accuracy, achieve consensus, and allow prediction based on past history.

7. Communication: During times of organizational change, as well as part of day-to-day operation, effective communications plays a large part in maintaining morale and in motivating employees at all levels. Communications involve strategies, method, and timeliness

➢ Principles of Total Quality Management

Total quality management (TQM) helps an organization improve its internal functioning and customer satisfaction. The entire system of TQM rests on the following basic principles:

1. Management of quality is possible

The first principle of TQM is that an organization can always manage quality. Unlike external factors, it is completely possible to control the quality of goods and services. TQM makes this possible even in large companies that deal with huge amounts of production.

2. Processes are the problem, not people

If any process is causing problems, the focus of managers must first be on correcting it. They must not, instead, think of simply hiring new workers. They should correct the process first and only then train their employees to adapt.

3. Look for the cure instead of treating symptoms

Managers often make the mistake of addressing problems by just remedying them in the short term. They should, however, go to the root cause and eradicate the source of the problem itself.

For example, imagine that a company faces problems with transporting its goods to certain areas. In such cases, managers should see whether their problem relates to the entire process of shipping in general.

4. Each employee is responsible for quality management

TQM places the burden of maintaining quality standards on every employee of an organization. From line workers in factories to top-level executives, everybody plays a large role here.

5. Quality should be measurable

Managers should always be able to measure and quantify their quality standards. Failure to do so makes it difficult to see achievable results clearly. TQM helps in this regard by employing statistics to measure quality standards.

6. Quality improvements must keep happening

TQM says that quality management is never a temporary phase that ends when it achieves its targets. It is, in fact, a permanent process that happens all the time.

It is always possible to improve quality more than its present standards. Managers must strive to keep improving quality constantly.

7. Quality helps in the long-term

TQM is not a quick fix that can cure quality defects immediately. It is a long-term investment that often shows results in the future only. Managers must keep an open mind and long-term vision while implementing it.

✓ **IMPORTANCE OF TOTAL QUALITY MANAGEMENT:**

Quality management plays a crucial role in your company's growth and performance. It is also a key resource in the competition for customer relationships, striving to deliver a superior experience. For your business to succeed, quality should be maintained at every level. Companies can implement a set of procedures to ensure their products meet the highest quality standards and perform optimally. The end goal is to enhance customer satisfaction and drive business growth.

1. More Consistent Products and Increased Efficiency

Quality management value lies in its ability to help companies improve their products' reliability, durability and performance. These factors help differentiate a business from its competitors. Better products equal happier customers and higher revenue. Besides product quality, quality management systems, such as ISO 9001, ensure clear communication structures, responsibilities and tasks across

all departments. This results in higher employee morale, improved performance and increased efficiency.

2. Greater Customer Satisfaction

The business cannot ignore the cost of bad customer relations. If the products and services fail to meet customer expectations,company's brand and revenue will suffer.

In today's competitive market, consumers are more demanding than ever. They can choose from thousands of brands and have access to millions of stores due to the advances in technology. If one want business to stand out, it's critical to meet or exceed their expectations. It's no longer enough to make sure that products are "fine." They need to address customers' needs and comply with the highest quality standards.

Quality management can helps to turn prospects into loyal customers. It does so by continuously improving the products, incorporating changes and eliminating defects. Furthermore, it provides companies with the information they need to develop goods and services that customers want. In the long run, this helps increase your market share and gives your business a competitive edge.

➢ SIX SIGMA (6Σ)

- ✓ It is a set of techniques and tools for process improvement. It was introduced by engineer **Bill Smith** while working at **Motorola in 1980**. Jack Welch made it central to his business strategy at General Electric in 1995.
- ✓ A six sigma process is one in which 99.99966% of all opportunities to produce some feature of a part are statistically expected to be free of defects.
- ✓ Six Sigma strategies seek to improve the quality of the output of a process by identifying and removing the causes of defects and minimizing variability in manufacturing and business processes.

➢ CONCEPTS IN SIX SIGMA :

1.Critical to Quality:

Critical to quality is one of the major concept in Six Sigma methodologies because the quality can affect the whole business objective or Goal.

Critical to quality means the measurable characteristics of a product or service which must be matches the customer requirement of product or service.

2. Defect:

The defect is defined as a product or service characteristics which are not the customer want.

3. Process Capability:

Process capability can be defined as a ability of your business process to deliver or produce a service or product which are meeting the customer demands.

4. Variation:

Variation term is a bit different in Six Sigma methodology, here variation means after delivering service and product the control person can measure the difference between the what customer sees and what they actual feels after acceptance of product or service.

5. Stable Operations:

Stable operations means not only the stabilizing the process but businesses have to ensure that the process of business in consistent to reduce the gap between what customer sees and feels.

- Customer & Product driven Features of Six Sigma Methodology:

1. Six Sigma is aim to avoid waste and in effeminacy, so increasing customer satisfaction by delivering what the customer is really expecting.

2. Six Sigma is strictly structured and disciplined structure methodology, which has very specific for the particular participants.

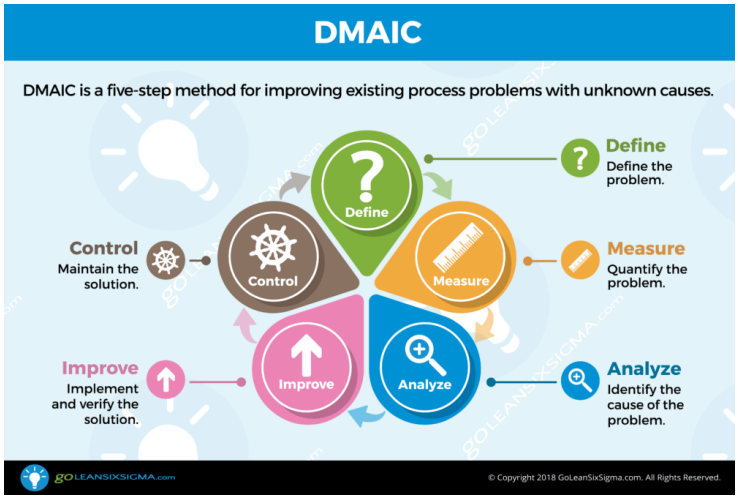
3. Six Sigma is statistical data driven methodology which requires accurate or error-less data to perfectly analyze the process.

4. Six Sigma is not just about the improving quality and increase the sale its about changing results in the financial statements also.

5. By applying Six Sigma in your business you are successfully achieve the below milestones what we called the business success facts:

- Improving Process
- Lowering Defects
- Increased Profit
- Increased Customer Satisfaction
- Reducing Costs
- Reducing Process Variability

Six Sigma includes the following:



"DMAIC" is an acronym indicating Six Sigma business performance guidelines used to Define, Measure, Analyze, Improve, and Control business performance. Collectively, the process becomes a

powerful tool to lead an organization to stronger performance standards and can be skillfully used to streamline resources and clarify business goals.

1. Define

The main objective of this stage is to outline the borders of the project.

- Stakeholders agree on the parameters that will define the project
- Scope and budgetary items, as well as customer needs, are aligned with project goals
- Team development takes place as the project begins to take shape

2. Measure

The main objective is to collect data pertinent to the scope of the project.

- Leaders collect reliable baseline data to compare against future results
- Teams create a detailed map of all interrelated business processes to elucidate areas of possible performance enhancement.

3. Analyze

The main objective is to reveal the root cause of business inefficiencies.

- Analysis of data reveals areas where the implementation of change can provide the most effective results
- Groups discuss ways that the data underscores areas ripe for improvement

4. Improve

The main objective at the end of this stage is to complete a test run of a change that is to be widely implemented.

- Teams and stakeholders devise methods to address the process deficiencies uncovered during the data analysis process
- Groups finalize and test a change that is aimed at mitigating the ineffective process

- Improvements are ongoing and include feedback analysis and stakeholder participation

5. Control

The objective of the last stage of the methodology is to develop metrics that help leaders monitor and document continued success.

- Six Sigma strategies are adaptive and on-going.
- Adjustments can be made and new changes may be implemented as a result of the completion of this first cycle of the process.

➢ BENEFITS OF SIX SIGMA TO BUSINESSES:

1. Lowering Defects:

Six Sigma completely revolves around only one principle reducing defects and ultimately increase the quality of product or service. So when a organization have Six Sigma implemented in their process then the business will totally focus on that one principle based statistical data driven approach.

2. Reducing Cost:

This is one of the final and long term benefits businesses get when they have implemented Six Sigma in their process because Six Sigma implementing ultimately leads to reducing the defects which means saving of time, resources, power, manpower efforts and ultimately money.

3. Increased Customer Satisfaction:

Six Sigma and DMAIC implementation starts with measuring the variation means measuring the gap between what the customer actually sees and feels. So the successfully implementation completed and if it is sustainable for business then it will ultimately reduces the variation their services or product that means increased customer satisfaction and increased customer loyalty.

4. Success ensured: The companies who have implemented Six Sigma methodology successfully in one or more operational and business spheres have gained immensely. Six Sigma has been used towards increasing sales, for increasing stock value, for enhancing customer satisfaction and in many

different spheres. GE or General Electric was able to save more than $ 8 billion in the initial 3 years of Six Sigma methodology implementation.

5. Increases value: Six Sigma has been beneficial towards adding more value and providing improved quality to a business organization's output that may be in the form of a product or service. Six Sigma can be used to optimize supply chain processes as well and to increase customer satisfaction. Six Sigma once adopted and implemented, becomes a part of business culture, and all processes can be optimized and improved one-by-one.

6. Avoids wastage and provides learning: Six Sigma identifies the errors and variances beforehand and hence helps in avoiding wastage. It also lowers the costs related to operations and provides greater profits. Six Sigma also creates a learning platform within an organization. The documentation and analysis of processes, errors, and variances provide experts and general employees a greater insight into the business processes and their efficiency.

➢ BENEFITS OF SIX SIGMA CERTIFICATION:

1. Help to protect your organization to Avoid Errors: If you are working in organization which needs improvement then your certification and skills gained during certification will help your organization to make better product or serve better service with minimum errors.

With Six Sigma certification and skills you will be able to improvise the process and increase the profit of your organization it will ultimately lead you to become a important asset for the company.

2. Higher Salary: As per the survey on Payscale.com Six Sigma certified persons are getting highest salary and working in the top multinational companies.

3. Increase your managerial and leadership ability:

When you are working as a Six Sigma professional in an organization then you have to undertake all the factors like finance, manpower, resources before taking any decision or before implementing any changes in any process or service or product.

Those who are achieved with Six Sigma Black Belt Certification are work as a Change Agent in their organization they have better understanding and knowledge about process and how to make it make it better.

To work as a leader in Six Sigma field you must have knowledge and understanding of financial management and risk assessment to perform a job without a error.

4. Large scope for Six Sigma across all the Industries:

Many individuals thinks that Six Sigma is only beneficial to manufacturing industry but actually six sigma is applicable to all types of industry. Service industry like IT, healthcare, hospitality needs to improve their service to provide 100% satisfaction to customers with completing their business objectives so all the service sector needs six sigma professionals to improve their overall business process and to complete business objectives.

5. Increase your productivity and capability:

After completing six sigma certification you are completing responsibility by doing less effort so the ultimate result will be increased productivity and capacity to handle large projects easily with sustainability.

- **DISADVANTAGES OF SIX SIGMA:**

1. Difficult implementation: Six Sigma requires a complete participation of all the employees working in the operations, and in other business processes. While it may be easily implemented in a company of smaller size, it can be practically difficult to implement Six Sigma in the large-sized business organizations

2. Complications: Six Sigma inspects the business processes minutely and large amounts of statistical and empirical data are generated during its implementation. The data needs to be carefully scrutinized and analysed to find out the variances. The process can be very complicated and time-consuming when running and sustained over a long period.

3.May get costly in the long run : Six Sigma may provide for cost saving in the long run, but as it is a quality improvement process at its core, it's repetition beyond a certain point may increase overhead and operational costs.

TOPIC: PURCHASING MANAGEMENT

Introduction

Purchasing: Purchasing describes the process of buying. It is the learning of the requirement, identifying and selecting a supplier, negotiation price.
The purchasing can be defined as the process of buying and procuring the materials, parts, components, equipments, spare parts, tools and supporting items required by industries or any organization to deliver its products as per customer requirements at the competitive rates and of good quality.

- ✓ Purchasing is an element of the wider function of procurement and it includes many activities such as ordering, expediting, receipt and payment.
- ✓ Purchasing is responsible for obtaining the materials, parts, supplies and services needed to produce of a product or provide a service.
- ✓ In small industry, this function is performed by works manager and in large manufacturing concern; this function is done by a separate department.
- ✓ Purchasing can be divided into **two broad categories**, large and small purchases, based on seven characteristics of purchased product – volume, specificity, technological complexity, essentiality, fragility, variability, and economic value.

- **Bulk Purchase:** In case of bulk purchases there are high volume items, large amount, and more frequent utilization with more specific use. Bulk purchases are handled in **large organisations and multinational organisations** with the standardized purchasing process, where as some other organizations use separate purchasing process. There are frequent misuse and lack of control in purchasing process in those organizations in which same standardized process is used for both bulk and small purchasing. Large purchases are typically non-urgent in nature. Large-volume, continuous-usage items can be covered by blanket purchase orders, which often involve annual negotiation of prices.

- **Small Purchase;** In case of small purchase there are low volume items, small amount, less frequency of utilization, high variety and low technical complexity. Mainly small purchases include machine parts, auto parts, machine repairs, in frequent sullies of offices and miscellaneous goods. Small purchases are urgent in nature.
  There are two basic types of purchasing in the business world: **purchasing for resale** or **purchasing for consumption or conversion.**

Purchasing for resale or resale purchasing is mainly performed by retailers and wholesalers (called merchants).
Purchasing for internal consumption or conversion is called industrial buying. The industrial buyers generally face different and complex problems with comparisons of merchandise buyers or resellers.

Important Terms

Purchasing: Purchasing describes the process of buying. It covers the knowledge of the requirements, identifying and selecting a supplier and negotiating price.

Procurement: It is a broader term. It includes purchasing products required for production, stores, traffic, receiving, inspection and salvage.

Materials Management: It includes planning, organising, communicating, directing and controlling of all those activities mainly concerned with the flow of materials into an organisation. Material management views material flows as a system.

Logistics Management: It is the planning and controlling of the flow of raw material in a cost effective manner from the suppliers or point of origin to the manufacturing and then flow of finished goods for consumption in the customers' hands.

Purchasing Management

Purchasing management is concerned with the planning and controlling of the acquisition of suppliers' goods and resources, to fulfill the administrative and strategic objectives of the organization. In practice, purchasing managers have to deal with both customers internal as well as external. He/she has to respond creatively to internal customers' need on the one hand and to maintain a mutually profitable relationship with suppliers on the other.

Purchasing management directs the flow of goods and services in a company and handles all data relating to contact with suppliers. To be effective, it requires knowledge of the supply chain, business and tax laws, invoice and inventory procedures, and transportation and logistics issues. Although a strong knowledge of the products and services to be purchased is essential, professionals in this field must also be able to plan, execute, and oversee purchasing strategies that help their company be more profitable.

- ✓ **Purchasing management** is the management of the purchasing process and related aspects in an organization.

- ✓ A **purchasing management department** can be formed and operated by one or more employees in order to ensure that all services, goods, supplies, and inventory needed for the organization to operate are ordered and kept in stock, as well as control inventory levels and costs associated with purchasing the items.

Purchasing management includes (and not only) the following expertise:

1. Supplier Management
2. Cost and Cost Reduction Management
3. Ramp up / slow down Management
4. Risk assessment
5. Purchase Order Management

Purchasing Management (PM) can affect product cost. PM ensure all of the goods, supplies and inventory needed to operate the business are ordered and kept in stock. PM also control the cost of goods ordered, control inventory levels, build a strong relationship with vendors.

Purchasing Management is

- **Purchase**: standard-specification product (commercial product)
- **Subcontract:** design/specs designated by owner --- which are being included in "purchasing management " and "material management" in broad terms
- **Logistics management** = purchase management + in-house physical distribution management + physical distribution of final product
- **Supply chain management (SCM)** = optimum management of total chain

Importance of Purchase Management

Purchasing management is supposed to be a very important department of materials management in any organization. Purchase staff has to manage various vendors and external agencies and thus they represent their organization's reputation to the larger world. They are responsible for negotiating and then finalizing big deals which might mean a lot to their company. Other than that, purchasing management helps in the following:

1. **Controlling the costs**: The purchasing management has to analyze and decide the best suppliers as per the quality of products and most reasonable cost. They also review many other factors like if the vendor or supplier can guarantee timely shipments, what's their reputation in the industry and relevant experience. Changing the vendors again and again is expensive; therefore, finding the best and reliable vendor is very important for controlling costs.

2. **Stabilizing the prices**: Another important role that purchasing management has to achieve price stability. In case the production cost goes up and down, other functions face roadblocks. For example, the marketing function gets confused about what price should be

charged to the customers, the finance department faces problem in calculating profits and the accounts cannot gauge the company's cash flow. Purchasing managers are the ones who are responsible for stabilizing the production cost by negotiating with suppliers and making long contracts for mutual benefit.

3. **Supply Chain Management**: Buyers also ensure that the material or supplies are received on time and are of the expected quality. In case the shipment is delayed or is not of the expected standard, it would affect the complete production chain. Hence, this function is of utmost importance across all industries.

4. **Customer Satisfaction**: Purchase management is responsible for customer satisfaction in the following ways: working towards the best quality of the products and ensuring on-time deliveries. When the purchase department opts for highest quality of supplies or ingredients at reasonable costs, it results in cost savings, which are further passed on to the customers. Therefore, purchasing management has a critical role to play in customer's experience with the final products and the organization.

5. **For Strategic Purpose:** Purchasing is a strategic issue. The manufacturers have to procure capital items like plant and machinery for manufacturing facilities. It requires heavy investment. So, purchasing is an important function. Purchasing also supports new product development by encouraging supplier involvement in product development.

Organization can realize **major benefits from their focus on purchasing management** as mentioned below:

- **From a Top Management Perspective:**
  There are five rights that every management expects from their purchasing executives:
  - Right Quantity
  - Right Quantity
  - Right Time
  - Right Supplier
  - Right Cost

- **From Functional Perspective:**
  - Uninterrupted flow of materials and services
  - Buying at competitive prices
  - Avoiding under-inventory and over-inventory
  - To have good relationship with other departments

- In nutshell, purchase management has the following benefits:

  - Cost reduction or improvement (required utmost to be competitive in market)
  - Improved material delivery (required for smooth flow of production)

- Shorter cycle time, including product development cycle times (helpful in fast production)
  • Quality improvement (required to satisfy or win the hearts of the customers ultimately)

❖ **What car/automobile companies buy:** Tires, Brakes leathers, Clutches, Wires, Steel plates, Glasses, Paint, Fabric, Aluminum sheets, Electronic components, Carpets etc.

❖ **What soft-drink producers buy**: Bottles, Sweetener, Carbonation, Flavoring substances, Caps, Cardboards, Plastic Containers etc

❖ **What software companies buy**: Computers, Hardware, Chairs, Tables, Wires, Data Cables etc.

❖ **What hotels/restaurants buy:** Vegetables, Utensils, Air conditioners, Gas Stoves, Carpets etc.

So, we see that different industries require different types of materials according to their requirements.

Purchasing Activities

There are two major forms of purchasing activities that take place in an organization:

i. Tactical purchasing

ii. Strategic sourcing

(i) **Tactical Purchasing**: The organisations require some materials for the smooth flow of production. The day to day management of materials flow is called tactical purchasing. These activities generally ensure that products and services are delivered to the right internal people at the right time but are often not carried out using a long term horizon.

(ii) **Strategic Sourcing:** The purchasing which affects the long-term profitability is called strategic purchasing. Strategic sourcing is a part of purchasing activities but in a border sense. In the strategic sourcing process there may includes members from other than purchasing department like from engineering, quality, design, manufacturing, marketing and accounting department for managing, developing and integrating with supplier capabilities to achieve competitive advantages like cost reduction, technology development, quality improvement and cycle time reduction.

Types of Purchase

There are mainly two types of purchases; the individual purchase and the organizational purchase.

- **Individual Purchase:** Individual or personal purchase includes those types of items or products which are purchased for personal or family consumption.

Factors influencing individual purchase behavior:

In general mainly there are four types of influence factors:

- Cultural Factors
- Social Factors
- Personal Factors
- Psychological Factors
- Organizational Purchase

- **Organizational purchase:** A purchase will be considered to be organizational if it is made in the name of a company or organization, regardless of size, from a medium sized company up to a multinational or state company. Organization consists of business, industries, retailers, wholesaler, government and non-government organizations.

- Business and industries purchase materials for business use or as a raw material to produce other product.
- Wholesalers/Retailers/traders buy product for resell at profit.
- Government organisations purchase products for use in offices or provide services to people.
- Non-government organizations purchase products to provide services to their client.

Consumer Purchasing / Decision making	**Industrial Purchasing / Decision-making**
Less risky	More risky
Emotional decision-making	Rational / Analytical decision-making
Personal purchasing is sometimes unplanned or on the spot or abrupt buying influenced by promotional activities	Scientific purchasing as whole organization's profitability affects

Purchasing Cycle

The purchasing cycle begins with a request from within the organization to purchase material, equipment, supplies, or other items from outside the organization, and the cycle ends when the purchasing department is notified that a shipment has been received in satisfactory condition, and managerial accounting is actively involved in each step.

The main steps in the cycle are as under:

- ✓ Recognition of need
- ✓ Description of need
- ✓ Selection of suppliers
- ✓ Determination of prices
- ✓ Preparation of purchase order
- ✓ Placing the order with a selected supplier
- ✓ Monitoring and follow up the order
- ✓ Receiving the ordered materials
- ✓ Checking and approving for payment to supplier

➢ 5R'S OF PURCHASE

1. Right Price:

Right price is determined by costing the production process of the supplier. Right price is determined by allowing reasonable profit for the supplier and insisting and helping to reduce cost. Tender system should be used to identify lowest responsible bidder rather than lowest bidder. Principles normally used to ensure right price are cost structure and learning curve.

2. Purchase of right quantity: The purchasing objective of right quantity relates to the amount of inventories to be carried. The quantity of purchased goods must be according to the requirement of the production. Purchase of more or less quantities than the requirement, it will lead to huge inventories and lock-up of finances. On the other hand, if purchased quantity is less than the requirement, it will lead to the stoppage of work and machinery may remain idle leading to loss in production. Both situations are harmful for any concern.

3. Purchase of right quality: Quality consideration is the main objective of the purchase because at one time the highest grade material might be the suitable quality but at the other time medium grade

material might be the suitable quality. However, the right quality of goods to be purchased must reflect the desired technical characteristics and also the cost and procure-ability factors. Determination of required quality of material and components is the basic responsibility of engineering-production department. Therefore, one or more engineers of the production department must be related with the purchasing department to help the buyer in properly discharging his responsibilities for purchasing right quality of materials.

4. Right Place:

It is the one where the item is going to enter the value stream. If the item is not available here, when needed, it is in short supply for the process.

5. Right Time:

Procurement of material at the right time is also very important objective of purchasing. If orders are submitted late, it will involve costly expediting and may even interrupt continuous flow of production process causing material shortage. Availability of working capital, material requirements based on sales and production forecasts and market situations are the important factors that buyer should bear in mind while doing his purchases.

- OBJECTIVES OR GOALS OF PURCHASE MANAGEMENT

Primary objective or goal of purchasing function is making inputs available to the conversion process at minimum cost to the final output of the company. Thus focus is on system output rather than on micro level objectives.

The inputs to be made available are raw materials, semi finished items, bought out items etc. There are certain parameters to be monitored for fulfilling the system objectives.

1. To avail the materials, supplies and equipment at the minimum possible costs:

These are the basic inputs in the manufacturing operations. The minimization of the input cost increases the productivity and resultant profitability of the operations.

2. To ensure the continuous flow of production:

Purchasing department helps in ensuring the interrupted production flow through continuous supply of raw material, components, supplies, tools etc. and good equipment with repair and maintenance services.

3. To increase the asset turnover:

The efforts of purchase department result in formation of fixed assets and maintenance of a certain level of investments in inventories. The investments in fixed assets and also in the inventories should be kept at minimum in relation to the corresponding volume of sales. This will increase the turnover of the assets and thus the profitability of the company will get enhanced.

4.To develop the alternate sources of supply:

Exploration of alternate sources of supply of materials increases the bargaining ability of the buyer, minimization of cost of materials and increases the ability to meet the emergencies.

To established and maintain the good relations with the suppliers: Maintenance of good relations with the supplier helps in evolving a favorable image in the business circles. Such relations are always beneficial to the buyer in terms of changing of reasonable price, preferential allocation of materials in case of material shortages, intimation about forthcoming shortages, information about the newly developed substitute, prolonged payments in case of temporary liquidity crisis etc.

5. To achieve maximum integration with other departments of the company:

The purchase function is related with the following other departments of the company:

i) Production department regarding the material specification, flow of materials, suggested supplies for certain items etc.

ii) Engineering department for the purchase of tools, machines and equipment.

iii) Marketing department regarding the forecast sales and its impact on procurement of materials, impact of quality of inputs on quality of outputs and sales.

iv) Finance department for the purpose of maintaining levels of materials, pledging and hypothecating the materials for meeting working capital needs, tapping the quantity discount, scheduling the investments in capital assets such as materials and equipment.

v) Personnel department for the purpose of manning and developing the personnel of purchase department, maintaining the vendor relationships etc.

6. To train and develop the personnel:

Purchasing department is manned with varied types of personnel. The company should try to build the imaginative employees force through training and development. This will ensure management succession and a contended workforce who are provided with an opportunity to fulfill their aspirations through promotions on higher positions.

7. Efficient record keeping and management reporting:

Paper processing is inherent in the purchase function. Such paper processing should be standardized so that the record keeping is facilitated.

Primary objective or goal of purchasing function is making inputs available to the conversion process at minimum cost to the final output of the company. Thus focus is on system output rather than on micro level objectives.

The inputs to be made available are raw materials, semi finished items, bought out items etc. There are certain parameters to be monitored for fulfilling the system objectives. We can call them goals of purchasing. .

➢ IMPORTANCE OF PURCHASING MANAGEMENT

Purchasing management is a significant component for any business. Companies recognize the significant cost savings that can arise from effective purchasing decisions and likewise how poor purchasing strategies may result in disaster: A vendor failing to deliver its purchasing order of beef to a hotel, for example, could hamper the business's ability to cater an event for 500 people.

1. Cost Control

Cost control is a critical factor in purchasing management. These managers analyze which suppliers are selling the necessary inputs for production and at what cost. From this information, they review a host of other factors, which include on-time shipments, warranties, industry reputation and length of time in business. Because switching vendors is costly, finding a reliable vendor is important to controlling costs.

2. Price Stability

An important role of purchasing management is achieving price stability. When the cost of production fluctuates wildly, other departments experience obstacles. For instance, the marketing team does not know what price to charge customers, finance experts cannot estimate profits and accountants cannot determine the company's cash flow. Purchasing managers keep the cost of production stable in a number of ways, one of which is negotiating with vendors to achieve the lowest price and to lock in the value for a lengthy contract. For inputs with volatile prices such as commodities, purchasing managers work with banks to hedge these items in the form of a forward contract. Alan E. Branch, author of "International Purchasing and Management," explains that these contracts also shield multinational corporations from the risk of currency fluctuations, which can also affect the cost of production.

3.Supply Chain Management

Securing the supply chain is another critical role of purchasing managers. Buyers are responsible for ensuring that all of the necessary materials appear on time, intact and of expected quality. If any of these shipments are delayed or of subpar, the effects reverberate throughout the production chain. A shipment of faulty screws, for instance, may cause the finished product to fall apart. In turn, the entire order is jeopardized because of the management's purchasing decision. As explained in a May 2011 "Bloomberg" article, the explosion of Apple's vendor in China caused a possible production loss of 500,000 iPads.

4. Customer Satisfaction

Purchasing managers play a fundamental role in ensuring customer satisfaction. Managers have this obligation in two ways: quality of product and on-time deliveries. When buyers select high-quality ingredients at lower costs, these cost savings can be issued to the customer. Likewise, poor quality deters customers from returning to the business. Delayed and defective products are other ways customers are affected by the decisions of purchasing managers. Thus, these employees play a critical role in shaping the customer's experience with the organization.

Objectives of Purchasing

The basic objective of the purchasing function is to ensure continuity of supply of raw materials, sub-contracted items and spare parts and to reduce the ultimate cost of the finished goods. In other words, the objective is not only to procure the raw materials at the lowest price but to reduce the cost of the final product.

The objectives of the purchasing department can be outlined as under:

- **To avail the materials, suppliers and equipments at the minimum possible costs:** These are the inputs in the manufacturing operations. The minimization of the input cost increases the productivity and resultantly the profitability of the operations.
- **To ensure the continuous flow of production** through continuous supply of raw materials, components, tools etc. with repair and maintenance service.

- **To increase the asset turnover:** The investment in the inventories should be kept minimum in relation to the volume of sales. This will increase the turnover of the assets and thus the profitability of the company.
- **To develop an alternative source of supply:** Exploration of alternative sources of supply of materials increases the bargaining ability of the buyer, minimization of cost of materials and increases the ability to meet the emergencies.
- **To establish and maintain the good relations with the suppliers:** Maintenance of good relations with the supplier helps in evolving a favorable image in the business circles. Such relations are beneficial to the buyer in terms of changing the reasonable price, preferential allocation of material in case of material shortages, etc.
- **To achieve maximum integration with other department of the company:** The purchase function is related with production department for specifications and flow of material, engineering department for the purchase of tools, equipments and machines, marketing department for the forecasts of sales and its impact on procurement of materials, financial department for the purpose of maintaining levels of materials and estimating the working capital required, personnel department for the purpose of manning and developing the personnel of purchase department and maintaining good vendor relationship.
- **To train and develop the personnel:** Purchasing department is manned with varied types of personnel. The company should try to build the imaginative employee force through training and development.
- **Efficient record keeping and management reporting:** Paper processing is inherent in the purchase function. Such paper processing should be standardized so that record keeping can be facilitated. Periodic reporting to the management

FUNCTIONS OF PURCHASING MANAGEMENT

The purchasing function is usually performed most economically and efficiently by a specialized, centralized purchasing department, directed by a skilled purchasing manager. The functions of purchasing department are varied and wide which are based upon different approaches. The purchasing activities may be divided into those that are always assigned to the purchasing department and those that are sometimes assigned to some other department. The followings are some of the important functions which are necessary to be performed.

1. Receiving indents

2. Assessment of demand or description of need

3. Selection of sources of supply

4. Receiving of quotation

5. Placing order

6. Making delivery at the proper time by following up the orders.

7. Verification of invoices

8. Inspection of incoming materials

9. Meeting transport requirements of incoming and outgoing materials

10. Maintaining purchasing records and files

11. Reporting to top management

12. Developing coordination among other departments

13. Creating goodwill of the organisation in the eyes of the suppliers.

1. Receiving indents:

The first and foremost function of purchasing is receiving demand/requisition of material from different departments of the organisation, such as from production, stores, maintenance, administrative, drawing office, planning, tool room, packing, painting, heat treatment etc.

After receiving the indent from users' departments it examines in details and takes action according to the need and urgency of any item. This is called 'recognition of need'. Sometimes, needs can be met by transfer of a stock of one department to another department. In other cases, the reserve stock or the stocks kept in bank can be utilized i.e., pledged stock with bank.

2. Assessment of demand or description of need:

After recognising the need with appropriate description, i.e., qualitative as well as quantitative, is necessary for the sound and successful purchasing. An improperly described demand can cost heavily money-wise as well as time-wise.

The real problem arises when the order is placed for want of preciseness in the description of goods needed, the items are received and these are not acceptable to the user department and it

also becomes difficult to convince the suppliers to return the goods in case of faulty supplies. Therefore, purchasing department must have adequate knowledge of items being purchased to be able to secure full description.

The purchasing department should not have such alternative purchases of commodities, which are not available easily, on their own responsibility or at a lower cost unless and until it gets the consent from the user department.

In a nutshell, it is recommended that the description of items for purchase on the part of indenter, purchaser and seller should be quite clear and without ambiguity to promote harmony in an organisation.

3. Selection of sources of supply:

Most important function of a purchasing department or officer is the selection of the sources for the requisitioned items of stores. There are different sources of supply which have no similarity between them.

For majority of items, selection of one of the vendors should be made. While selecting the item, the purchase officer has to see whether the item to be purchased is on a regular basis i.e., it is being purchased time and again or it is a seldom purchase on non-recurring basis.

Whenever the items are to be bought from single manufacturer, such as branded or patented item, there is no difficulty in the selection of the sources of supply; the order can be placed with the party according to terms and conditions of their sale.

Selection of source of supply requires the services of shrewd purchasing officer who can keep pace with policies of the organisation and market from where the materials have to be purchased.

4. Receiving of quotation:

As soon as the purchase requisition is received in the purchase division, sources of supply will be located; a decision is then taken in respect of the method of tendering/limitation of quotations from prospective suppliers.

Prices are also ascertained by preparing a comparative statement with the help of either of the following documents supplied either by the supplier or taken from the previous records of advertisements, like:

(a) Catalogues, price lists etc.

(b) Telephonic quotations.

(c) Previous purchase records.

(d) Quotation letter or tender i.e., letter of inquiry.

(e) Sample and related price cards.

(f) Negotiation between suppliers and the purchase department like catalogue, price lists etc.

It is in the interest of purchasing department to keep this information up to date. Even for the items which are being purchased on a regular basis, the purchasing section should invite tenders and know full well the market price. It will ensure that prices being paid to the existing vendor are competitive.

5. Placing order:

Placing a purchase order is the next function of purchasing officer. Since purchase order is a legal binding between the two parties, it should always be accurate, clear and acceptable to both. The purchase order should contain the following particulars:

(a) Description and specifications of the material.

(b) Quantity order.

(c) Transport and packing charges and shipping instructions.

(d) Name and address of the supplier.

(e) Date, time and place of delivery.

(f) Price, discount and terms of payment.

(g) Signature of the purchase manager.

(h) The name and address of the buyer.

6. Making delivery at the proper time by following up the orders:

Since one of the objectives of successful purchasing is delivery of goods at right time so as to ensure delivery when and where needed? In normal practice, the responsibility of the purchasing department is upto the time the material is received in the stores and is approved by the inspection department.

Every purchasing department has the responsibility for follow-up of the orders it places on different suppliers. All items do not require extensive follow-up. For some less important and low value items follow-up would be costly and wastage of money and time only.

7. Verification of invoices:

In normal course, it is also the responsibility of purchase department to check the invoices and accordingly advise the accounts department for clearing the payment to the parties concerned. Contradictory statements have been given as to who should be assigned this function.

Some are of the view that invoices should be checked by the purchase department placed by it whereas other suggests that it should go to the accounting department. In support of this, the experts add that it is part of the responsibility of purchase department that orders are accurately executed and properly filled as per terms and conditions of the contract.

If there is any error in the bills, the purchase department can get the correction done or adjustment effected. If the invoices are checked by the stores or accounts departments, there may be some delay in attending to the errors.

8. Inspection of incoming materials:

The purchasing department should have a close contact with inspection department. On receipt of the materials from different suppliers, they are to be inspected as per specifications indicated in the purchase order to verify their quality and quantity.

Uninspected materials are a burden on the economy of the organisation. If inspection is delayed, the payments of the suppliers also are likely to be delayed, resulting in bad relations between suppliers and purchasers.

9. Meeting transport requirements of incoming and outgoing materials:

The purchasing officer must make goods/materials available at the right time they are required, at the place they are needed, and at the lowest possible cost. It is a big responsibility, and even a slight error amounts to delay in consignment required at a particular time.

In this regard, the purchase department should have a thorough knowledge of the means of transportation. It should make a correct choice of carriers or routes because otherwise it may entail delay and additional transportation costs.

10. Maintaining purchasing records and files:

Purchasing involves a lot of paper work. Daily a number of letters, bills, quotations, notes, challans, railway receipts, parcel, way bills, bills of ladings, goods received notes, lorry receipt, goods receipt (transport delivery notes), inspection notes have to be dealt with. It involves a lot of clerical work.

This department has to refer to previous correspondence on purchase orders, notes, catalogues, blue prints, price lists etc. very frequently which makes it imperative to maintain records in appropriate manner. These records are essential for making the day to day purchase.

11. Reporting to top management:

It is also an important function of the purchasing department to prepare weekly, monthly, quarterly, bi-annually and yearly reports regarding expenditures of this department and send the same to top management along with details of purchases made and suggestions or improvements, if any.

12. Developing coordination among departments:

A purchasing department has to fulfill the needs of other departments in the organisation. It is the function of purchasing department to work in close coordination and cooperation with other departments of the company.

To a considerable extent, the attitude and reactions of other departments towards purchasing department extends to these other departments. Mutual trust and cooperation is essential between the purchasing department and other departments to secure high degree of efficiency.

13. Creating goodwill of the organisation in the eyes of the suppliers:

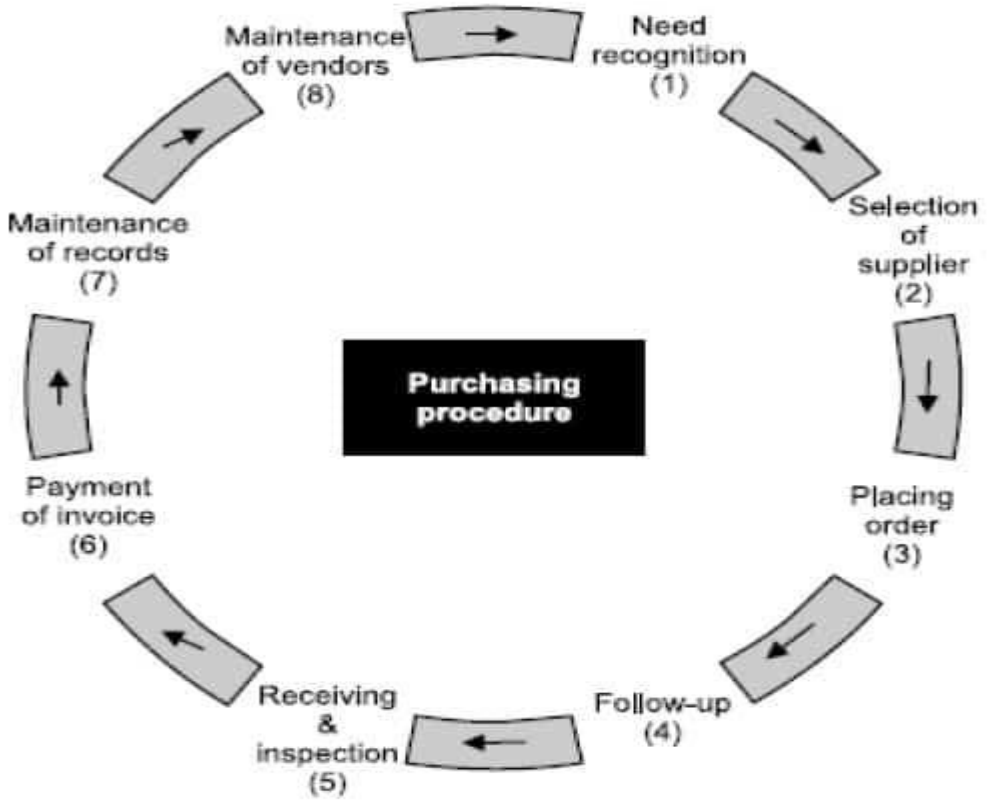
Good vendor relationship has to be maintained and developed to reflect enterprise's image and goodwill. Maintaining such relations requires mutual trust and confidence which grows out of dealings between the two parties over a period of time. Worth of a purchasing department can be measured by the amount of goodwill it has with its vendors.

PROCEDURES OF PURCHASING:

The policy statements are guidelines and they should be difficult to understand. Lengthy and too many policies have to be avoided. The purchasing policy provides the guidelines and direction in the following categories. It defines:

(a) Rules of purchasing
(b) Conduct of purchasing personnel
(c) Social and minority business objectives
(d) Operational issues

The procedure describes the sequence of steps leading to the completion of an identified specific task. The purchasing procedure comprises the following steps as indicated in Fig.



PURCHASING PROCEDURE

1. Recognition of the need:

The initiation of procedure starts with the recognition of the need by the needy section. The demand is lodged with the purchase department in the prescribed Purchase Requisition Form forwarded by the authorized person either directly or through the Stores Department. The purchase requisition clearly specifies the details, such as, specification of materials, quality and quantity, suggested supplier, etc. Generally, the low value sundries and items of common use are purchased for stock while costlier and special items are purchased according the production programmes. Generally, the corporate level executives are authorized signatories to such demands. Such purchases are approved by the Board of Directors. The reference of the approval is made on requisition and a copy of the requisition is sent to the secretary for the purpose of overall planning and budgeting.

2. The Selection of the supplier:

The process of selection of supplier involves two basic aspects: searching for all possible sources and short listing out of the identified sources. The complete information about the supplier is available from various sources, such as, trade directories, advertisement in trade journals, direct mailing by the suppliers, interview with suppliers, salesmen, suggestions from business

associates, visit to trade fair, participation in industries convention, etc. Identification of more and more sources helps in selecting better and economical supplier. It should be noted that **the low bidder is not always the best bidder.** When everything except price is equal, the low bidder will be selected. The important considerations in the selection are the price, ability to supply the required quantity, maintenance of quality standards, financial standing etc. It should be noted that it is not necessary to go for this process for all types of purchases. For the repetitive orders and for the purchases of low-value, small lot items, generally the previous suppliers with good records are preferred.

3. Placing the order:

Once the supplier is selected the next step is to place the purchase order. Purchase order is a letter sent to the supplier asking to supply the said material. At least six copies of purchase order are prepared by the purchase section and each copy is separately signed by the purchase officer. Out these copies, one copy each is sent to store-keeper, supplier, accounts section, inspection department and to the department placing the requisition and one copy is retained by the purchase department for record

4. Follow-up of the order:

Follow-up procedure should be employed wherever the costs and risks resulting from the delayed deliveries of materials are greater than the cost of follow-up procedure, the follow-up procedure tries to see that the purchase order is confirmed by the supplier and the delivery is promised. It is also necessary to review the outstanding orders at regular intervals and to communicate with the supplier in case of need. Generally, a routine urge is made to the supplier by sending a printed post card or a circular letter asking him to confirm that the delivery is on the way or will be made as per agreement. In absence of any reply or unsatisfactory reply, the supplier may be contact through personal letter, phone, telegram and/or even personal visit.

5. Receiving and inspection of the materials:

The receiving department receives the materials supplied by the vendor. The quantity are verified and tallied with the purchase order. The receipt of the materials is recorded on the specially designed receiving slips or forms which also specify the name of the vendor and the purchase order number. It also records any discrepancy, damaged condition of the consignment or inferiority of the materials. The purchase department is informed immediately about the receipt of the materials. Usually a copy of the receiving slip is sent to the purchase department.

6. Payment of the invoice:

When the goods are received in satisfactory condition, the invoice is checked before it is approved for the payment. The invoice is checked to see that the goods were duly authorized to purchase, they were properly ordered, they are priced as per the agreed terms, the quantity and quality confirm to the order, the calculations are arithmetically correct etc.

7. Maintenance of the records:

Maintenance of the records is an important part and parcel of the efficient purchase function. In the industrial firms, most of the purchases are repeat orders and hence the past records serve as a good guide for the future action. They are very useful for deciding the timings of the purchases and in selecting the best source of the supply.

8. Maintenance of vendor relations:

The quantum and frequency of the transactions with the same key suppliers provide a platform for the purchase department to establish and maintain good relations with them. Good relations develop mutual trust and confidence in the course of the time which is beneficial to both the parties. The efficiency of the purchase department can be measured by the amount of the goodwill it has with its suppliers.

Characteristics of a Purchasing Manger

The following pre-requisite traits are required for a purchase manager:

1. **Interpersonal skills:** The purchase manger must have good communication skills. There are many aspects of interpersonal communication such as handling suppliers, respect of other opinion and so on. He or she must be efficient in the same.
2. **Analytical Decision Making:** Purchase manager may face many problems in his or her job like placing order, selection of best supplier, to maintain healthy relationship with supplier, and purchase right materials in right quantity at right time and so on. So, a good purchase manager must have analytical decision making.
3. **Loyal to the Organisation**: The purchasing manager is involved in large activities of purchasing materials consistently involving very large financial deals. So, he has to be loyal to the organisation and he has to prove his loyalty from time to time.
4. **Computer Literacy:** The purchase manager must be well skilled in computer as he requires use of computer in many activities. If he is computer literate, then he can work efficiently.
5. **Technical skills:** Now-a-days, in production a very highly sophisticated technology is used. Purchase manager must have technical understanding of the business. The purchase manager has enough technical background to understand the production process, the supplier's processes and scheduling system in order to making improvement.
6. **Ability to Make Decision:** The purchasing manager has to take quick decisions in line with procurement strategy of organization vis-à-vis liaison with other departments. He or she has to take decisions with quality, market, economic, social and political environment and issues taken into account.

7. **Innovative:** Innovation is very necessary for survive in the market in present competitive market condition. So, a purchase manager should take innovative decisions related to purchase techniques, maintaining quality, inventory stock, inventory control, re-ordering level and order processing.
8. **Bargaining Power:** It must be the prime motive of the purchase manager that organization can purchase more and best materials with less cost. For this a purchase manager should have good bargaining power.

Materials Management

Material management is defined as the planning, acquiring, storing, moving and controlling of materials as per the requirement of the organisation. Materials management is basically related with the smooth flow of materials. The major activities covered under materials management are the anticipation of the materials required in the organisation from time-to time. It involves ordering and obtaining materials from the suppliers, introducing the materials to the organisation and monitoring the status of materials. It helps to optimize the usage of facilities, personnel and funds and to provide service to the user in the line with the organizational aims. Materials management is the coordination and control of the various material activities. The key material activities are:

- **Purchasing Activities:** It involves mainly identification of materials needs, market research, maintaining materials records etc.
- **Procurement Activities:** It involves material specifications, materials studies, receiving materials etc.
- **Inventory Management:** It involves planning and controlling of materials handling, storing materials and managing material supplies etc.
- **Supply Management:** It involves monitoring in-plant material handling, strategic planning of materials etc.

Classification of Manufacturing Materials

The manufacturing materials can be classified into following categories:

- **Raw Materials:** It is the materials that the company is required to transform into finished goods. It is very important. The shortage of halts can stop the production and can cause high losses. It is different for different industries. As for example, for textile industry the cotton is main input. For automobile industry, the spare parts are very important.
- **Manufactured Parts:** These parts are the output of the organizations. These are the finished materials built by the company.
- **Work in Process:** These are semi-finished products found at various stages in the production process.

Packaged Materials: These are materials that are packaged together to prevent damage during transportation and deterioration when they are stored.

- **MRO Supplies:** These materials are required for maintenance, repairing, and operating supplies used in the manufacturing process regularly for the smooth manufacturing, i.e. soap, lubricating oil, grease, plastic and rubber parts, screw driver, nuts etc.
- **Loose Materials:** These are materials that are partially fabricated and that should be handled individually.

Objectives of Materials Management Department

- **The primary objectives of Materials Management department are:**

  - ✓ Low Procurement price
  - ✓ High inventory turnover
  - ✓ Low cost of acquisition and possession
  - ✓ Continuity of supply
  - ✓ Consistent quality
  - ✓ Low payroll costs
  - ✓ Favorable supplier relations
  - ✓ Maintenance of good records

- **The secondary objectives of Materials Management are:**

  - ✓ New materials, processes and products
  - ✓ Economic make or buy decisions
  - ✓ Standardization
  - ✓ Product improvement

Relationship between Materials Management Department and other Departments

Materials Management Department plays a very important role in an organization and it must have good relationship with other departments. The departments that are mostly involved are: Production, Engineering design, Quality control, and Finance Department.

- **Materials Management Department and Production Department**
  The materials management department must have good relationship with production department. Materials Management is responsible for the purchase of all materials required by the production department. If the needed materials are not supplied at right time then the production process can halt and generate huge losses. So, for the smooth functioning of the production department, the materials department must be vigilant about the latest requirements.

- **Materials Management and Engineering Design Department**
  If both materials management and engineering design department work together then the much required innovative strategies can be formulated and implemented. Both departments can work together for standardization of materials. The suggestions of the materials management are very important for engineering department.
- **Materials Management and Quality Control Department**
  The selection and rejection of the materials purchased depends upon the parameters set by the quality control department. So, if both the departments have cooperation and cordial relationship then the delay in the purchasing of raw materials can be avoided.
- **Materials Management and Finance department**
  usually finance department release fund to materials department for the materials purchased. It is the responsibility of the both departments to clear payments to the suppliers smoothly, without much delay unnecessarily.

Risks to be Considered by Purchase Material Manager

The purchase and materials manager must avoid the following consequences:

- Receiving materials before they are required, causing more inventory cost and chance of deterioration in quality;
- Not receiving materials at the time of requirement, causing loss of productivity;
- Incorrect materials take off from drawing and design document;
- Subsequent design changes;
- Damage/loss of items;
- Failure on installation; Selection of type of contract for specific material procurement;
- Vender evaluation criteria;
- Pilling up of the inventory and controlling of the same;
- Management of surplus materials; and
- Any one of the above or all of the above, or combinations.

Summary

The smooth functioning of the production department depends upon a large extent on the right type of materials purchased at right time at right quality and at right cost. The right cost of materials leads to good saving. It is possible through efficient buying. The purchase manager must be technically skilled, innovative, intelligent, vigilant and efficient in bargaining. Heavy competition has generated the importance of efficient purchasing. For any industrial project, the purchasing is main function that contributes in the timely execution and delivery. The corporate policy indicates the guidance map for purchasing. It includes the purchasing strategies, plans, programmes and goals. The purchasing department must have good coordination with other departments like finance, engineering,

production, quality department, etc. The purchasing department is responsible for avoiding any type of over-inventory or under-inventory. The purchasing department helps in the clearance of all the bills of external parties like suppliers, etc. Every organisation must adopt scientific and analytical way of identifying the need and type of materials, right supplier and smooth flow of materials

Self-assessment Questions

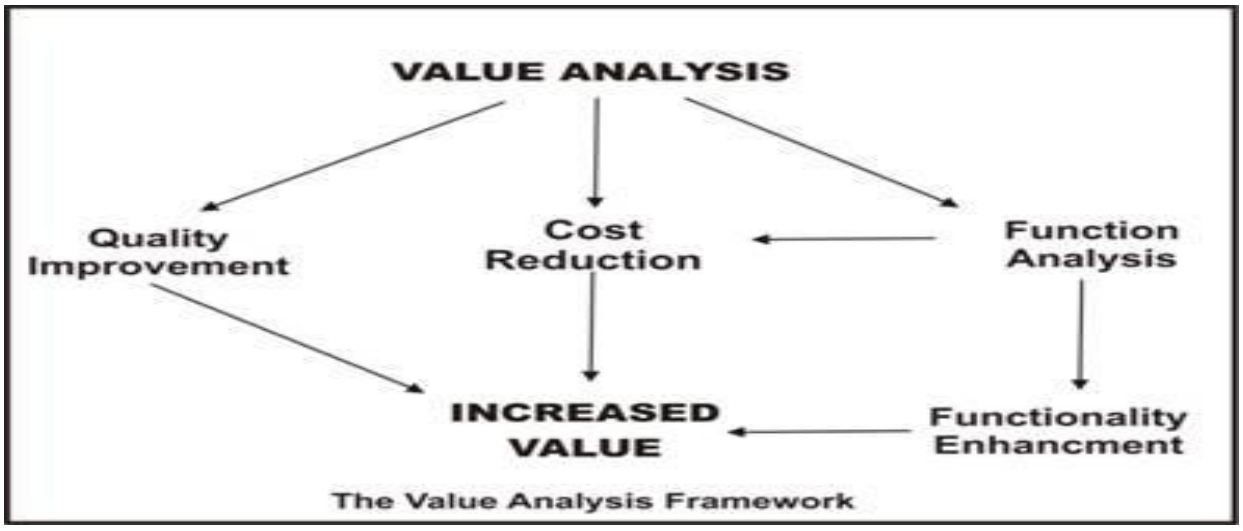
1. What is purchasing management? Explain its characteristics and functions.
2. Explain purchasing management concept and enumerate its importance in a construction industry.
3. What is the process of purchasing in a purchase department in Cement Company?
4. Explain different stages in the development of the purchasing function.
5. What is the importance of the materials management?
6. Explain the objectives of the materials management departments.
7. What are the various functions of the materials management? Explain.
8. Describe the duties and responsibilities of the materials manager?
9. What is the concept of materials management? How it is different from purchase management?
10. How will you integrate the various activities of materials management?
11. What types of materials are to be managed by automobile industry?
12. Elaborate the relationship between materials department and other departments?

TOPIC: VALUE ANALYSIS

Value Analysis – An Introduction

The competition is tough among companies due to globalization. Domestic as well as international companies are competing for same market share. The national as

well as international Multinational Companies (MNCs) are in search of competitive strategies like cost cutting techniques that can provide them competitive advantage. The managers in production houses are always in hunt of new quality tools, new production techniques, and in search of cheaper quality raw materials, etc. The materials mangers, production managers, and design managers are usually having get-together and maximum times the talk of the meeting or the agenda is how to reduce the cost of the product of the product? In this scenario, **value analysis is synonymous with cost reduction and is not only a powerful but also practical cost reduction technique available for production, design and materials manager**. Value analysis is concerned with ascertaining whether the material purchased is good value for money, for the required purpose or not. It is a planned and scientific way of cost reduction. It reviews and changes the materials composition and design of the product.



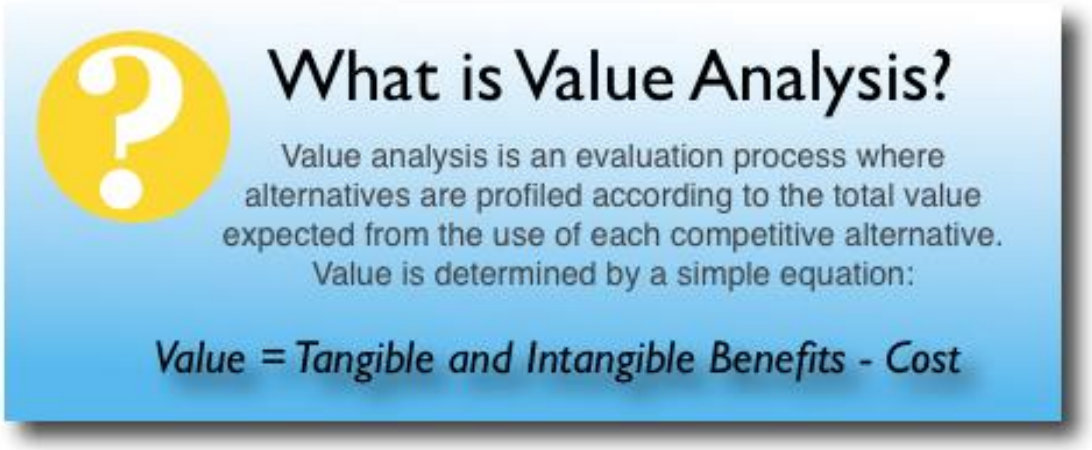
The Value Analysis Framework

"VE is an organized way of thinking or looking at an item or a process through a functional approach. It involves an objective appraisal of functions performed by parts, components, products, equipment, procedures, and services; and so on anything that costs money. Value methodology is commonly applied under the names Value Analysis (VA), Value Engineering (VE), and Value Management (VM). These term can be used interchangeably with the value methodology throughout the places according to need of the situation." Therefore, Value analysis is an organized creative approach aimed at identifying unnecessary costs and eliminating the same from the product without affecting the quality of the product.

Value Analysis – A Brief History

Value Engineering had its origin at the General Electric Company (GEC). Value analysis technique was developed by accident. During the World War II, there was

shortage of supplies of labour, components, parts, raw materials due to World War in General Electric Co. in U.S.A. Engineers like Lawrence D. Miles, Jerry Leftow, and Harry Erlicher at G.E. looked acceptable substitutes to avoid delay in production. They observed that the substitutions of raw materials, components and parts often reduced costs, improved the product, or both. They noticed that the methods of substitutions started out as an accident of necessity was turned into an organised process. Through team-oriented creative techniques they made changes in products to lower their cost without affecting their utility and quality. They called their systematic methods as "Value Analysis". Miles found that many of the substitutes used were providing equal or better performance at lower costs. Lawrence D. Miles is known as the father of the Value Analysis/Value Engineering technique.



Meaning of Value

Value is the ratio of function to cost. It is a relationship between the worth or utility of the product and the actual monetary cost of the product. Value can, therefore, be increased by either improving the function or reducing the cost. It is the association between a function for customer satisfaction and the cost of that function. Value analysis/engineering is a systematic method to improve the 'value' of products to be manufactured by analytically examining the functions of the products. According to Lawrence D. Miles, "Value is the lowest price you must pay to provide a reliable function or service." The determination of value requires a combination of the following considerations:

- **Cost Value:** It is the cost of production and selling an item.
- **Exchange Value:** It is the price a customer is prepared to pay for the product, or service.

- **Use Value:** It is the purpose the product fulfils. It can be called functional value.
- **Esteem Value:** It is the prestige a customer attaches to the product. It is related with the pride of possession of the customer.
- **Scrap Value:** It is related with the write off value of the product whenever it is not in use.

The concept of the value changes with time. A product having use value today will have scrap value with the passage of time.

Meaning of Value Analysis

According to Lawrence D. Miles, "Value Analysis is a philosophy implemented by the use of specific set of techniques, and a group of learned skills. It is an organized creative approach which has the purpose of the efficient identification of unnecessary cost, i.e. cost which provides neither quality, nor use, nor appearance, nor customer features".

"Value analysis/engineering is a systematic rating of all distinctive features of the value chain and elimination of unnecessary cost associated with an item with the objective of promoting the quality and satisfaction of customer needs in a cost effective manner."

"Value analysis/engineering is a systematic and organized approach to provide the necessary functions in a project at the lowest cost. Value engineering promotes the substitution of materials and methods with less expensive alternatives, without sacrificing functionality. It is focused solely on the functions of various components and materials, rather than their physical attributes. It is also called value analysis."

Difference between Value Analysis and Value Engineering

Value Analysis	Value Engineering

➢ For exiting product or service ➢ Manufacture, after sales ➢ Process improvement ➢ Concentrate on eliminating unnecessary cost, improvement performance	➢ For new product or service ➢ Prototype development, Design and engineering stage of product (before manufacturing) ➢ Functional improvement ➢ Concentrate on delivering value

Difference between Value Analysis and Value engineering

- ✓ Value Analysis concept is used in connection with cost-function analysis of existing product or process.
- ✓ Value Engineering is a concept of design analysis and engineering stage of the product prior to manufacturing and commercialization.
- ✓ Value analysis involves a creative approach for finding out unnecessary costs. Such costs are those costs which though incurred on a product or service, are unnecessary and do not improve its quality or efficiency, give it a better appearance, prolong its life, nor provide any additional satisfaction to the customer.

However, in both VA and VE the teams concentrate on the cost reduction without the compromising the value of the functions of the products or processes. The difference in both terms is not considered at large scale in maximum texts and these two terms are used interchangeably.

VALUE ANALYSIS

✓ **Value Analysis meaning:**

It is one of the major techniques of cost reduction and control. It is a disciplined approach which ensures the necessary functions for the minimum cost without diminishing quality, reliability, performance and appearance.

✓ It is a creative approach to eliminate the unnecessary costs which add neither to quality nor to the appearance of the product. It is a systematic application of techniques to identify the functions of a product or a component and to provide the desired function at the lowest total cost.

- ✓ These are the days of providing the customer with really best quality products at least cost which is possible through value analysis which proves wrong rightly "Best and Cheap" or "Best is never cheap" or "Cheap is Costly"

- **TYPES OF VALUE:**

a. Use Value:

There are certain characteristics of a product which make it useful for certain purposes. For example, a book of Cost Accountancy if written for ICWA—Inter students, has a use value provided it serves the purpose of such category of students. It measures the quality of performance of a product. Use value may be primary use value, secondary use value and auxiliary use value.

b. Esteem Value:

Certain properties of a product do not increase its utility or performance but they make it esteem able which would induce customers to purchase the product. For example, a watch with gold cover has esteem value. A rich customer may prefer a watch with gold cover although a watch with a steel cover may serve the same purpose of keeping time.

Some products may have both uses as well as esteem value and yet both may be important. For example, a fountain pen with a gold plated body will have both use and esteem value as it will not only look better but will also last longer.

c. Cost Value:

This value is measured in terms of cost involved. In case of a manufacturing concern it refers to the cost of production of the product produced and if some part of the product is purchased from outside, it means cost of purchase of that part.

d. Exchange Value:

Certain characteristics of a product facilitate its exchange for something else and what we get is the exchange value of that product. It is equivalent to its sale value. All these values play an important part in our personal lives, but in value analysis, we are mainly concerned with use value and to some extent to the esteem value.

➢ PHASES OF VALUE ANALYSIS:

1. Phase of Origination:

In the first phase, a value analysis study team is constituted. The project is selected and clearly defined. The team examines in detail the product and its components to understand thoroughly their nature.

2. Phase of Information:

After familiarization, a functional analysis is carried out to determine the functions and uses of the product and its components. The cost and importance of each function are identified. A value index is calculated on the basis of cost benefit ratio for each function. A list is being prepared in which the items of functions are arranged in decreasing order of value.

3. Phase of Innovation:

This is the creative phase concerned with the generation of new alternatives to replace or removing the existing ones.

4. Phase of Evaluation:

Each and every alternative is analyzed and the most promising alternatives are selected. These alternatives are further examined for economic and technical feasibility.

The alternatives finally selected must be capable of performances the desired functions satisfactorily. These must meet the standards of accuracy, reliability, safety, maintenance and repairs, environmental effects and so on.

5. Phase of Choice:

In this phase, report is prepared. This report contains a summary of the study, conclusions and specific proposals. The decision makers choose the alternative. The programs and action places are then developed to implement the chosen alternative.

6. Phase of Implementation:

The chosen alternative is put to the actual use with the help of the programs and action plans so developed in advance.

7. Phase of Review:

The progress of analysis changes in continuously monitored and followed up in order to provide assistance, to clarify any misconceptions and to ensure that the desired results are achieved.

- **MERITS OF VALUE ANALYSIS:**

Value analysis is really a very valuable technique of cost reduction and quality improvement. The specific merits of its are:

1. Improvement in Product Design:

It leads to improvements in the product design so that more useful products are given shape. **For example**: In case of ball points, we do not have clogging, there is easy and even flow of ink and rubber pad is surrounding that reduces figures fatigue.

2. High Quality is maintained:

High quality implies higher value. For example: dry cells were leaking; now they are leak proof; they are pen size with same power. Latest is that they are rechargeable.

3. Elimination of Wastage:

Value analysis improves the overall efficiency by eliminating the wastages of various types. It was a problem to correct the mistakes. It was done by pasting a paper. Now, pens are there and liquid paper is developed which dries fast and can write back.

4. Savings in Costs:

The main aim of value analysis is to cut the unwanted costs by retaining all the features of performance or even bettering the performance. Good deal of research and development has taken

place. Now milk, oils, purees pulp can be packed in tetra packing presuming the qualities and the tetra pack is degradable unlike plastic packs.

5. Generation of New Ideas and Products:

It helps in the generation of new ideas and product with reduced cost. For example in case of took brushes, those in 1930's were flat and hard, over 60 to 70 years brushes have come making brushing teeth easy, cozy and dozy as it glides and massages gums.

6. Encourages Team-Spirit and Morale:

Value analysis is a tool which is not handled by one, but groups or teams and an organisation itself is a team of personnel having specification. A product is the product of all team efforts. Therefore, it fosters team spirit and manures employee morale as they are pulling together for greater success.

7. Neglected Areas are brought under Focus:

The organizational areas which need attention and improvement are brought under the spot-light and even the weakest gets a chance of getting stronger and more useful finally join's the main strain.

8. Qualification of Intangibles:

The whole process of value analysis is an exercise of converting the intangibles to tangible for decision making purpose. It is really difficult to make decisions on the issues where the things are (variables) not quantifiable.

However, value analysis does it. The decision makers are provided with qualified data and on the basis of decisions are made. Such decisions are bound to be sound.

9. Wide Spectrum of Application:

The principles and techniques of value analysis can be applied to all areas-man be purchasing, hardware, products, systems, procedures and so on.

10. Building and Improving Company Image:

The company's status or image or personality is built up or improved to a great extent. Improvement in quality and reduction in cost means competitive product and good name in product market; it is a good pay master as sales and profits higher and labour market it enjoys reputation; it capital market, nobody hesitates to invest as it is a quality company.

- **Limitations:**

Like any other cost reduction technique, value analysis has its own limitations. The most common limitations are that the man made excuses are the blocks in implementing these plans of value analysis.

The most common excuses given are:

a. Lack of motivation

b. Resistive to change

c. Lack of knowledge and patience

d. Attitude of 'It will not work in India

e. We are very small or very big

f. This has been tried earlier and failed

g. The change is too big

h. 'Let competitors try before we try'

i. Difficulty of teams meeting or team meeting for getting consensus.

These limitations are man-made and can be over-come one the company divides to implement. However, they should be educated of the plus and minus points and the main beneficiaries are those that are to be told and they are to be taken into confidence.

Objectives of Value Analysis/Value Engineering

Value Analysis/Value Engineering is an activity that focuses on improving the value of the functions of product, process, service, or organization. The main objectives are as under:

- The main objective of value analysis/engineering is to provide only the necessary functions to meet the required performance at the lowest overall cost of product or processes.

- To improve the products or processes in terms of designs

- To provide better value to a product/service/process

- To use the multi-disciplined teams of specialists to identify essential versus nonessential functions of the products or processes

- The next important objective is to think creatively and to identify the ways to segregate the necessary functions from the unnecessary functions.

- To identify the costs associated with each type of functions.
- To improve the design, process, service, or product effectiveness by exploring the alternate ways of performing the functions at a lower overall cost

- To improve the company's competitive position

Value analysis/engineering is a team effort and it improves value by sustaining or improving the functions of the products/processes. It is a planned and scientifically systematic technique which concentrates on reducing the overall cost. This technique does not compromise with the value to be given to customer via product.

Techniques of Value Analysis

The most important technique of value analysis is the design analysis. It is a systematic analysis of the parts of the product or service or process.

Design Analysis: It is a step-by-step analysis of the design of a product in relation to the function it performs. In this approach the component parts of the products are dismantle or taken apart to pieces. All the pieces/parts of the products are demonstrated separately. The theme is to demonstrate visually the functional relationships of the various pieces/parts. The most important issues in design analysis are:

- ✓ Can any piece/part be removed permanently without affecting the functions of the product?
- ✓ Can the design be altered without compromising the value delivery? Can the part(s) be replaced with cheaper part(s)?
- ✓ Can the overall design be simplified to make it more functional?

The discovery of such potential improvements is the net result of the product design approach. The design approach is a very difficult process which requires highly creative expertise in value analysis. Thus some companies hire value analysis experts for this exercise. Different experts use different practices to solve this mystery. Some of the commonly used practices are the value analysis checklist, brainstorming, cost analysis checklist, supplier analysis as follows:

a) The Value Analysis Checklist

The companies develop the value analysis checklist to assist the analyst. This list consists of questions related with product design analysis. This list can have hundreds of questions and key ideas related with value analysis concept.

SR.NO	GENERAL QUESTIONS	YES	NO	REMARKS
1	Can any part of the product be eliminated without affecting the functions of the complete product?			
2	Can the design of the part of the product be altered?			
3	Can the overall design of the product be simplified?			
4	Can the material(s) be substituted with other material(s) in the product?			
5	Can the parts of the product be standardized?			
6	Can the weight of the overall product be reduced?			
7	Can any part of the product be made more cheaply in any of our production plants?			

The Value Analysis Checklist

b) Brainstorming

Brainstorming is a technique designed to stimulate creative thinking. The core philosophy of brainstorming sessions is to emphasis on generation of as many ideas as possible. During this exercise, no one is going to judge/evaluate the ideas as they come. The brainstorming group for design analysis consists of six to seven experts of different backgrounds drawn from different departments like materials department, design department, purchasing department, finance department, production department etc. The ideas given by members are listed for evaluation and development of promising idea(s) to generate a satisfactory solution of the problem. This technique is an integral part of the total value analysis procedure.

c) Cost Analysis Checklist

The companies develop cost analysis checklist to assist the analyst. This list consists of questions related with cost analysis of the part(s) of the product, overall product, standardization, product weight, product design, etc. This list can have hundreds of questions and key ideas related with cost analysis concept.

SR.NO	GENERAL QUESTIONS	YES	NO	REMARKS
1	Can any part of the product be eliminated to minimise the overall cost of the product?			
2	Can the design of the part of the product be altered to lower down the cost?			
3	Can the overall design of the product be simplified with less cost?			
4	Can less expensive materials be used in the product?			
5	Can the parts of the product be standardized to lower down the overall cost?			
6	Can the weight of the overall product be reduced to minimise the carrying/packaging cost?			
7	Can any part of the product be made more cheaply in any of our production plant?			

The Cost Analysis Checklist

d) Supplier Analysis

The organisations invite the current and potential suppliers for the purpose of offering possible cost-reduction suggestions for the product(s), the parts of the products, standardization of part(s) and product(s), weight, packaging etc. The interaction with supplier(s) provides valuable suggestions and solutions of the value analysis problems. Here, the experience, creativity and production facility of the suppliers is utilized.

Value Analysis Process

The first step of the value analysis process is to define the problem and its scope. Once this is done, the functions of the product and its items are derived. The value analysis process is normally organized by a value analysis team. It is conducted in the sequential phases (which may overlap in practice). The phases are Problem Identification Phase, Selection of the Members for the Functional Analysis Team, Information Phase,

Function Analysis Phase, Creative Phase, Evaluation Phase, Development and Presentation Phase, and Implementation Phase:

- **Problem Identification Phase**

The first step of the value analysis process is the identification of the problem by the management and preparation for the value analysis. The problem can be complex design of the product and the production cost is high. Other reasons for selecting a particular product for value analysis might be apparently the high cost, low yield rates or the manufacturing problems. The competitors are offering better product and the market demands remodeling or some changes in the product. There can be a need for a more compact design.

- **Selection of the Members for the Functional Analysis Team**

Usually six to eight members from different departments such as materials accounting, production, purchasing, engineering, design and marketing, etc. are selected for further analysis.

- **Information Phase**

This is a very important phase in which the issues/problems are addressed. The targets for improvement and evaluation factors are discussed by the team members. For that purpose, the information from both inside the organisation like present detailed design, materials, manufacturing and marketing information and outside the organisation like the competitors' product designs, information about new technologies, etc. is collected.

- **Function Analysis Phase**

In this phase, first of all the major function(s) and supporting functions of the product are identified. Further, all parts of the products are dismantle or taken apart to pieces. All the pieces/parts of the products are demonstrated separately. The theme is to demonstrate visually the functional relationships of the various pieces/parts. In last, a table illustrating the relationship between the functions and the parts of the product, as well as relevant existing costs, is drawn up.

- **Creative Phase**

The core philosophy of this step/phase is to emphasis on generation of as many ideas as possible to solve the problem identified in the first phase. During this exercise, no one is going to judge/evaluate the ideas as they come. The brainstorming group for idea generation consists of six to seven experts of different backgrounds. The ideas given by members are listed for evaluation and development of promising idea(s) to generate a satisfactory solution of the problem. This technique is an integral part of the total value analysis procedure.

- **Evaluation Phase**

In this phase, the best idea(s) for the problem(s) is refined and selected. The idea selected might be to use new materials or parts / to adopt a different method of manufacturing / to adopt completely new product / to add on new product functions / to modify the function(s) of the product / to combine the different functions / to eliminate of certain function(s). The best idea can be new design / compact design / new packaging / new technology etc. The core of the selection of the best solution for the problem is to lower down the cost.

- **Development and Presentation Phase**

At this stage, the 'best' alternative(s) is developed finally for the presentation to management. Next is the commitment to follow a course of action for initiating the 'best' alternative.

- **Implementation Phase**

In this stage, the final approval of the proposal is obtained from the management and facilitates its implementation.

Benefits of Value Analysis/Value Engineering

Value analysis/engineering is an effective problem solving and quality assurance tool that can facilitate goals of cost-function analysis. The benefits of this concept are as under:

- The biggest benefit of value analysis/engineering is the improvement in the functions of the product and value delivery.

- Value analysis / engineering delivers best product designs at lower costs.

- Value analysis/engineering is a team approach to solve many problems of product, parts, standardization, packaging, weight, design, technology, materials, etc.

- Value analysis/engineering provides a method of communication within a product development team and achieving team consensus. Good outcome is expected as it is a team effort of experts of various departments.

- It meets standards and safety objectives.

- It improves a product's performance while maximizing quality and value delivery.

- It decreases the cost of a product without compromising the functions of the product and quality of product. The entire focus is to provide essential functions to fulfill the product requirements.

Summary

Value is the ratio of function to cost. It is a relationship between the worth or utility of the product and the actual monetary cost of the product. Value can, therefore, be increased by either improving the function or reducing the cost. It is the association between a function for customer satisfaction and the cost of that function. Value analysis/engineering is a systematic method to improve the 'value' of products to be manufactured by analytically examining the functions of the products. The components/parts are improved by either reducing their cost or increasing the value of the functions. The most important technique of value analysis is design analysis. It is a systematic analysis of the parts of the product or service or process. Some of the commonly used practices are the value analysis checklist, brainstorming, cost analysis checklist, and supplier analysis. The first step of the value analysis process is to define the problem and its scope. Once this is done, the functions of the product and its items are derived. The value analysis process is normally organized by a value analysis team. It is conducted in the following sequential phases (which may overlap in practice) as follows: Problem Identification Phase, Selection of the Members for the Functional Analysis Team, Information Phase, Function Analysis Phase, Creative Phase, Evaluation Phase, Development and Presentation Phase, Implementation Phase. The biggest benefit of value analysis/engineering is the improvement in the functions of the product and value delivery. Value analysis / engineering delivers best product designs at lower costs.

Self Assessment Questions

1. Define value analysis. What are the objectives of value analysis?
2. What is design analysis? How is it used in a value analysis program?
3. Elaborate various techniques used in design analysis by experts.
4. Enumerate various phases of the value analysis process.
5. What are the benefits of value analysis/engineering?
6. How value is related to purchasing decisions?

STOCK CONTROL SYSTEMS

What is stock?

- stock of items kept to meet future demand
- stock of materials
- stored capacity

AN INVENTORY is simply a list of all the goods purchased and used in the manufacturing process.

Types of stock

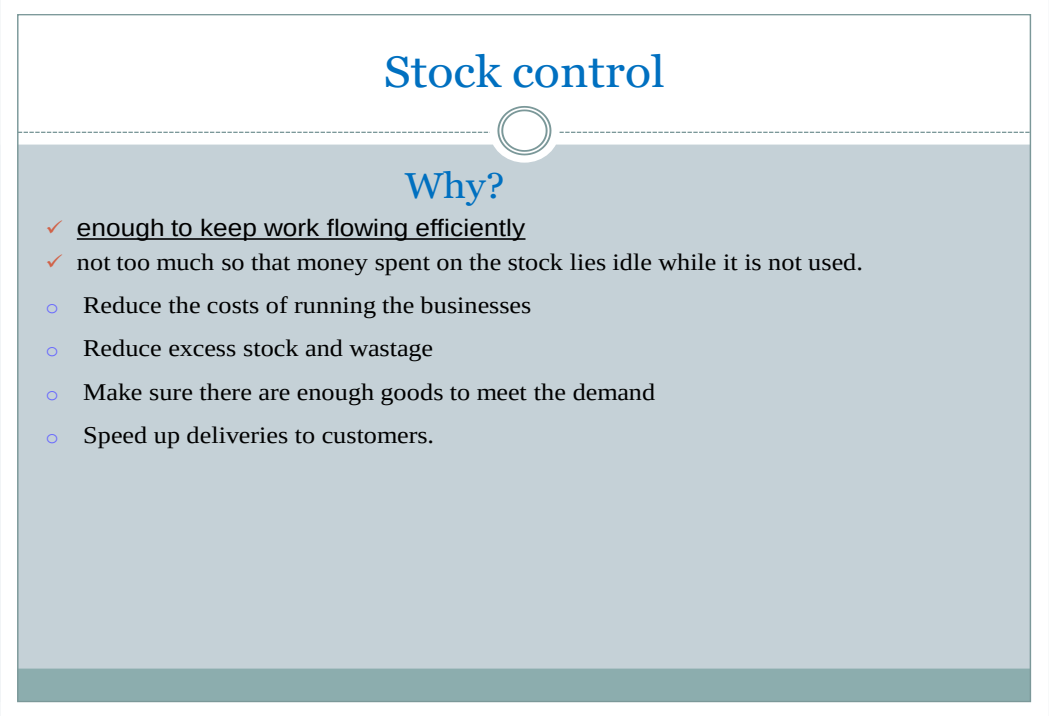
- **Raw Materials**
  - ✓ Substances in a natural state before they go through manufacturing process
  - ✓ Components that require assembly purchased from outside suppliers
- **Work in progress**
  - ✓ Items which, at a given time, are going through the production process. Some products have a long production process so the value of the work in progress is often substantial e.g. construction projects
- **Finished goods**
  - ✓ Goods that are complete
  - ✓ May be stocked awaiting delivery to customer
  - ✓ May be produced some time in advance ahead of seasonal increases in demand

What is Stock Control?

Every business needs to keep track of the items that it manufactures or sells (the stock). The system that monitors the items in stock is called the stock control system. E.g. in a store, the stock includes all of the items on the shelves and out the back in the storeroom.

It is important that a business does not keep too much stock, or too little.

- Too much stock costs money as you have to store it all somewhere
- Too much perishable stock (e.g. food) means that it may go bad before it is sold
- Too little stock means that you might run out of stock before the next delivery arrives.



Data in a Stock Control System

A stock control system is basically a database. Each record (row) of the database is identified by an item code (the primary key).

Other fields in each record would include:

- Description
- Item price

- Stock level (the number of items held in stock)
- Minimum stock level (when stock falls below this, it needs to be reordered)
- Reorder quantity (how many items we should order each time)

Receiving New Stock

When items are added in to stock (because a delivery has arrived) this is recorded in the stock control system.

The code of the new items is input to the system (usually using a barcode scanner, or similar technology). The record for the item is found in the stock database, or a new record is created, and the stock level is increased.

In many stores, the POS system is directly linked to the stock control system, so that stock levels are adjusted as soon as an item is sold.

Selling / Delivering Stock

When items are taken from stock (because they have been sold, or delivered somewhere) this is recorded in the stock control system.

The code of the item is being sold/delivered is input to the system (usually using a barcode scanner, or similar technology). The record for the item is found in the stock database, and the stock level is decreased.

In many stores, the POS system is directly linked to the stock control system, so that stock levels are adjusted as soon as an item is sold.

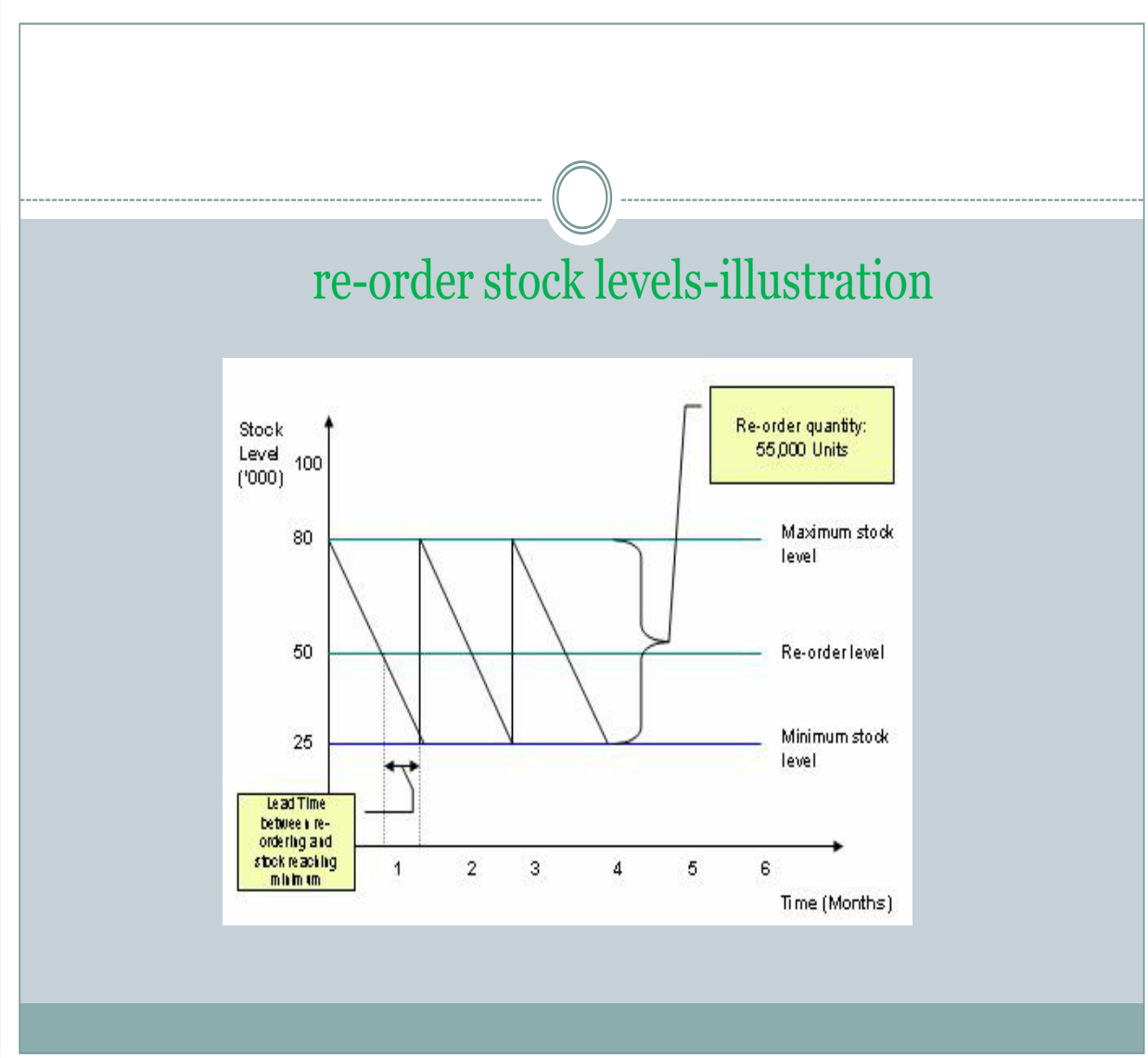
Automatic Re-Ordering of Stock

Stock control systems make it very easy for stock levels to be monitored, and for stock to be reordered when it is running low.

The stock control system regularly goes through all the records in the stock database and checks if the stock level is less than the minimum stock level.

Is Stock Level < Minimum Stock Level?

If the stock is too low, it is reordered from the supplier. The quantity that is ordered is read from the stock database (larger amounts for more popular items)

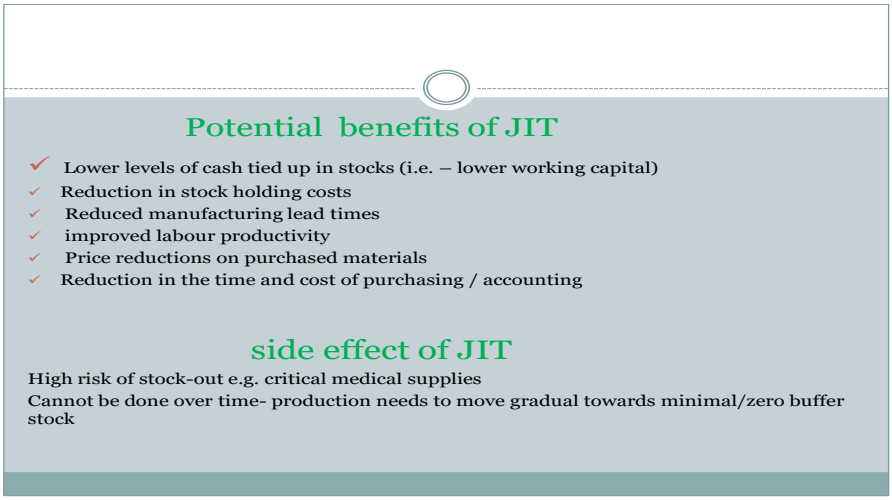


DIFFERENT METHODS FOR STOCK CONTROL MANAGEMENT

1. **Stock reviews:** Your business will take regular stock reviews to establish whether new stock must be ordered. This considers pre-determined figures that help business leaders make the decision to order new stock or hold off. Many businesses operate a minimum stock level – the lowest point stock can go before more is ordered.

2. **Fixed-time/fixed-level reordering:** This involves ordering new stock either at fixed times, fixed levels or both. For example, a company may have a standing order for 500 units every third Sunday of the month. This type of stock control is particularly useful for companies with fixed contracts and stable demand, with sporadic irregular orders unless they're placed with a long-term delivery date.

3. **Just in time (JIT):** This stock control system originated in Japan. As the name suggests, stock is ordered as and when it is required to keep costs down and liquidity high. However, the increased cash flow comes at a cost. The company must be exceptionally organised in order to ensure orders are made at the right time, and suppliers must be reliable to fulfill requirements. There is also a risk of running out of stock should a big order be placed.



4. **Economic Order Quantity (EOQ):** EOQ is a complex mathematical formula that aims to keep stock at an optimal level, depending on the type of firm and the industry it operates within. EOQ calculations can be time consuming, so you may find it easier to consult a professional or invest in stock management software which should be able to make out-of-the-box EOQ calculators. EOQ can be combined with other forms of stock management where required.

5. **First in, first out**: This system is popular with businesses that work with perishable stock. It aims to ensure that stock does not deteriorate before use. Stock is identified by when it was received and moves onto the next stage of production before stock received at a later date.

6. **Batch control:** Batch control separates stock management and production into batches. This reduces complexity in the production process and helps make sure short-term targets are met. Batch control can also help keep costs down as firms only need the raw materials and components needed to satisfy the demands of an individual batch.

7. **Vendor-managed inventory (VMI):** Vendor-managed inventory (VMI) is a relatively new model of stock management that emphasizes shared risk between the buyer and supplier. The buyer provides information to the supplier about their stock requirements; the supplier is then responsible for maintaining a level of stock at a specified location, normally the buyer's point-of-sale. VMI helps reduce the chance of under-stocking and reduces the time stock spends in the supply chain.

How can my business avoid over or under spending on stock?

Here are some tips around how to effectively manage your inventory for increased profitability as well as how to avoid under or overspending on stock.

1. Define processes and stock types

Carefully defining the processes involved in production, and the types of stock required, are important to ensure your business maintains appropriate levels of stock at the right times. There are four main types of stock:

- Raw materials – components used to create new products
- Unfinished goods – materials that are in the process of being converted to products
- Finished goods – products ready for entry into the market
- Consumables – additional resources used in the production process e.g. fuels and gas canisters

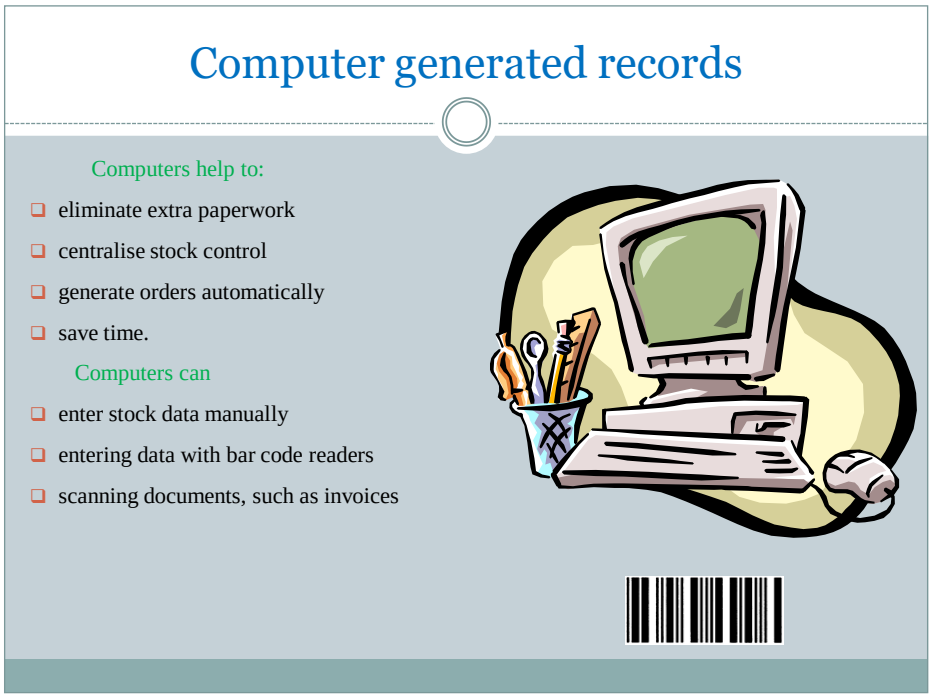
By understanding when and where in the production process the various types of stock are needed, businesses can more easily maintain stock at optimal levels. Here's an example to show how this works:

- The production process takes two weeks and a new order is due in three weeks
- Check to see whether there are unfinished or finished goods available to fulfill the order.
- If there are, no action on stock is necessary. If there aren't, check to see whether there are enough consumables and raw materials to fulfill the order through production
- If there are, production can commence. Otherwise raw materials and/or consumables must be ordered

Following this process helps companies ensure they hold the minimum amount of superfluous stock at any one time.

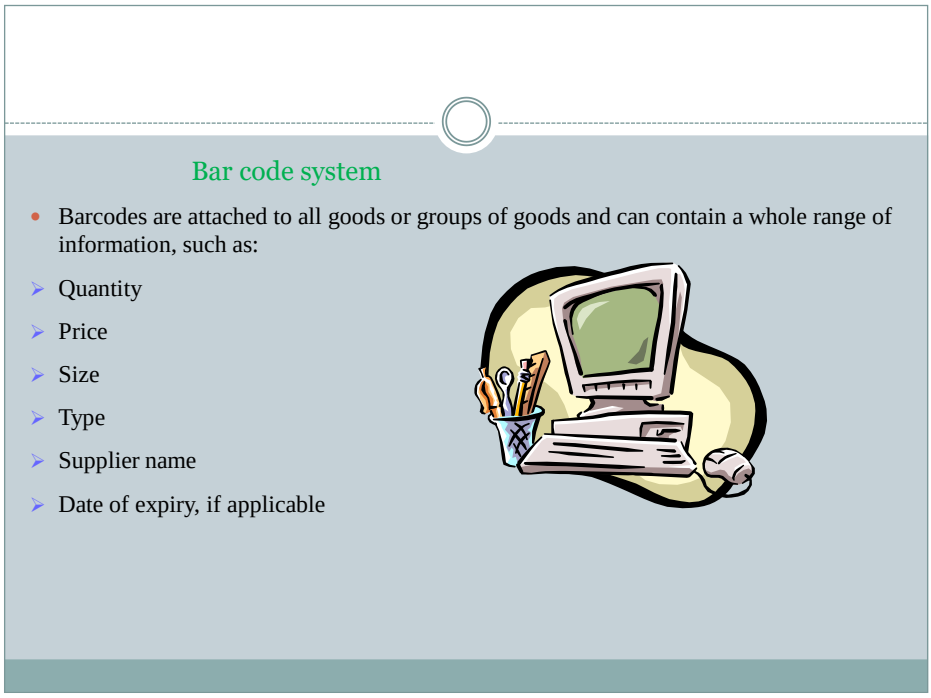
2. Use inventory management software

Inventory management software gives you control over all aspects of stock and supplies, integrating related processes into a centrally accessible software package. As your business functions, the software can advise you of necessary action, such as ordering new products once your stock hits a certain level. This can help you make data-informed decisions to help avoid overstocking.



3. Explore integrated technology

Inventory management software isn't the only technology that can help your business manage stock. Mobile scanners and POS (point of sale) systems can help too. When investing in technology, prioritize systems that work together. A POS system that doesn't connect well to your inventory management software can cost you both time and money. Transferring the data manually between systems may also result in inaccuracies.



4. Track sales

As well as adding up sales at the end of the day it is beneficial to know what items sold, how many, and update the businesses inventory totals. Then take time to analyze this data and ask some important questions:

- When do certain items sell faster or drop off?
- Is this a seasonal factor?
- Is there a specific day of the week when you sell certain items?
- Do some items almost always sell together?

Understanding your sales totals and the bigger picture of how things look is important for keeping inventory under control.

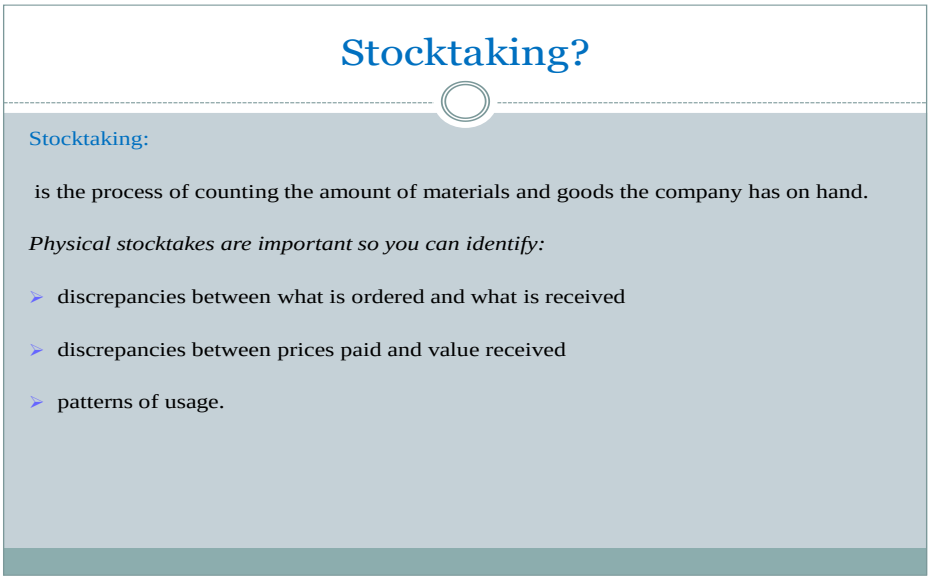
5. Stock security

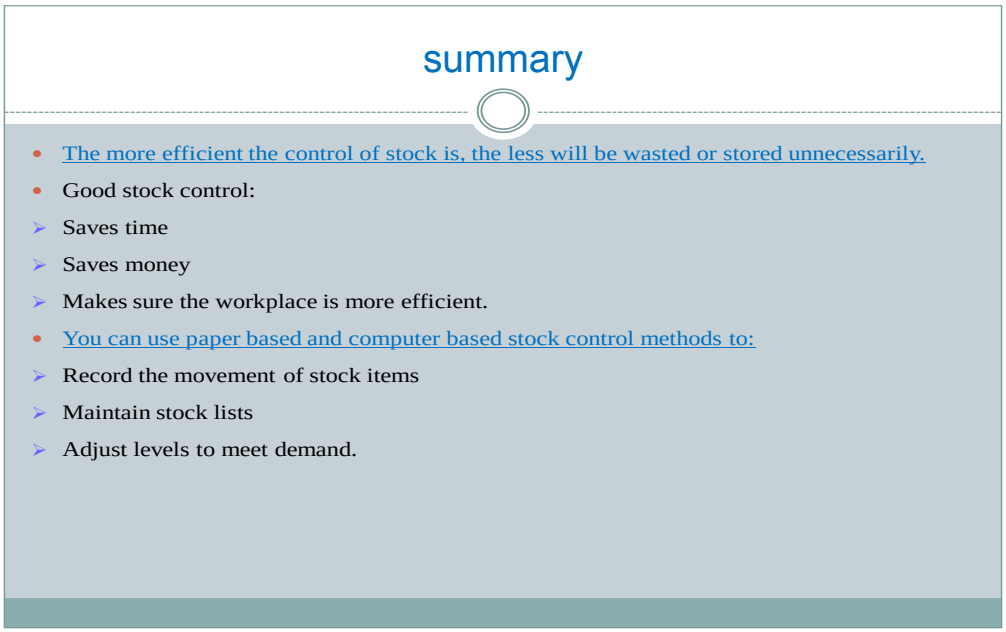
Damage and theft can not only affect stock levels but can also impact your bottom line. Stock should be delivered to and kept in a secure area, preferably with CCTV or similar protection. Staff should be trained to follow specific safety procedures in order to protect stock, such as recognizing distraction burglaries and escalating issues to senior management should security concerns arise.

Firms may also wish to know what security steps suppliers are taking; a damaged or stolen pallet of stock could mean the difference between fulfilling an order and disappointing a valuable customer.

6. Use effective stock management that suits your business model

There is no 'one-size-fits-all' solution for stock management. Numerous methods are commonly used in business depending on the type of company and the industry in which it operates. Find the one that works best for your business.





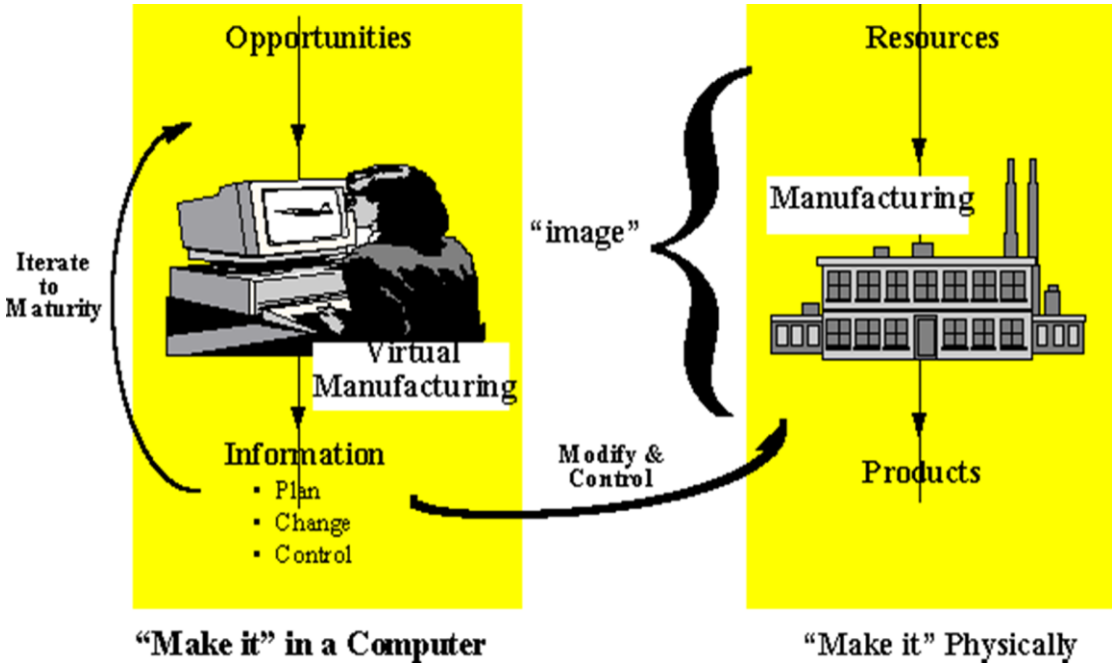
TOPIC: VIRTUAL FACTORY CONCEPT

What is Virtual Factory?

- **VIRTUAL FACTORY**

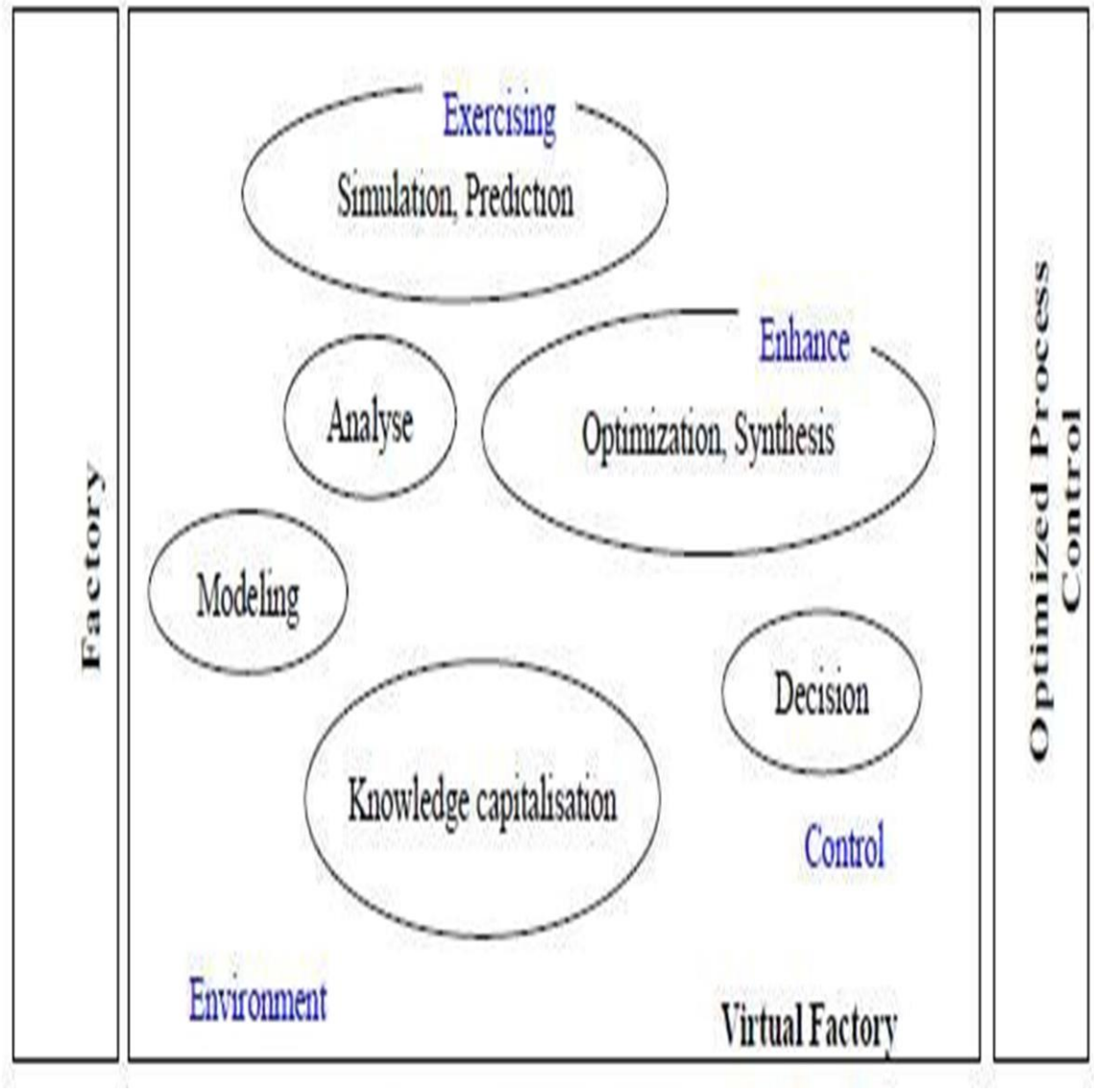
It refers to an integrated model that includes variety of software, tools, and methodologies in order to solve any real time problem of manufacturing system. This model sees a real factory as a combination of various sub-systems and includes them. In manufacturing, it creates a virtual simulation exercise that helps in replicating the real life scenario and helps in designing and implementation.

It refers to an integrated model that includes variety of software, tools, and methodologies in order to solve any real time problem of manufacturing system. This model sees a real factory as a combination of various sub-systems and includes them. In manufacturing, it creates a virtual simulation exercise that helps in replicating the real life scenario and helps in designing and implementation.



- It is a new kind of manufacturing technology.
- It is based on :
  - **Simulation technology.**
  - **Virtual reality technology.**
  - **Information technology.**
- Virtual Manufacturing system is a computer system which can generate the same information about manufacturing system's structure, states and behaviors as we can observe in real manufacturing systems.

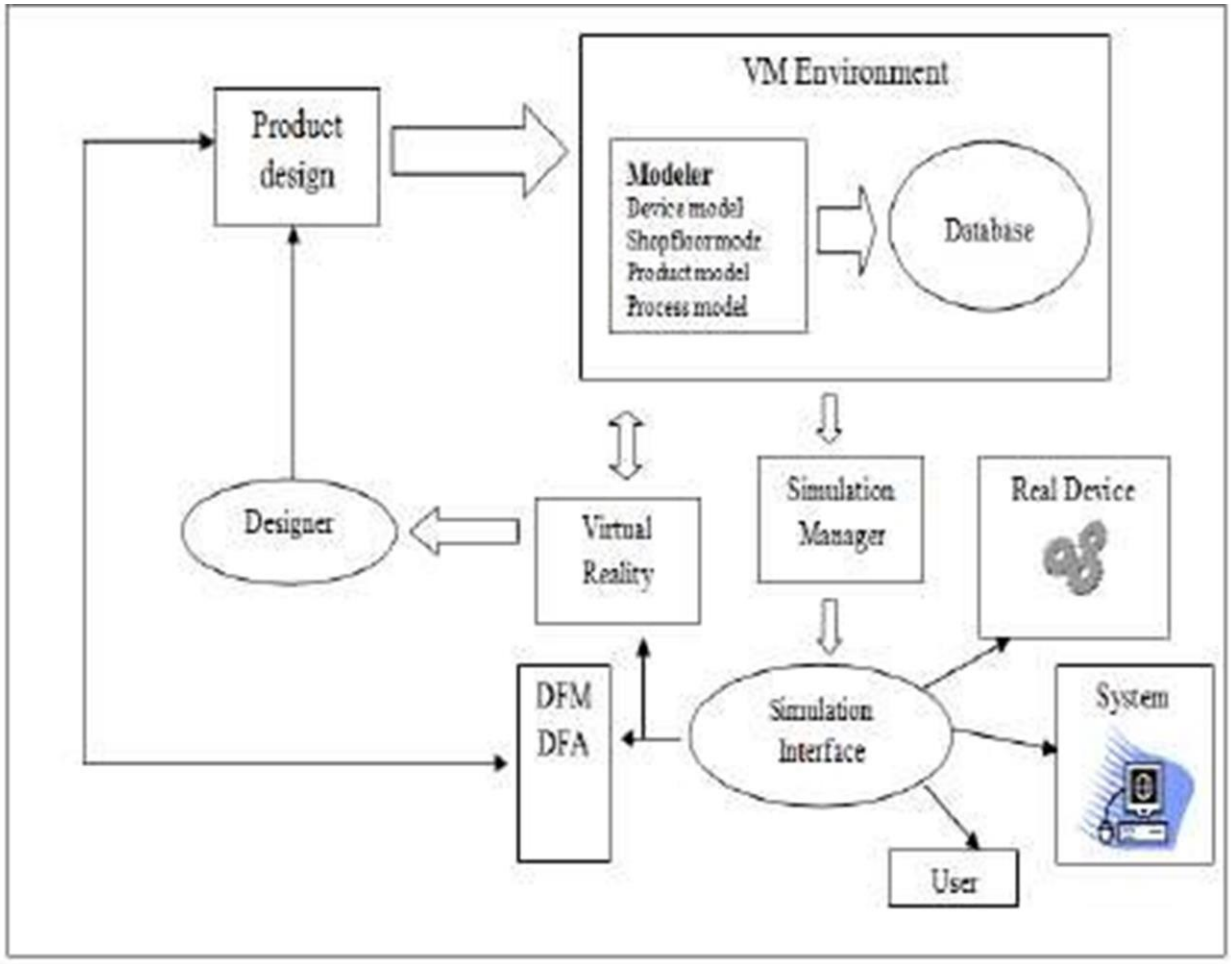
- VM is used in interactive simulation of various manufacturing process such as virtual prototyping, virtual machining, virtual inspection, virtual assembly and virtual operational system.
- Virtual manufacturing is manufacturing in a computer.
- Virtual manufacturing is a manufacturing of imaginary objects in an imaginary or *virtual environment* to attain concrete objective.
- An integrated, synthetic manufacturing environment exercised to enhance all levels of decision and control .



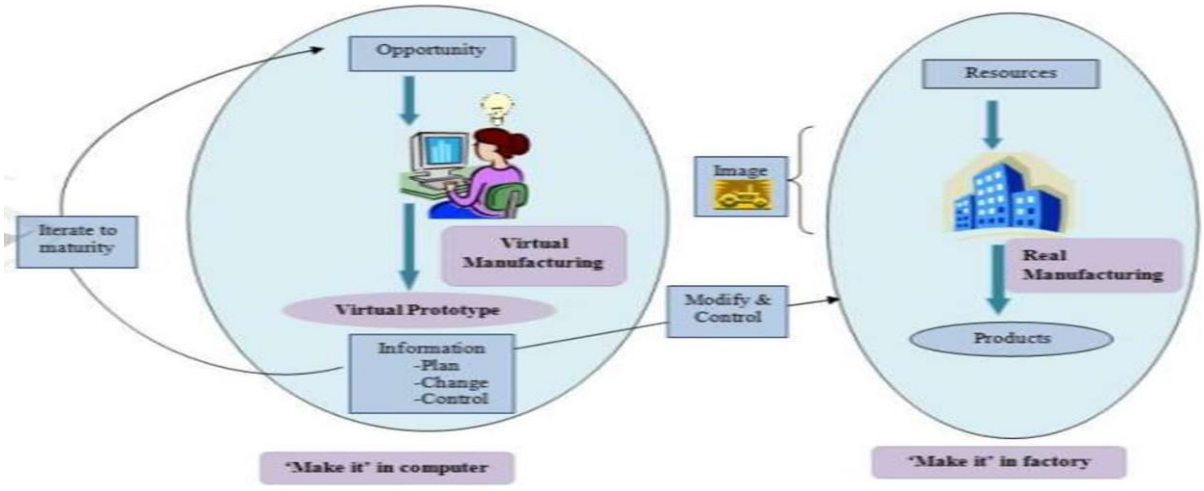
VIRTUAL ENVIRONMENT

- A computer-generated, 3-D representation of a setting in which the user of the technology perceives themselves to be and within which interaction takes place.
- A place containing things that can be manipulated easily.

ENVIRONMENT OF VM



VISION OF VM



- Manufacture in the computer.
- Provide a powerful modeling and simulation environment.

CHARACTERISTICS

- Virtual manufacturing deals with the information and data of the product and manufacturing system.
- Virtual manufacturing is not true manufacturing, but in the manufacturing of computer and network system related with software.
- Virtual manufacturing processing results are digital products, rather than the real material products.
- Virtual manufacturing is a disperse system.
- The simulation of product design, processing and assembling process can be parallel operated.

CLASSIFICATION

1. Classification based on types of products and process design.
2. Classification based on type of system integration.
3. Classification based on functional usage.

Classification based on types of product and process design

1. Production-oriented Virtual Manufacturing
2. Control-oriented Virtual Manufacturing
3. Design-oriented Virtual Manufacturing

Classification based on type of system integration

4. Real Physical System
5. Real Information System
6. Virtual Physical System
7. Virtual Information System

Classification based on functional usage

8. Virtual Prototyping
9. Virtual Machining
10. Virtual Inspection
11. Virtual Assembly
12. Virtual Operational Control

METHODS AND TOOLS USED IN VIRTUAL MANUFACTURING

- Manufacturing characterization
- Modeling and representation technologies
- Visualization, environment construction technologies
- Verification, validation and measurement
- Multi discipline optimization

EXISTING TOOLS FOR VM

- **Design Tools**
  - Computer Aided Engineering (CAE)
  - 3-Dimensional Computer Aided Design (CAD) Models
  - Design for Manufacturability & Assembly (DFMA)
- **Production Tools**
  - Computer Integrated Manufacturing (CIM)
  - Advanced Modeling and Simulation
  - Distributed Interactive Simulation (DIS)
  - Integrated Product/Process Development (IPPD)
  - Just in Time (JIT)
  - Materials Requirement Planning (MRP),
  - Manufacturing Resources Planning (MRP II)
  - Virtual Reality
- **Quality Tools**
  - Total Quality Management (TQM)
  - Quality Function Deployment (QFD)
- **Artificial Intelligence (AI) Tools**
  - Expert Systems
  - Neural Networks
  - Fuzzy Logic,

- Object Oriented Technologies
- Autonomous Agents

- **Management Tools**
  - Quality Philosophies in Manufacturing
  - Manufacturing Strategies
  - Management Information Systems (MIS)

The **advantage** of virtual factory involves:

• It helps in creating capabilities to support the rapid development in manufacturing sector by pooling the experts.

• It helps in providing solutions in a speedy and cost effective manner.

• It eliminates the need for pilot plants or production runs and replaces it with virtual simulation on software.

• It helps in the decision making process.

The functions can be grouped into 3 major subsystems in a virtual factory are:

• Primary subsystems of manufacturing

• Business process subsystem

• Communication network subsystem

These subsystems are properly integrated to mimic the real life scenario.

Apart from manufacturing, companies also use virtual factory in providing service to their customers. Companies use the power of internet and ever increasing bandwidth to create a chain of experts/ freelancers with necessary skill sets and motivation. When customer seeks service, he is mapped to an expert who helps in solving the problem of customer.

DRAWBACKS

- Integration of simulation systems in planning and design tools
- Automatic generation of simulation models
- Distributed simulation, optimization and control
- Hybrid simulation
- Human-computer interfaces
- Virtual prototyping

UNIT-IV

TOPIC: INVENTORY MANAGEMENT

INTRODUCTION: A business can run smoothly its operating activities only when appropriate amount of inventory is maintained. Inventory affects all operating activities like manufacturing, warehousing, sales etc. The amount of opening inventory and closing inventory should be sufficient enough so that the other business activities are not adversely affected. Thus, inventory plays an important role in operations management.

Inventory management is a very important function that determines the health of the supply chain as well as the impacts the financial health of the balance sheet. Every organization constantly strives to maintain optimum inventory to be able to meet its requirements and avoid over or under inventory that can impact the financial figures.

Inventory is always dynamic. Inventory management requires constant and careful evaluation of external and internal factors and control through planning and review. Most of the organizations have a separate department or job function called inventory planners who continuously monitor, control and review inventory and interface with production, procurement and finance departments.

MEANING OF INVENTORY: Inventory is a list for goods and materials, or those goods and materials themselves, held available in stock by a business

- Inventory is stock of items held to meet future demand.
- It is a list for goods and materials, or those goods and materials themselves, held available in stock by a business.
- It is collection of goods processed to form desired output to the organization.
- A stock of items held to meet future demand.

Inventory is an idle stock of physical goods that contain economic value, and are held in various forms by an organization in its custody awaiting packing, processing, transformation, use or sale in a future point of time.

➢ Different Types of Inventory

Inventory of materials occurs at various stages and departments of an organization. A manufacturing organization holds inventory of raw materials and consumables required for production. It also holds inventory of semi-finished goods at various stages in the plant with various departments. Finished goods inventory is held at plant, FG Stores, distribution centers etc. Further both raw materials and finished goods those that are in transit at various locations also form a part of inventory depending upon who owns the inventory at the particular juncture. Finished goods inventory is held by the organization at various stocking points or with dealers and stockiest until it reaches the market and end customers.

Inventory Management flow cycle

Raw Material → Inspection→Moving →Processing → Setup→ Final Product

Besides Raw materials and finished goods, organizations also hold inventories of spare parts to service the products. Defective products, defective parts and scrap also form a part of inventory as long as these items are inventoried in the books of the company and have economic value.

Nature of Inventories

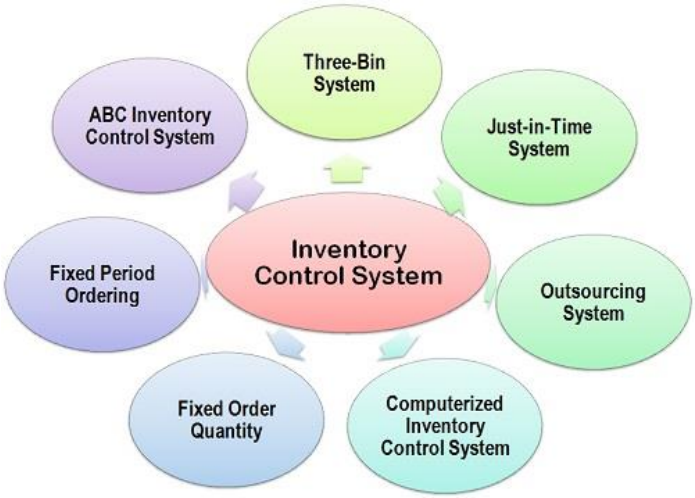
- **Raw Materials** – Basic inputs that are converted into finished product through the manufacturing process
- **Work-in-progress** – Semi-manufactured products need some more works before they become finished goods for sale
- **Finished Goods** – Completely manufactured products ready for sale
- **Supplies** – Office and plant cleaning materials not directly enter production but are necessary for production process and do not involve significant investment.

TYPES OF INVENTORY BY FUNCTION

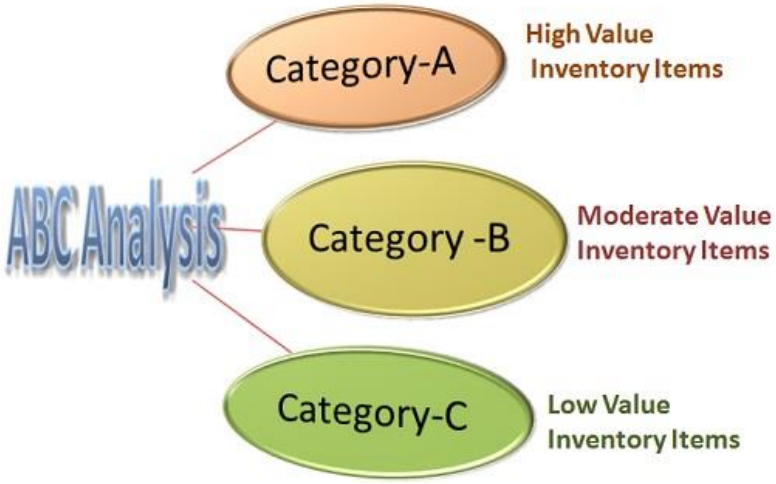
INPUT	PROCESS	OUTPUT
Raw Materials	Work In Process	Finished Goods
Consumables required for processing. Eg : Fuel, Stationary, Bolts & Nuts etc. required in manufacturing	Semi Finished Production in various stages, lying with various departments like Production, WIP Stores, QC, Final Assembly, Paint Shop, Packing, Outbound Store etc.	Finished Goods at Distribution Centers throughout Supply Chain
Maintenance Items/Consumables	Production Waste and Scrap	Finished Goods in transit
Packing Materials	Rejections and Defectives	Finished Goods with Stockiest and Dealers
Local purchased Items required for production		Spare Parts Stocks & Bought Out items
		Defectives, Rejects and Sales Returns
		Repaired Stock and Parts
		Sales Promotion & Sample Stocks

MEANING OF INVENTORY MANAGEMENT

Inventory management is the practice overseeing and controlling of the ordering, storage and use of components that a company uses in the production of the items it sells. A component of supply chain management, inventory management supervises the flow of goods from manufacturers to warehouses and from these facilities to point of sale. Inventory control means efficient management of capital invested in raw materials and supplies, work- in – progress and finished goods.



1. ABC Inventory Control System: It is used to determine the importance of each item of the stock in terms of its value of annual consumption and are categorized as A, B, and C.



The items of high value are categorized as **"A"** and generally consist of 15%-25% of inventory items; that accounts for 60%-75% of annual usage value. The firm keeps strict control over these inventory items.

The Category **" B",** is comprised of those items that are of relatively less value or has moderate importance and consists of 20%-30% of inventory items, that accounts for 20%-30% of annual usage value. A reasonable control is kept on the "B" category inventory items.

The least important items of the inventory are categorized as **"C".** It consists of 40%-60% of inventory items; that accounts for 10%-15% of annual usage value. Due to a low value of these items, a simple or an ordinary control is kept on them.

Thus, the ABC Inventory Control System focuses on significant items of the inventory and hence is also called as **"Control by Importance and Exception."**

2. Three-Bin System

The **Three-Bin System** is like a two-bin system, wherein the third bin of inventory is reserved with the supplier. In other words, a manufacturing firm keeps a stock of inventory in two bins, and at the same time, the supplier of the inventory will keep one bin reserved at his location.

3. Just-in-Time System:

The **Just-in-Time or JIT** is an inventory management system wherein the material, or the products are produced and acquired just a few hours before they are put to use. The Just-in-time system is adopted by the firms, to reduce the unnecessary burden of inventory management, in case the demand is less than the inventory raised.

4. Outsourcing Inventory System:

The **Outsourcing Inventory System** is adopted by the firms to reduce the burden of manufacturing the components of the finished goods in-house i.e. within the organization. Thus, a system of buying the products or components from outside vendors rather than manufacturing internally is called as Outsourcing Inventory system.

5. Computerized Inventory Control System:

A **Computerized Inventory Control System** is the integration of sub-functions involved in the management of inventory into a single cohesive system. It is software installed on the computer systems that enables a firm to keep a check on the inventory levels by performing the automatic counting of inventories, recording withdrawals and revising the stock balance.

6. Fixed Order Quantity:

The **Fixed Order Quantity** is the inventory control system, wherein the maximum and minimum inventory levels are fixed, and maximum and fixed amount of inventory can be replenished at a time when the inventory level reaches the auto set reorder point or the minimum stock level.

7. Fixed Period Ordering:

The **Fixed Period Ordering** is an inventory control system, wherein the order for the replenishment of inventory items is sent periodically or after a fixed time interval. It is also called as **Fixed Period Deficit Ordering system**, because every time the order is placed, the order quantity is different.

➢ REASONS TO HOLD INVENTORY

1. Meet variations in customer demand:
    a) Meet unexpected demand
    b) Smooth seasonal or cyclical demand
2. Pricing related:

a) Temporary price discounts
b) Hedge against price increases
c) Take advantage of quantity discounts

3. Process & supply surprises

a) Internal – upsets in parts of or our own processes
b) External – delays in incoming goods

➢ Objective of Inventory Management

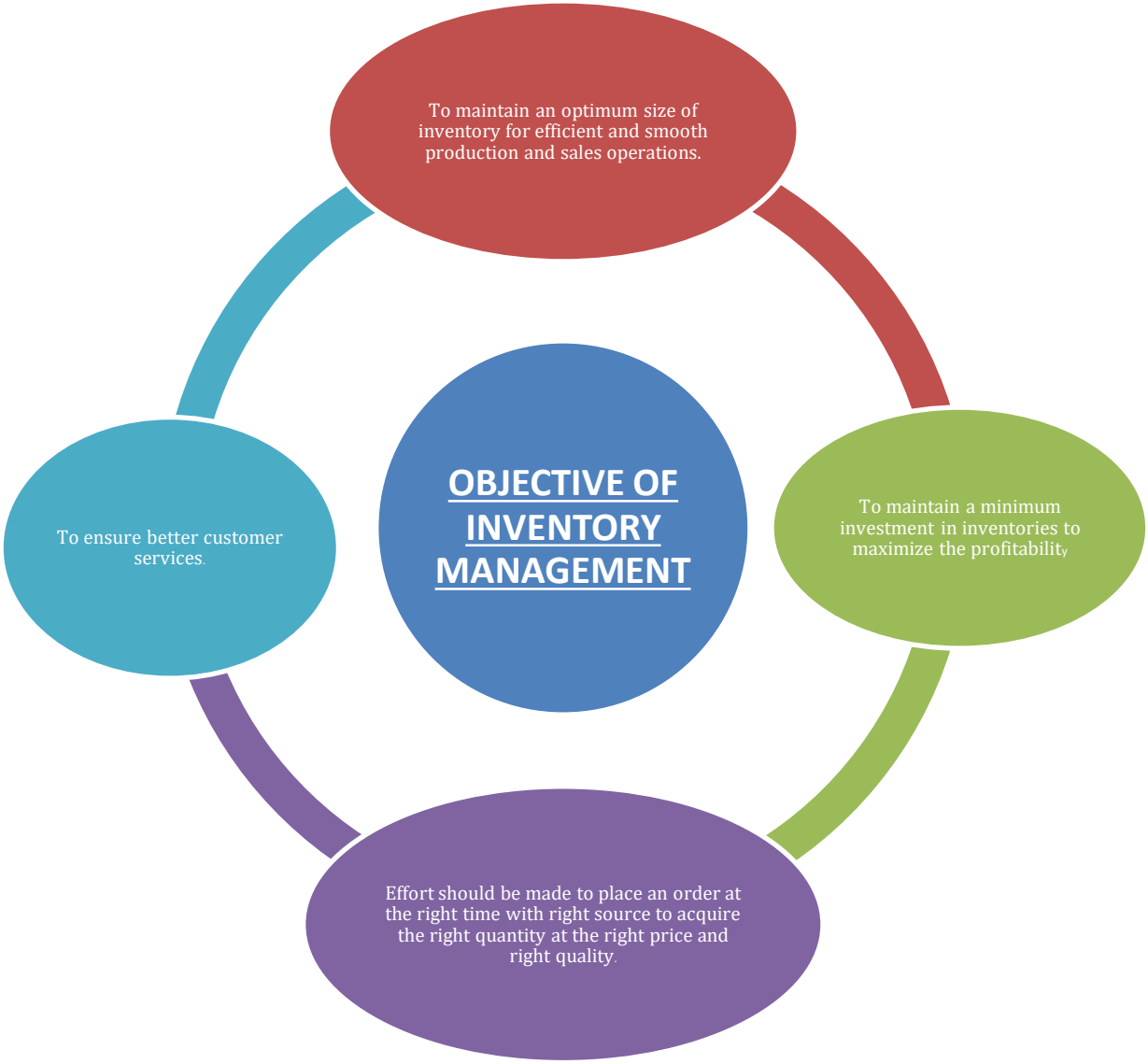
The objective of inventory management is to maintain inventory at an appropriate level to avoid excess or shortage of inventory. Inventory management systems reduce the cost of carrying inventory and ensure that the supply of raw material and finished goods remains continuous throughout the business operations. The objectives specifically may be divided into two categories mentioned below:

A. **Operating objectives**: They are related to the operating activities of the business like purchase, production, sales etc.

a. To ensure continuous supply of materials.
b. To ensure uninterrupted production process.
c. To minimize the risks and losses incurred due to shortage of inventory.
d. To ensure better customer services.
e. Avoiding of stock out danger.

B. **Financial Objectives:**

a. To minimize the capital investment in the inventory.
b. To minimize inventory costs.
c. Economy in purchase.



Apart from the above objectives, inventory management also emphasizes to bring down the adverse impacts of holding excess inventory. Holding excess inventory lead to the following consequences:

- Unnecessary investment of funds and reduction in profit.
- Increase in holding costs.
- Loss of liquidity.
- Deterioration in inventory.

➢ Reasons why organizations maintain Raw Material Inventory

Most of the organizations have raw material inventory warehouses attached to the production facilities where raw materials, consumables and packing materials are stored and issue for production on JIT basis. The reasons for holding inventories can vary from case to case basis.

1. **Meet variation in Production Demand:** Production plan changes in response to the sales, estimates, orders and stocking patterns. Accordingly the demand for raw material supply for production varies with the product plan in terms of specific SKU as well as batch quantities.

   Holding inventories at a nearby warehouse helps issue the required quantity and item to production just in time.

2. **Cater to Cyclical and Seasonal Demand:** Market demand and supplies are seasonal depending upon various factors like seasons; festivals etc and past sales data help companies to anticipate a huge surge of demand in the market well in advance. Accordingly they stock up raw materials and hold inventories to be able to increase production and rush supplies to the market to meet the increased demand.

3. **Economies of Scale in Procurement:** Buying raw materials in larger lot and holding inventory is found to be cheaper for the company than buying frequent small lots. In such cases one buys in bulk and holds inventories at the plant warehouse.

4. **Take advantage of Price Increase and Quantity Discounts:** If there is a price increase expected few months down the line due to changes in demand and supply in the national or international market, impact of taxes and budgets etc, the company's tend to buy raw materials in advance and hold stocks as a hedge against increased costs.

   Companies resort to buying in bulk and holding raw material inventories to take advantage of the quantity discounts offered by the supplier. In such cases the savings on account of the discount enjoyed would be substantially higher that of inventory carrying cost.

5. **Reduce Transit Cost and Transit Times:** In case of raw materials being imported from a foreign country or from a far away vendor within the country, one can save a lot in terms of transportation cost buy buying in bulk and transporting as a container load or a full truck load. Part shipments can be costlier.

   In terms of transit time too, transit time for full container shipment or a full truck load is direct and faster unlike part shipment load where the freight forwarder waits for other loads to fill the container which can take several weeks. There could be a lot of factors resulting in shipping delays and transportation too, which can hamper the supply chain forcing companies to hold safety stock of raw material inventories.

6. **Long Lead and High demand items need to be held in Inventory:** Often raw material supplies from vendors have long lead running into several months. Coupled with this if the particular item is in high demand and short supply one can expect disruption of supplies. In such cases it is safer to hold inventories and have control.

➢ Factors affecting the level of inventory

The level of inventory should be appropriate. The appropriateness of the amount of inventory depends upon a number of factors. Some significant factors affecting the level of inventory are explained as follows:

1. Nature of business: The level of inventory will depend upon the nature of business whether it is a retail business, wholesale business, manufacturing business or trading business.

2. Inventory turnover: Inventory turnover refers to the amount of inventory which gets sold and the frequency of its sale. It has a direct impact on the amount of inventory held by a business concern.

3. Nature of type of product: The product sold by the business may be a perishable product or a durable product. Accordingly, the inventory has to be maintained.

4. Economies of production: The scale on which the production is done also affects the amount of inventory held. A business may work on large scale in order to get the economies of production.

5. Inventory costs: More the amount of inventory is held by the business, more will be the operating cost of holding inventory. There has to be a trade-off between the inventory held and the total cost of inventory which comprises of purchase cost, ordering cost and holding cost.

6. Financial position: Sometimes, the credit terms of the supplier are rigid and credit period is very short. Then, according the financial situation of the business the inventory has to be held.

7. Period of operating cycle: If the operating cycle period is long, then the money realization from the sale of inventory will also take a long duration. Thus, the inventory managed should be in line with the working capital requirement and the period of operating cycle.

8. Attitude of management: The attitude and philosophy of top management may support zero inventory concepts or believe in maintaining huge inventory level. Accordingly, the inventory policy will be designed for the business.

TECHNIQUES OF INVENTORY CONTROL

Inventory control refers to a process of ensuring that appropriate amount of stock are maintained by a business, so as to be able to meet customer demand without delay while keeping the costs associated with holding stock to a minimum. Inventory control signifies a planned approach of finding when to shift, what to shift, how much to shift and how much to

stock so that costs in buying and storing are optimally minimum without interrupting production or affecting sales. To solve these problems of inventory management various techniques are there.

These techniques are divided into two categories – modern techniques and traditional techniques.

(1) **MODERN TECHNIQUES**

(a) Economic Order Quantity (EOQ)

(b) Re-Order Point (ROP)

(c) Fixing Stock Levels

(d) Selective Inventory Control

(i) ABC Analysis

(ii) VED Analysis

(iii) SDE Analysis

(iv) FSN Analysis

(2) **TRADITIONAL TECHNIQUES**

(a) Inventory Control Ratios

(b)Two Bin Systems

(c) Perpetual Inventory System

(d) Periodic Order System

Modern Techniques: Modern techniques of inventory control refer to those techniques which are evolved through a scientific process. These techniques involve the use of a formula or a method which is logically derived to keep control on the inventory levels. These techniques are explained as below:

(a) ECONOMIC ORDER QUANTITY (EOQ): The optimal size of an order for replenishment of inventory is called economic order quantity. Economic order quantity (EOQ) or optimum order quantity is that size of the order where total inventory costs (ordering costs + carrying

costs) are minimized. Economic order quantity can be calculated from any of the following two methods:

- Formula Method
- Graphic Method

Formula Method: It is also known as 'SQUARE ROOT FORMULA' or 'WILSON FORMULA' as given below:

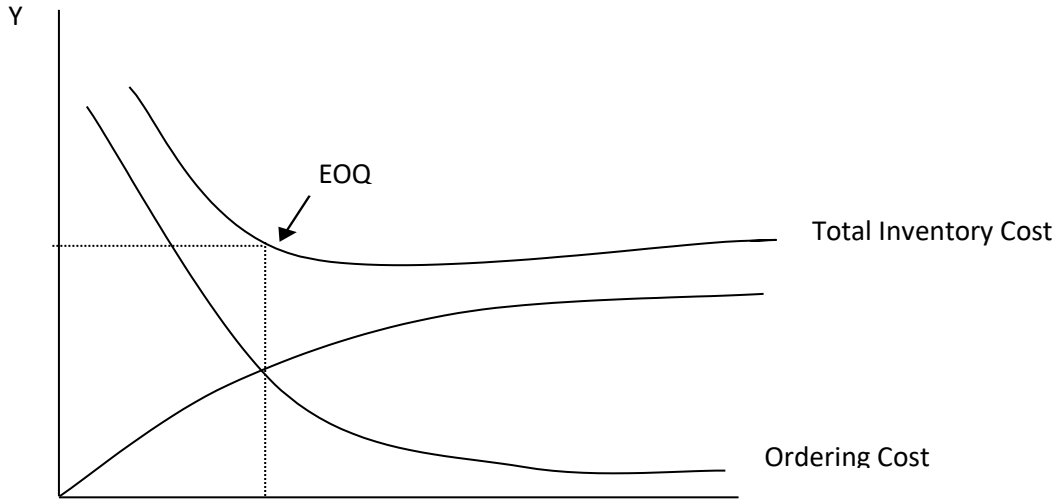
$$EOQ = \sqrt{\frac{2RO}{C}}$$

Where, EOQ = Economic Order Quantity, R = Annual Requirement or consumption in units, O = Ordering Cost per order, C = Carrying Cost per unit per year, No. of orders = R/EOQ

- Time gap between two orders = No. of days in a year/No. of orders
- Total Cost =Purchase Cost + Carrying Cost + Order Cost

  =(R x Unit Price) + (EOQ/2 x C) + (R/EOQ x O)

Graphic Method: The economic order quantity can also be determined with the help of graph. Under this method, ordering costs, carrying costs and total inventory costs according to different lot sizes are plotted on the graph. The intersection point at which the inventory carrying cost and the ordering cost meet, is the economic order quantity. At this point the total cost line is also Least.



Assumptions: The following assumptions are made:

- The rate of consumption of inventory is assumed to be constant.
- Costs will not change over time.
- Lead time is assumed to be known and constant.
- Per order cost, carrying cost and unit price are constant.
- Carrying or holding costs are proportionate to the value of stock held.
- Ordering cost varies proportionately with the price.

(b) RE-ORDER POINT: After determining the optimum quantity of purchase order, the next problem is to specify the point of time when the order should be placed. Re-order level is that level of inventory at which an order should be placed for replenishing the current stock of inventory. The determination of re-order point depends upon the lead time, usage rate and safety stock. These terms are explained below:

1. **Lead Time:** Lead time refers to the time gap between placing the order and actually receiving the items ordered.

2. **Usage Rate**: It refers to the rate of consumption of raw material per day.

Usage Rate = Total annual consumption / No. of days in a year

3. **Safety Stock:** It is the minimum quantity of inventory which a firm decides to maintain always to protect itself against the risk and losses likely to occur due to stoppage in production and loss of sale, due to non- availability of inventory.

Re Order Point = (Lead Time x Usage Rate) + Safety Stock or

Re Order Point = Maximum usage x Maximum Re Order Period

Safety Stock = Usage Rate x Days of safety

© Fixing Stock Levels: Fixing of the stock levels is necessary to avoid increased cost on account of high inventory levels and to avoid loss of sales or stoppage of production due to low level of inventory. Therefore, efforts should be made to keep the inventory level within the specified minimum and maximum limits. The maximum & minimum stock levels are fixed after considering the following factors:

- Availability of ample storage space.
- Lead time involved i.e. time required in receiving the goods ordered.

- Availability of working capital to meet the routine expenses.
- Average rate of consumption of material
- Cost of storage and insurance of inventory.
- Risk of obsolescence and deterioration of the inventory.
- Economy in prices such as making bulk purchases during period of low prices.

Maximum Level = (ROL + ROQ) – (Minimum Usage x Minimum Re Order Period)
or Maximum Level = Safety Stock + EOQ

Minimum Level = Re-order level – (Normal Usage Rate x Normal Re-order period)
= Re Order Level – (Normal Usage x Average Re Order Period)

Average stock level = (Maximum level + Minimum level) / 2 or

Average stock level = (Minimum level + 1/2 Re- order Quantity)

- Re-order level.

Note: ROL – Re Order Level, ROQ – Re Order Quantity**,** ROQ is also known as EOQ (Economic Order Quantity).

DANGER LEVEL: Danger level refers to the level below the minimum stock level. The following factors should be considered to determine the danger level:

- Causes for failure of regular supplies
- Easy and quick sources of supply
- Rescheduling of work- order in the light of such exigencies
- Quickest means of transportation
- Emergency period of procurement

Formula: Danger Level = Minimum rate of consumption x Emergency delivery period.
Danger Level = Maximum rate of consumption x Emergency delivery period.

(d) SELECTIVE INVENTORY CONTROL: Controlling all inventories in the stock is a very difficult task especially where huge inventories are maintained of variety of items. In such circumstances, following smart techniques for managing and controlling the different types of inventories held

are as follows:

(i) ABC Analysis: ABC analysis may be defined as a technique where inventories are analyzed with respect to their value so that costly items are given greater attention and care by the management. Three categories are created namely A, B and C. Following table represents the approximate classification of items along with their value and quantity.

(ii) VED Analysis: VED stands for Vital, Essential and Desirable. Highest control is over vital items, medium control is exercised over essential items and least control is inferred over desirable items.

(iii) SDE Analysis: SDE stands for Scarce, Difficult and Easy. Highest control is over scarce items, medium control is exercised over difficult items and least control is inferred over easily available items.

(iv) FSN Analysis: FSN stands for Fast Moving (F), Slow Moving (S) and Non Moving (N). Highest control is kept over fast moving items, medium control is exercised over slow moving items and least control is inferred on non-moving items.

Traditional Techniques: Traditional techniques refer to those techniques which are prevalent before the evolution of the modern techniques. These techniques were derived with the working practice and are based on experience and ease of usage by the workers and the small business enterprises. These techniques are explained as follows:

(a) INVENTORY CONTROL RATIOS: Ratios related to inventory are calculated and further used as a measure of control.

Stock Turnover = Cost of goods sold / Average Stock

(b) TWO BIN SYSTEMS: Under two bin systems, all the inventory items are stored in two separate bins. Bin means container of any size. In the first bin, a sufficient amount of inventory is kept to meet the current requirement over a designated period of time. In the second bin, a safety stock is maintained for use during lead time. When the stock of first bin is completely used, an order for further stock is immediately placed. The material in second bin is then consumed to meet stock needs until the new order is received. On receipt of new order, the stock used from the second bin is restored and the balance is put in the first bin. Therefore, depletion of inventory in the first bin provides an automatic signal to re-order. Thus, this technique is traditional yet logical and can be used by illiterate workers also without using any formula.

(c) PERPETUAL INVENTORY SYSTEM: Perpetual inventory system is defined as the method of recording stores balance after each receipt and each issue to facilitate regular checking of inventory. It is also known as continuous stock checking. The application of perpetual inventory control system involves –

(i) Attaching bin cards with bins.

(ii) Continuous stock taking to compare the actual stock.

Bin cards refers to the cards attached to every bin in which the details regarding the quantity of material received, issued and balance left in that bin is recorded hand to hand. Under this system, statement of material, follow up actions, monitoring etc. can be smoothly carried out.

(d) PERIODIC ORDER SYSTEM: Under this system, the stock levels of all types of inventories held are reviewed after a fixed time interval. Time interval may be weekly, fortnightly, monthly, quarterly etc. depending upon the criticality of the item. Critical items may require a short review cycle and on the other hand, lower cost and non-moving items may require long review cycle. Therefore, for different items different time intervals should be used. After the review, the items which are less than the required level, order is placed to replenish their exhausted level.

Practice Problems

1. Calculate the economic order quantity from the following particulars:

- Annual requirement =2,000 units
- Cost of materials per unit =Rs. 20
- Cost of placing and receiving one order= Rs. 40
- Annual carrying cost of inventory, 20% of inventory value

SOL: Here, R = 2,000 O = 40 Unit Price = 20

C = 20% of Unit Price = 20% of 20 = 4

EOQ = $\sqrt{2RO / C}$

= $\sqrt{2\ (2000)\ (40) / (4)}$ = 200 units

2. Compute EOQ and the total variable cost from the following information:

Annual demand	= 4,000 units
Units Price	= Rs. 40
Order Cost	= Rs. 20
Storage Rate	= 7% Per annum
Interest Rate	= 3% Per annum

SOL: Here, R = 4,000 , O = 20 , Unit Price = 40 , C = 10% of Unit Price = 10% of 40 = 4

$$EOQ = \sqrt{2RO / C}$$

$$= \sqrt{2\ (4000)\ (20) / (4)} = 200 \text{ units}$$

Total Variable Cost = Carrying Cost + Order Cost

$$= (EOQ/2 \times C) + (R/EOQ \times O)$$

$$= (200/2 \times 4) + (4000/200 \times 20) = 400 + 400 = \text{Rs. } 800$$

Total Cost = Purchase Cost + Carrying Cost + Order Cost

$$= (R \times \text{Unit Price}) + (EOQ/2 \times C) + (R/EOQ \times O)$$

$$= (4000 \times 40) + (200/2 \times 4) + (4000/200 \times 20) = 1,60,000 + 400 + 400 = \text{Rs. } 1,60,800$$

3. Two components P and Q are used as follow:

- ✓ Normal usage is 600 units per week each.
- ✓ Maximum usage 900 units per week each
- ✓ Minimum usage 300 units per week each
- ✓ Re-order quantity- P = 4,000 units; Q = 7,000 units
- ✓ Re-order period- P = 4 to 6 weeks; Q = 2 to 4 weeks

CALCULATE:

(i) Re-order level
(ii) Minimum Level
(iii) Maximum Level
(iv) Average stock level

Solution: **For P**

(i) Re-order Level = Maximum usage x Maximum Re Order Period = 900 x 6 = 5, 400 units
(ii) Minimum Level = Re-order level – (Normal Usage Rate x Normal Re-order period)
= 5, 400 – (600 x 5) = 2, 400 units
(iii) Maximum Level = (ROL + ROQ) – (Minimum Usage x Minimum Re Order Period)
= (5, 400 + 4, 000) – (300 x 4) = 8, 200 units
(iv) Average stock level = (Maximum level + Minimum level) / 2
= (8, 200 + 2, 400) / 2 = 5, 300 units

For Q

(i) Re-order Level = Maximum usage x Maximum Re Order Period = 900 x 4 = 3, 600 units
(ii) Minimum Level = Re-order level – (Normal Usage Rate x Normal Re-order period)

= 3, 600 – (600 x 3) = 5, 400 units

(iii) Maximum Level = (ROL + ROQ) – (Minimum Usage x Minimum Re Order Period)

= (3, 600 + 7, 000) – (300 x 2) = 10, 000 units

(iv) Average stock level = (Maximum level + Minimum level) / 2

= (10, 000 + 5, 400) / 2 = 7, 700 units

- **FACTORS AFFECTING INVENTORY MANAGEMENT AND CONTROL:**

1. Consumer Demand

Consumer demand is the lifeblood of inventory management. Take this example: If your customers buy huge quantities of soap but minimal amounts of shampoo, it wouldn't make sense to stock equal amounts of both. In this scenario, you would likely face a shortage of soap, excess inventory of shampoo, or both. To avoid these negative outcomes – and their financial effects on your business – you have to track customer demands and product sales, and order inventory accordingly.

2. Amount of Inventory

It's crucial to stock the right amount of inventory. Ordering too much puts you at risk of getting stuck with stock you'll have to sell at a discount or discard altogether. Overstock can lead to major cash flow problems, with gaps in the budget due to dropping large amounts of capital on inventory at once. Ordering too little and you may compromise customer service by failing to have requested items available. To master this careful balance, you need an inventory management system that accurately predicts consumer demand based on data gathered form past sales. When you can forecast consumer demand for a product, you can pinpoint the ideal amount to order to avoid overstock and stockout.

4.Financials

Getting your financials right is crucial when it comes to inventory management as every step of the process involves a great deal of financial risk. Spending too much on inventory can cause money problems and spending too little can create unhappy customer reviews online.

By planning the spending of each inventory management task such as item ordering, tax costs associated with stocks, transportation, storage…etc strategically you'll be able to handle your inventory management process smoothly reducing major cashflow problems. Additionally, it's also important to pay attention to fluctuations in the economy that affects the financial factor of inventory management process.

5. Suppliers

Having a reliable group of suppliers is an essential factor to maintain a seamless inventory management without comprising the customer satisfaction. It is huge in order to minimize delays and shortages of stocks which can directly affect on production and then on order fulfillment. No matter how reliable your suppliers are, having a backup supplier will always give you that extra guarantee of a delay-free manufacturing process.

6. Product quantity

Having the right item in the right quantity in your inventory will enhance not only the smoothness of inventory management but also of the entire supply chain management process.

Having a good understanding of your inventory item levels, consumer demand, item shelf life…etc will help you always maintain all the necessary items in the necessary level. For an example, it's better to order items that are shortly perishable in short amounts more frequently so you can avoid wastes.

7. Managing tools and technology

Introducing modern technology to your inventory can save you both time and money while improving the efficiency and effectiveness of inventory management processes. With the right tools and systems in place, you'll be able to streamline your inventory management process further.

Thus, the productivity and the efficiency will get improved drastically. Tools like barcode scanners, label printers, mobile computers…etc along with a good inventory management software can double or even triple the speed of your inventory processes, as the new technology involved with these will help you do the counting, recounting, receiving, picking…etc more efficiently.

8. The smoothness of the supply chain process

Inventory management is a part of the supply chain process of a company. Therefore, any issue or delay in the supply chain management process will affect your inventory management.

For an example supplier delay in raw material orders or a delay in logistics will cause delays in stocks and productions. Thus, the seamlessness in your supply chain management process is another main factor that affects inventory management.

9. Product Type

The type of product greatly influences the inventory control policies assigned to manage the product. For example, products with short shelf lives, such as perishable foods, require a different policy than men's dress shirts. Short shelf life products must rotate based on expiration date. Although it seems like a first in/first out (FIFO) policy works in this case, if at any time goods come into the warehouse out of expiration date sequence, a FIFO policy will fail to manage the inventory properly.

10. Lead-times

Lead-time is the amount of time it takes for a product to move from order placement to manufacturing to final delivery to your warehouse or facility. Different suppliers have different lead-times, and it pays to research and check with various suppliers what their lead-times are before settling with the right one for your business.

Generally, the shorter the lead-time the better it is for your business, however sometimes it pays to endure a slightly longer lead-time from a supplier if the quality is notably improved. Knowing the lead-times of your suppliers makes the job of your purchasing managers that much easier.

This helps to ensure that goods are re-ordered in time to meet fluctuations in customer demand. A good inventory management software system can be programmed to alert managers to low or high inventory levels and prompt timely re-ordering based off supplier lead-times

11. Inventory levels – they need to be accurate

Fluctuations in consumer demand means that inventory levels need to be constantly fluctuating too. The key is to have your inventory levels fluctuating in synergy with demand. This comes down to accurate demand forecasts driven by up-to-date, accurate data, timely re-ordering and a detailed, precise and exact overview of all inventory – on order, in storage and en route to customer.

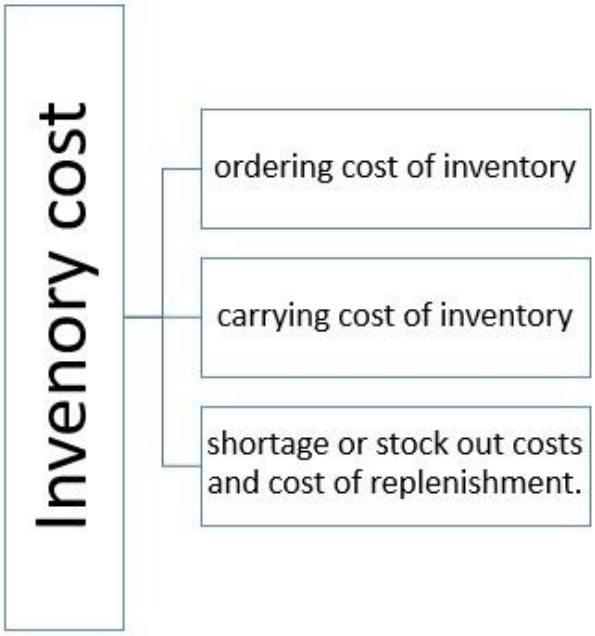
When inventory levels are poorly managed one of two costly situations will manifest. The first occurs if not enough inventory is on hand to meet demand. Stock-outs are every inventory manager's worst nightmare because when there is not enough inventory to meet demand, customers walk away empty handed. Lost sales equals lost revenues, but also lost customer loyalty.

If inventory levels are too high, costs resulting from storage, labor and losses suffered from damaged, stolen or obsolete goods skyrocket. Not only does this place a burden on overall efficiency, but also more importantly, available cash flow gets pooled into maintaining these new costly demands. This in turn means less working capital is available to capitalize on new opportunities should they arise, giving the advantage over to your competitors.

INVENTORY COSTS

Inventory costs are the costs associated with the procurement, storage and management of inventory. It includes costs like ordering costs, carrying costs and shortage / stock out costs.

Inventory costs can be categorized into three sub headings-



1. Ordering cost of inventory refers to the cost incurred for procuring inventory. It includes cost of purchase and the cost of inbound logistics. In order to minimize the ordering cost of inventory we make use of the concept of EOQ or Economic Order Quantity.

2. Carrying cost of inventory refers to the cost incurred towards inventory storage and maintenance. The inventory storage costs typically include the cost of building rental and other infrastructure maintained to preserve inventory. The inventory carrying cost is dependent upon and varies with the decision of the management to manage inventory in house or through outsourced vendors and third party service providers.

3. Shortage or stock out costs and cost of replenishment are the costs incurred in unusual circumstances. They usually form a very small part of the total inventory cost.

Hence, this concludes the definition of Inventory Costs along with its overview.

➢ BENEFITS OR IMPORTANCE OF INVENTORY CONTROL

1. Protects from fluctuations in demand

Many a times, the demand forecast of a product is not accurate. There is always a small difference between the demand forecast and actual demand. However, sometimes, there is a big difference between the demand forecast and actual-demand.

So, there are always chances of fluctuations in the demand of a material. These fluctuations can be adjusted if there are sufficient items in the stock of inventory. Therefore, proper inventory control protects the company from fluctuations in demand.

2. Better services to customers

If the company maintains a proper inventory of raw-materials, then it can complete its production in time. So, it can deliver the finished goods to the customers in time.

Similarly, if the company has a proper inventory of finished goods, then it can satisfy the additional demand of the customers. So, inventory control helps the company to deliver goods at the right time as demanded by the customers.

After making timely delivery, the company can concentrate on giving other services to the customers.

3. Continuity of production operations

Proper inventory control helps to maintain continuity of production operations. This is because it maintains a smooth flow of raw materials. So, there are no shortages of raw-materials required for production process.

4. Reduces the risk of loss

Proper inventory control helps to reduce the risk of loss due to obsolescence (outdated) or deterioration of items. This is because it checks all the items regularly.

Furthermore, it sells all the slow-moving items, in time, at the market prices. It only maintains the right stock at all times. So, the chances of any item getting outdated are reduced.

5. Minimizes the administrative workload

Proper inventory control helps to minimize the administrative work load of purchasing, inspection, warehousing, etc. This will reduce the manpower requirement and will minimize the labor cost too.

6. Protects fluctuation in output

Inventory control tries to reduce the gap between planned production and actual production. There are cases where the production schedule cannot be followed because of:

Sudden breakdown of machines, Problems in supply of materials, sudden labor strikes, Loss due to failure of power supply, etc.In such cases, the difference between planned production and actual production can be bridged by inventories held in stock.

7. Effective use of working capital

Proper inventory control helps to make effective use of working capital. Inventory control helps in maintaining the right amount of stocks of materials, components, etc. Over stocking is avoided. Therefore, the working capital will not be blocked in excess inventory.

8. Check on loss of materials

Inventory control helps to maintain a check on the loss of materials due to carelessness or pilferage (stealing). If there is no proper inventory control, then there are more chances of carelessness and pilferage by the employees, especially in the store-keeping department.

9. Facilitates cost accounting activities

Inventory control facilitates cost accounting activities. This is because, inventory control provides a means of allocating materials cost of products, departments or other operating accounts.

10. Avoids duplication in ordering

Inventory control avoids duplication in ordering of stock. This is done by maintaining a separate purchase department. This department will do all the purchasing for the full organisation. No other department is allowed to do purchasing. So there will not be any duplication in ordering of stock.

- **LIMITATIONS OF INVENTORY CONTROL SYSTEM**

(i) Efficient inventory control methods can reduce but cannot eliminate business risk.

(ii) The objectives of better sales through improved service to customer; reduction in inventories to reduce size of investment and reducing cost of production by smoother production operations are conflicting with each other.

(iii) The control of inventories is complex because of the many functions it performs. It should be viewed as shared responsibilities.

KEY TERMS

Inventory: Inventory refers to the stock pile of the product a firm is offering for sale and the components that make up the product.

Inventory Management: Inventory management is the practice overseeing and controlling of the ordering, storage and use of components that a company uses in the production of the items it sells.

Economic Order Quantity: The optimal size of an order for replenishment of inventory is called economic order quantity.

Re-Order Level: Re-order level is that level of inventory at which an order should be placed for replenishing the current stock of inventory.

Self-Assessment Questions

1. Akbar Enterprises require 2, 70,000 units of a certain item annually. The cost per unit is Rs. 3, the cost per purchase order Rs. 100 and the inventory carrying cost Rs.6 per unit per year. What is the economic order quantity?

2. Explain the factors affecting the level of inventory in an organization.

3. Define inventory. What do you understand by inventory management?

4. Discuss the objectives of inventory management.

5. What is inventory control? Explain the various techniques of inventory control.

TOPIC: INVENTORY COST AND ABC ANALYSIS

Introduction: Inventory management is very essential for every organization especially manufacturing and trading organizations. Optimization of the investment in inventory and managing the level of inventory are the key objectives of inventory management. Inventory control is essential to keep a track on the types of inventories held and the cost involved. **Many techniques are used to control the inventory namely traditional techniques and modern techniques.** This unit will focus upon the most popularly used selective inventory control technique – ABC Analysis.

Meaning of Inventory Cost: Maintaining varied types of inventories involve different costs associated with them. Some inventory items are low priced, some are medium priced and some are very expensive. Thus, inventory costs have to be looked into first before deciding the type of control to be exercised on it. The costs associated with inventory include the purchase cost, ordering cost and the holding cost. In case of selective inventory control technique – ABC analysis, inventory cost plays a very significant role as the category classification and the kind of control exercised, completely depend upon the cost of inventory.

Meaning and purpose of ABC Analysis: Inventory ABC Classification, known as ABC Analysis, is a term used to define an inventory categorization method used in materials management to exercise selective inventory control.

The ABC Classification provides a mechanism for identifying the inventory items that captures the significant portion of the overall inventory cost. It also provides a mechanism for identifying different categories of stock on which different inventory policy and inventory control practices can be used.

ABC analysis divides the inventory items into three categories namely A, B and C .The classification is based on their cost. Costly items are **categorized 'A' and highest control is exercised on these items.** Least valuable items are **categorized 'C' and least control is exercised on them** and remaining items are **categorized as 'B' on which moderate control is exercised.**

The basic purpose of ABC Analysis is to provide basis for material management processes and

helps to define how stock is to be managed. Further, it can form the basis for various activities comprising plans on alternative stock arrangements and reorder calculations. It also helps to determine at what intervals inventory checks should be carried out. For instance – 'A' class items are to be checked more frequently than 'C' class items. Thus, ABC analysis forms the basis of many such activities and policy frameworks.

ABC analysis also serves the following purposes directly or indirectly:

- Significant reduction in investment in inventory.
- Protection against stock outs.
- Reducing the work load involved in different activities such as ordering, procuring, receiving, inspecting, handling and storage of inventory items.
- Reduction in obsolescence losses.
- Increase in profits.

The Pareto Principle

The Pareto Principle is developed by Vilfredo Pareto (1848 - 1923). According to Pareto Analysis, critical few is separated from the trivial many. Pareto principle is also known as the 80/20 rule. Pareto principle is based upon the theory that 20% of the population owns 80% of the nation's wealth, most of the businesses get 80% of their sales revenue from 20% of the customers, 80% of the problems are caused because of 80% of the employees and 20% of the items accounts for 80% of the firms expenditure.

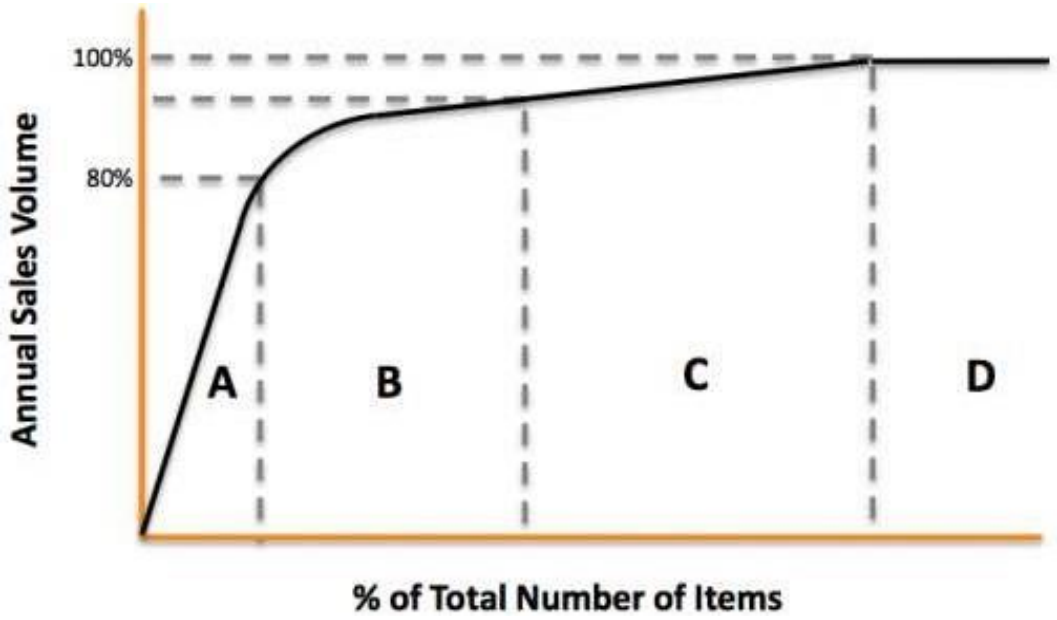
Therefore, the classification of the inventory is done on the basis of the Pareto principle, in which 20% of the impactful items should fall into 'A' classification category.

This rule, in general, applies well and is frequently used by inventory managers to put their efforts where greatest benefits, in terms of cost reduction as well as maintaining a smooth availability of stock, are required.

The principle emphasizes on working out the rupee value of each individual inventory item on annual consumption basis. Then the ratio between the number of items and the currency value of the items is calculated and the following categorization is done:

- 10-20% of the items (**'A' class**) account for 70-80% of the consumption
- the next 15-25% (**'B' class**) account for 10-20% of the consumption

- the balance 65-75% (**'C' class**) account for 5-10% of the consumption



ABC Classification & the Pareto Rule for Inventory Management

The above figure depicts the classification according to the Pareto principle. All the items are divided into three broad categories – A, B and C, according to the calculation of the above mentioned ratio.

Criteria for ABC classification

The ABC analysis suggests that inventories of an organization are not of equal value. It specifies that the company should rate the inventory items from A to C, based upon their quantity and value. The three categories A, B and C possess the following characteristics:

"A" Category

- These items generally represent approximately 15%-20% of an overall inventory by quantity, but represent 80% of the value of an inventory.
- These are high value items and are extremely important.
- By paying close attention to the optimization of these items in inventory, a significantly positive impact may be created with a nominal increase in the inventory management costs.
- Very strict control is kept on these items.
- Accurate records need to be maintained for these items.

- Because of the high value of these items, frequent value analysis is required.
- Appropriate order pattern should be chosen such as 'Just- in- time' to avoid excess capacity

"B" Category

- These items represent 30%-35% of inventory items by item type, and about 15% of the value.
- These are intermediary value items.
- These items can generally be managed through period inventory and should be managed with a formal inventory system.
- Comparatively less control than 'A' category items is needed.
- Proper records should be maintained for these items.

"C" Category

- These items represent 50% of actual items but only 5% of the inventory value.
- These are low value items and are marginally important.
- Most organizations can afford a relatively relaxed inventory process surrounding these items.
- Least amount of control is required.
- Minimum possible records should be maintained in the simplest form.

Steps for Classification of Items

The categorization of the inventory items requires a particular process to be followed. The inventory items are first classified, then their total cost is ascertained, thereafter ranking is done followed by the computation of ratio or percentages. Then finally the A, B and C categories are determined. The process generally consists of six basic steps as explained below:

1. Identify the objective for ABC analysis. An ABC analysis can accomplish one of two primary goals: to reduce procurement costs or to increase cash flow by having the right items available for production.
2. Collect data related to the inventory under analysis. The data can be obtained from standard accounting if used in the organization. The data required is the raw material purchased or weighted cost including all ordering costs and carrying costs.
3. Rank the inventory in decreasing order of their cost.

4. Calculate the cumulative impact for all inventory items by dividing item annual cost by total inventory annual expenditure, then adding that amount to the cumulative total of percentage spent.
5. Draw a curve of percentage items and percentage value. Take a holistic view taking into account the Pareto principle.
6. Mark the limits bifurcating the three classes as A, B and C rationally. Analyze classes and make appropriate decisions. The key to this step is follow-up and tracking. The periodic review should be done for monitoring the success or failure of the decisions and categorization done.

Difference between A, B and C class items

There is a difference in the various classes A, B and C. Following differences present the suggested policy guidelines for different categories which may differ for different businesses:

Basis	**A class items**	**B class items**	**C class items**
Control	Very strict control	Moderate control	Least control
Safety stock	No or very low safety stock	Low safety stock	High safety stock
Order delivery	weekly	Once in three months	Once in six months
Control report	Weekly Control report	Monthly Control report	Quarterly Control report
Follow up	Maximum follow up	Periodic follow up	Optional
Sources supply of	Should have as many sources as possible	Should have two or more reliable sources	Should have two reliable sources
Forecast	Accurate forecasts are needed	Estimates based on past data are sufficient	Rough estimate is required
Purchasing function	Should have centralised purchasing function	May have centralised or decentralised or a combination of both purchasing function	Should have decentralised purchasing function
Officers	Should be handled by senior officers	Should be handled by middle level officers	Can be delegated to lower level staff.

Applications of ABC Analysis

The ABC classification system leads to grouping of items according to their annual issue value. Apart from exercising varying degree of control over the inventory items, there are other applications where ABC analysis has proved to be useful. Following represent some applications of ABC analysis:

- It highlights specific items on which efforts can be concentrated profitably.
- It provides a sound basis on which the allocation of funds and time is done.
- It helps in reviewing the stock levels especially minimum and maximum levels of the inventory items. 'A' items will generally have greater impact on projected investment and purchasing expenditure, and therefore should be managed more aggressively in terms of minimum and maximum inventory levels. The inactive items will fall at the bottom of the 'C' category. It is the best place to start when performing a periodic obsolescence review.
- The frequency of usage can be worked out and accordingly the time gap between orders is decided. 'A' category items are very frequently used and their accurate record balances need to be kept. Thus, frequent stock taking is done for these items. Accordingly, the strategy is planned for B and C category items.
- It helps in identifying the inventory items for potential consignment or vendor stocking.
- Separate inventory goals may be specified for each category of inventory items.

Let's Sum-up

ABC analysis is a valuable tool to enable companies dedicated to strategic cost management to measure the current status for their materials management system and introduce certain changes in the inventory control policies in such a manner that it yields the largest cost management benefits in the near and middle term periods. ABC analysis is based upon the Pareto principle which focuses on the concept 'Critical Few Trivial Many'. ABC analysis divides the inventory items into three categories - A, B and C. These categories are identified on the basis of the number of items and the total value in rupees for each inventory item. The process starts from the classification of inventory, then ascertaining their cost and assigning ranks which is followed by the calculation of percentages. On the basis of these, the categories A, B and C are determined. After determining the categories, the inventory management policies, control mechanisms, procurement and warehousing policies are framed for each category in a different manner according to their impact on overall inventory cost. Thus, ABC analysis suggests that inventories of an organization are not of equal value and so different policies and treatment should be given in order to minimize the efforts and time as well as maximize the profits through savings in cost.

Key Terms

Inventory Cost: It refers to the costs associated with the inventory including the purchase cost, ordering cost and the holding cost.

ABC Analysis: It is a term used to define an inventory categorization method used in materials management to exercise selective inventory control.

Pareto Principle: According to Pareto Analysis, critical few is separated from the trivial many. Pareto principle is also known as the 80/20 rule. It says that 20% of the impactful items should fall into 'A' classification category and accordingly the other categories may be determined.

TOPIC: QUALITY MANAGEMENT

QUALITY CONCEPTS

INTRODUCTION: Quality is far larger than business. In the broadest sense, quality is that which adds value, that which makes our lives better.

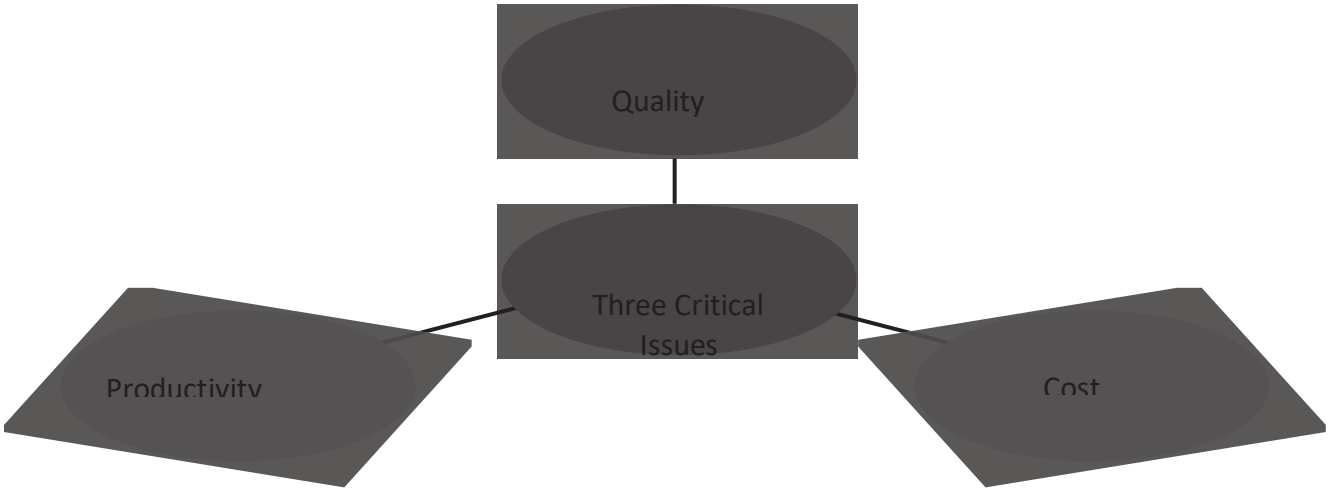
The quality of product or service is the degree to which it satisfies customer's requirements. This is influenced by

- **Design quality:** The degree to which the specification of the product or service satisfies customer's requirements.
- **Process quality:** The degree to which the product or service, when made available to the customer confirms to specifications.

NATURE OF QUALITY: Quality, cost and reliability are generally interrelated. Higher quality is usually associated with higher reliability and where items are produced or where services are provided efficiently, some additional cost is usually incurred in attaining higher levels of quality, but some other costs are reduced.

IMPORTANCE OF QUALITY: The challenge today for business is to produce quality products or services efficiently. Quality is one of the four key objectives in operations management along with cost, flexibility and delivery of goods and services.

Mr. Procter's statement addresses three issues that are critical to managers of manufacturing and service organisations:



Productivity, the cost of operation and the quality of the goods and services that create customer satisfaction, all contribute to profitability. Of these three determinants of profitability-productivity, cost and quality, the most significant factor in determining the long-run success or failure of any organisation is quality. Good quality of goods and services can provide an organisation with competitive edge. Good quality reduces costs due to product returns, rework and scrap. Good quality increases productivity, profits and other measures of success such as brand image, product image and company image. Most importantly, good quality generates satisfied customers, who reward the organisation with continued patronage and favorable word-of-mouth advertising.

Levels of Quality: An organisation that is committed to quality must examine quality at three levels:

- The organisational level
- The process level
- The performance/job level

At the organisational level, quality concerns centre on meeting external customer requirements. An organisation must seek customer input on a regular basis. Questions such as the following help to define quality at the organisational level:

- Which products and services meet your expectations?
- Which do not?
- What products or services do you need that you are not receiving?
- Are you receiving products or services that you do not need?

Customer-driven performance standards should be used as the basis for goal setting, problem solving performance appraisal, incentive compensation, non- financial rewards and resources allocation.

At the process level, organisational units are classified as functions or departments, such as marketing, design, product development, operations, finance, purchasing, billing and so on. Since most processes are cross-functional, the managers of particular organisational units may try to optimize the activities under their control, which can sub-optimize for the organisation on a whole. At the level, managers must ask questions such as:

- What products or services are most important to the external customer?
- What processes produce those products and services?
- What are the key inputs to the process?

- Which processes have the most significant effect on the organisation's

Customer-driven performance standards

- Who are my internal customers and what are their needs?

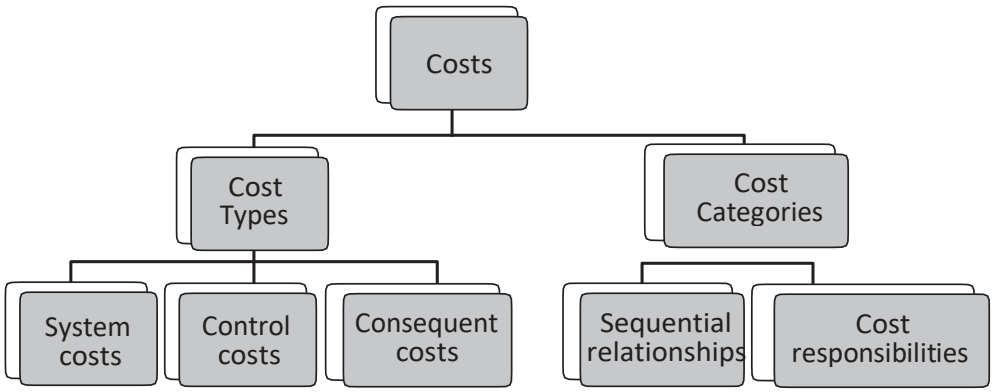
At the performance level, standards for output must be based on quality and customer-service requirements that originate at the organisational and process level. These standards include requirements for accuracy, completeness, innovation, timeliness and cost. For each output of an individual's job, one must ask questions such as:

- What is required by the customer, both internal and external?
- How can the requirements be measured?
- What is the specific standard for each measure?

Quality Costs- Types and Categories

There are three types of costs that are identified:

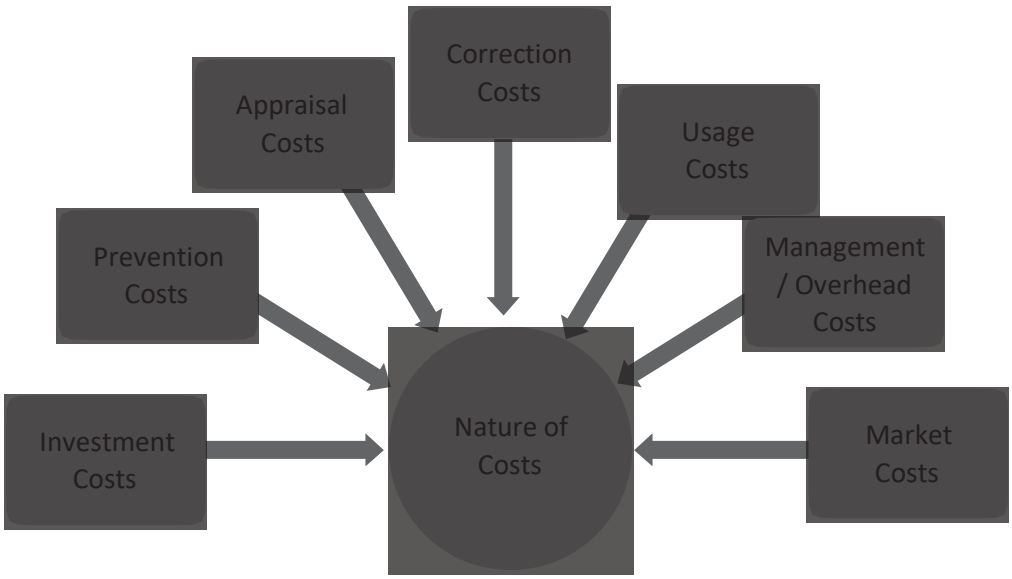
- **System costs**: These are associated with setting up the operating system to aim to provide goods or services of appropriate quality.
- **Control costs**: Control costs are incurred in monitoring, checking and correcting activities during the operations.
- **Consequent costs**: Consequent costs are incurred after completion of operations, i.e., after delivery of the goods or completion of the services.



Two categories of the cost are identified for each cost type and in addition one category, that of management/overhead costs is identified as being incurred during control and also after completion of operations.

- **Sequential relationships**: There is a general sequential relationship between these costs. The greater the effect or the benefit gained from system costs, the less is the need for control costs. The greater the combined benefit of system and control costs, the less the consequent cost implication.

- **Cost responsibilities**: Most of these costs will fall on the supplier. Certainly, all of the costs of investment, prevention, and appraisal and usually all of the correction costs must be borne by the supplier, as also the consequent cost implications. Customers will normally bear some but perhaps not all of the usage costs, some of which may have to be met by the supplier.



Investment costs

- Investment costs are incurred before operations begin. They are, essentially concerned with the provision of appropriate facilities and systems and also the design/development of the product or service.

- All this work will always be required, but here we are concerned with the additional costs which are incurred at the outset to try to ensure that an adequate quality level can be achieved and maintained.

- This expenditure, therefore, is intended to make life easier later. Some example of 'one – off' costs incurred in advance include:

  - The design of products or the specification of services to make it easier to achieve and sustain specified quality.

- The training of staff in quality procedures.
- The design and installation of facilities to make quality objectives more easily obtainable.
- The establishment of arrangements with suppliers.
- The design and installation of the quality management system.

Prevention costs

• Prevention costs also relate to the operating system as a whole, but they are incurred repetitively, if not continually over the life of that system.

- Examples of such 'ongoing' costs include factors shown in the figure below.

Appraisal costs

• Appraisal costs are also 'ongoing'. They include all costs associated with activities aimed at determining and monitoring current quality levels, including checking, testing, inspecting, monitoring customer views, benchmarking activities, etc.

Correction costs

Correction costs are incurred because the costs outlines above generally fail to ensure completely that nothing goes wrong. Correction involves:

- doing things again
- replacing things which, when found to be wrong
- cannot be rectified
- repetition of operations
- Recycling of items or customers, etc.

• There are also costs of wastage, loss, scrap and so on. These are often referred to as the 'internal costs of defects'.

Usage costs

• These are the principal costs associated with individual failures. If, despite all of the activities referred to above, an operating system fails to deliver goods or devices to the specified quality, then subsequent costs will be incurred.

- For example, if a defective item is passed to a customer, then it may fail in service, so there will be a cost of disruption, referral, replacement, even compensate under warranty arrangement.
- On occasions, disputes may arise, so there will be legal costs. The same can apply to a service which fails to meet specifications; whilst this may not be evident immediately on completion of the service, so that neither the supplier nor the customer may be aware of it. Failure to meet the specified quality standards may result in subsequent losses.
- For example, something may be damaged in transport and only noticed later. Treatment in a

hospital may be inadequate, resulting in recurrence of an illness. The food provided in a restaurant may be identified subsequently as causing food poisoning, etc.

- In all such situations, costs will be incurred for the customer and/or the supplier. These are often called the 'external costs of defects.'

Management/overhead costs

- Management/overhead costs remind us that there are many more indirect costs associated with failure to achieve quality standards.

- Management may have to devote considerable time to customer relations in order to offset the effects of poor quality.

Persistently poor quality or major quality failures, even infrequent, may cause loss of morale, motivation and commitment of staff, which must then be re– established.

- Activities may need to be rescheduled. Organisational changes may need to be introduced.

- Management and others may be discharged and other activities may be neglected or delayed. All of these are the indirect managerial consequences of quality failures.

Market costs

- The ability of an operating system to consistently provide goods or services at the required quality or its inability to do so will influence its reputation in the market.

That reputation or image will in turn affect customer loyalty and will influence future demand.

- A high reputation will facilitate and complement other marketing / promotional activities and make them more cost effective. A poor reputation will be an obstacle which may require extra effort and thus extra cost to compensate.

QUALITY CONTROL

"QUALITY IS NOT AN ACCIDENT; BUT IT IS THE RESULT OF INTELLIGENT EFFORTS"

Quality control refers to all those functions or activities that must be performed to fulfill the company's quality objectives. Quality control begins long before products and services are delivered to the customers. Quality begins with the design of a product in accordance with the customer's specification. Early in the production system, raw materials, parts and supplies must be of acceptable quality before they are allowed to be used in production. Materials must meet the appropriate specifications as stipulated in the product design. As the inputs of the production system proceed through production processes, the quality of the semi-finished parts and sub-units is monitored to determine whether the system is operating as intended. This monitoring of

quality alerts the operation managers to take corrective action needed before poor quality products are produced. Then finished products are examined to determine their acceptability.

Quality control involves the establishment of quality standards, the use of proper materials, the selection of appropriate manufacturing processes and the necessary tooling to make the product, the performance of the necessary manufacturing operations and the inspection of the product to check on conformance with the specifications.

Quality control is an effective system of principles and methods for prevention of defects and control of variability in materials, bought-out items, manufactured parts and sub-units, by taking timely preventive measures. Quality control starts with product design and includes materials, bought-out items, manufacturing processes and finished products in the hands of the customers.

Quality control is a staff function concerned with the prevention of defects in manufacturing so that the items may be manufactured right at the first time and not have to be reworked or rejected. In order to achieve this, there must be inspection and control of incoming raw materials to ensure that they meet the specifications, in-process inspection of manufacturing processes and final inspection and testing of the finished products to ensure satisfactory performance.

Objectives of Quality Control

The ultimate objective of quality control is to provide products which are dependable, satisfactory, and economical. A quality control system is designed to ensure economical production of products of uniform quality which is acceptable to the customer.

Benefits of Quality Control

An effective quality control programme provides the following benefits:

- Minimum scrap, rework and other losses
- Reduced cost of material and labour
- Uniformity of quality and reliability of products which increases sales turnover
- Reduced inspection cost
- Reduced customer complaints
- Higher operating efficiency
- Higher quality consciousness among employees
- Better utilization of all resources
- Higher productivity and improved profits

EXAMPLE OF QUALITY CONTROL: Once the training is completed, how can we make sure that the training was successfully done for all the team members? For this purpose, we will have to collect statistics e.g. the number of marks the trainees got in each subject and the minimum

number of marks expected after completing the training. Also, we can make sure that everybody has taken training in full by verifying the attendance record of the candidates.
If the marks scored by candidates are up to the expectations of the trainer/evaluators, then we can say that the training is successful otherwise we will have to improve our process in order to deliver high-quality training.

Another way to improve the training process would be collecting feedback from the trainees at the end of the training program. Their feedback will tell us what was good about the training and what are the areas where we can improve the quality of training So, such activities are a part of the QA process.

Quality Control ,Inspection & Quality Assurance

INSPECTION MEANING: Inspection implies comparing actual quality characteristics of a material or product with predetermined or specified standards or accepted specifications of quality. The purpose of inspection is to separate good products from bad products to take decisions regarding accepting or rejecting the products.

The rejected products may be salvaged by rework or disposed off as scrap if they cannot be reworked. While inspection merely helps to discriminate and segregate the good products from the bad, quality control attempts to find the root cause of defects and to take corrective actions to avoid the defects in future.

QUALITY CONTROL: Quality Control is known as QC and focuses on identifying a defect. QC ensures that the approaches, techniques, methods and processes are designed in the project are following correctly. QC activities monitor and verify that the project deliverables meet the defined quality standards.

Quality Control is a reactive process and is detection in nature. It recognizes the defects. Quality Control has to complete after Quality Assurance.

QUALITY MEANING: Quality is meeting the requirement, expectation, and needs of the customer is free from the defects, lacks and substantial variants. There are standards needs to follow to satisfy the customer requirements.

ASSURANCE MEANING: Assurance is provided by organization management, it means giving a positive declaration on a product which obtains confidence for the outcome. It gives a security that the product will work without any glitches as per the expectations or requests.

QUALITY ASSURANCE: Quality Assurance is known as QA and focuses on preventing defect. Quality Assurance ensures that the approaches, techniques, methods and processes are designed for the projects are implemented correctly.

- Quality assurance activities monitor and verify that the processes used to manage and create the deliverables have been followed and are operative.
- Quality Assurance is a proactive process and is Prevention in nature.
- It recognizes flaws in the process. Quality Assurance has to complete before Quality Control.

QUALITY ASSURANCE EXAMPLE: Suppose our team has to work on completely new technology for an upcoming project. Our team members are new to technology. So, for that, we need to create a plan for getting the team members trained in the new technology.

Based on our knowledge, we need to collect pre-requisites like DOU (Document of Understanding), design document, technical requirement document, functional requirement document, etc. and share these with the team.

This would be helpful while working on the new technology and even would be useful for any newcomer in the team. This collection & distribution of documentation and then kicking off the training program is a part of the QA process.

What is The Difference in QA/QC?

Many people think QA and QC are the same and interchangeable but this is not true. Both are tightly linked and sometimes it is very difficult to identify the differences. Fact is both are related to each other but they are different in origins. QA and QC both are part of Quality Management however QA is focusing on preventing defect while QC is focusing on identifying the defect.

QUALITY ASSURANCE	QUALITY CONTROL
It is a process which deliberates on providing assurance that quality request will be achieved.	QC is a process which deliberates on fulfilling the quality request.
A QA aim is to prevent the defect.	A QC aim is to identify and improve the defects.
QA is the technique of managing quality.	QC is a method to verify quality.
QA does not involve executing the program.	QC always involves executing the program.
All team members are responsible for QA.	Testing team is responsible for QC.
QA Example: Verification	QC Example: Validation.
QA means Planning for doing a process.	QC Means Action for executing the planned process.
Statistical Technique used on QA is known as Statistical Process Control (SPC.)	Statistical Technique used on QC is known as Statistical Quality Control (SPC.)
QA makes sure you are doing the right things.	QC makes sure the results of what you've done are what you expected.
QA Defines standards and methodologies to followed in order to meet the customer requirements.	QC ensures that the standards are followed while working on the product.
QA is the process to create the deliverables.	QC is the process to verify that deliverables.
QA is responsible for full software development life cycle.	QC is responsible for software testing life cycle.

- **Quality Assurance, assures that the right production process is performed in the right manner.**
- **Quality Control, on the other hand, ensures that the product will match the requisite standard.**

COMPARISON:

BASIS FOR COMPARISON	QUALITY ASSURANCE	QUALITY CONTROL
Meaning	Quality Assurance is the process which guarantees that the preferred level of quality is fulfilled in the product or service at each phase of the process.	Quality Control is a technique which ensures that the product quality is, as per the set standards.
Approach	Proactive	Reactive
Focus on	Process	Product
Concept	Protection from defects	Finding out the defects
System	Prevention based system	Correction based system
Activity	Verification	Validation
Function	Staff Function	Line Function
Creation of quality	Designing stage	Control stage
Emphasis	Customer	Standard

➢ DIFFERENCE BETWEEN QUALITY CONTROL AND INSPECTION

- **Quality control** refers broadly to the process of managing product **quality** to meet a desired standard. **Inspection** is only a part of this process used to identify **quality** defects in products. **Inspection** can help you find any defects earlier in production before they affect the majority of a shipment
- Quality control (QC) is an ongoing process that begins at the earliest stages of manufacturing. Selecting parts and materials to be used in production, training staff and calibrating equipment in the factory could all be considered part of overall QC. Remember, quality is ***built into a product***, it can't be added after the fact. For example, if a factory produces an order of garments, but has used fabric with the wrong material composition, there's not much that can be done now that the product is finished.
- "Inspection" as it relates to QC is an effort to check the manufactured goods to ensure they meet the customers' specifications and quality standards. Inspection can occur at several stages before, during or after inspection, including:
  - **Checking raw materials and parts** before mass production (also called "incoming quality control"
  - **First article inspection (FAI)** - checking one or a few parts of the first batch coming off the production line
  - **During production inspection (DUPRO)** - checking finished goods, generally when 15–80% of the order is finished
  - **Final inspection** - checking finished goods, generally when 80% or more of the goods are finished (often includes checking packaging as well)
  - **Inspecting contain loading** - checking a shipping container as workers load the finished and packaged goods

Conclusion

Key Points:

- In QA, processes are planned to evade the defects
- QC agreements with the discovery of the defects and modifying them while making the product
- QA detects weakness
- QC detects defects
- QA is process oriented
- QC is product oriented
- QA is a failure prevention system
- QC is a failure detection system.

QA & QC both are different from each other and required as part of quality management. They should not be misunderstood as interchangeable terms. QA is process focused while QC is end-product focused.

Quality control is inspecting something (a product or a service) to ensure that it is working fine. If the product or service is not working fine, then the issue needs to be fixed or eliminated in order to meet conformance standards. So, it aims at detecting and correcting issues.

Quality assurance, on the other hand, aims at preventing the issues from occurring in the future by improving the process.

To summarize, we can say that Quality assurance does not eliminate the need for Quality control as QC lies at the very core of Quality management.

Total Quality Management (TQM)

Total Quality Management (TQM) is a management style that implies non- stop process of quality improvement of products, processes, and personnel work. This is a bunch of methodologies that drive company to strategic goals achievement through unceasing quality development. It is focused on production of goods and services that possess high-quality from viewpoint of customers.

Total Quality Management is a popular "quality management" concept. However, it is about much more than just assuring product or service quality. TQM is a business philosophy, a way of doing business. It describes ways to managing people and business processes to ensure complete customer satisfaction at every stage. TQM is often associated with the phrase, "*doing the right thing right, first time.*" This revision note summarises the main feature of TQM.

TQM was elaborated on basis of Edward Deming's theory. This philosophy has successfully started many years ago in Japan and USA. TQM has shown phenomenal results and now it is used in many successful enterprises all across the world. It allows obtaining faster, fundamental and more efficient business development, because it stimulates production of much better products for better prices. W. Edwards Demings defines Total Quality Management as- a philosophy which advocates four basic principles:

- Intense focus on customer satisfaction
- Accurate measurement of activities
- Continuous improvement of products and processes
- Empowerment of people

Like most quality management concepts, TQM views 'quality' entirely from the point of view of 'the customer'. All businesses have many types of customer. A customer can be someone 'internal' to the business. A customer can also be 'external' to the business. This is the kind of customer you will be familiar with. For example: when you fly with an airline you are their customer. TQM recognises that all businesses require 'processes' that enables customer requirements to be met. TQM focuses on the ways in which these processes can be managed, with two key objectives:

- 100% customer satisfaction
- Zero defects

The Importance of Customer-Supplier Relationships- Quality Chains

- TQM focuses strongly on the importance of the relationship between customers and suppliers. These are known as the "quality chains" and they can be broken at any point by one person or one piece of equipment not meeting the requirements of the customer.
- Failure to meet the requirements in any part of a quality chain has a way of multiplying and failure in one part of the system creates problems elsewhere, leading to yet more failure and problems and so the situation is exacerbated.
- The ability to meet customers' requirements is vital. To achieve quality throughout a business, every person on the quality chain must be trained to ask the following questions about every customer – supplier chain:

About Customers:

- Who are my customers?
- What are their real needs and expectations?
- How can I measure my ability to meet their needs and expectations?
- Do I have the capability to meet their needs and expectations?
- Do I continually meet their needs and expectations?
- How do I monitor changes in their needs and expectations?

About suppliers:

- Who are my internal suppliers?
- What are my true needs and expectations?
- How do I communicate my needs and expectations to my suppliers?
- Do my suppliers have the capability to measure and meet these needs and expectations?

- How do I inform them of changes in my needs and expectations?

Main Principles of TQM

The main principles that underlie TQM are as follows:

- **Prevention:** Prevention is better than cure. In the long run, it is cheaper to

stop product defects than trying to find them.

- **Zero defects:** The ultimate aim is no (zero) defects or exceptionally low defect levels if a product or service is complicated.

- **Getting things right first time:** Better not to produce at all than produce something defective.

- **Quality involves everyone:** Quality is not just the concern of the production or operations department, it involves everyone, including marketing, finance and human resources.

- **Continuous improvement:** Business should always be looking for ways to improve processes to help quality.

- **Employee involvement:** Those involved in production and operations have a vital role in spotting improvement opportunities for quality and in identifying quality problems.

Introducing TQM into a Business

➔ TQM is not an easy concept to introduce into businesses, particularly those that have not traditionally concerned themselves too much with understanding customer needs and business processes. In fact, many attempts to introduce TQM fail.

➔ One of the reasons for the challenge of introducing TQM is that it has significant implications for the whole business.

➔ For example, it requires that management give employees a say in the production processes that they are involved in. In a culture of continuous improvement, workforce views are invaluable.

➔ The problem is, many businesses have barriers to investment. For instance, middle managers may feel that their authority is being challenged.

➔ So "empowerment" is a crucial part of TQM. The key to success is to identify the management culture before attempting to install TQM and to take steps to change towards the management style required for it.

➔ Since culture is not the first thing that managers think about, this step has often been missed or ignored with resultant failure of a TQM strategy.

➔ TQM also focuses the business on the activities of the business that are closest to the customer.

Why do TQM programs fail?

The most common causes for TQM program failures appear to be the following:

- Lack of commitment from the top management.
- Focusing on specific techniques rather than on the system.
- Not obtaining employee buy-in and participation.
- Program stops with training.
- Expecting immediate results, not a long term pay-off.
- Forcing the organisation to adopt methods that are not productive or compatible with its production system and personnel.

Elements of TQM concept:

The TQM concept supports the philosophies of customer focus, continuous improvement, defect prevention and recognition that responsibility for quality is shared by all employees of an organisation:

The basic elements of TQM concept are:

- Sustained management commitment to quality
- Focusing on customer requirements and expectations
- Preventing defects rather than detecting them
- Recognizing that responsibility for quality is universal
- Quality measurement
- A continuous improvement approach
- Root cause corrective action
- Employee involvement and empowerment
- The synergies of teamwork
- Process improvement
- Thinking statistically
- Benchmarking
- Inventory reduction
- Value improvement
- Supplier teaming

- Training

Summary

- ➔ Higher quality is usually associated with higher reliability and where items are produced or where services are provided efficiently, some additional cost is usually incurred in attaining higher levels of quality, but some other costs are reduced.
- ➔ The quality of product or service is the degree to which it satisfies customer's requirements.
- ➔ System costs – These are associated with setting up the operating system to aim to provide goods or services of appropriate quality.
- ➔ Control costs – Control costs are incurred in monitoring, checking and correcting activities during the operations.
- ➔ Consequent costs – Consequent costs are incurred after completion of operations, i.e., after delivery of the goods or completion of the services.
- ➔ Prevention costs also relate to the operating system as a whole, but they are incurred repetitively, if not continually over the life of that system.
- ➔ Appraisal costs are also 'on – going'. They include all costs associated with activities aimed at determining and monitoring current quality levels, including checking, testing, inspecting, monitoring customer views, benchmarking activities, etc.
- ➔ Correction costs are incurred because the costs outlines above generally fail to ensure completely that nothing goes wrong.
- ➔ The purpose of inspection is to separate good products from bad products to take decisions regarding accepting or rejecting the products.
- ➔ Management/overhead costs remind us that there are many more indirect costs associated with failure to achieve quality standards.
- ➔ Quality is not just the concern of the production or operations department, it involves everyone, including marketing, finance and human resources.
- ➔ The Taguchi loss function is a graphical representation of defeat urbanised by the Japanese business statistician Genichi Taguchi to explain an occurrence distressing the worth of goods shaped by a concern.

➔ The Taguchi loss function is a method to explain how every not adequate division formed, results in a defeat of the company.

CONTROL CHARTS

Control charts, also known as **Shewhart charts** or process-behavior charts, are a statistical process control tool used to determine if a manufacturing or business process is in a state of control. It is more appropriate to say that the control charts are the graphical device for Statistical Process Monitoring.

If analysis of the control chart indicates that the process is currently under control (i.e., is stable, with variation only coming from sources common to the process), then no corrections or changes to process control parameters are needed or desired. In addition, data from the process can be used to predict the future performance of the process. If the chart indicates that the monitored process is not in control, analysis of the chart can help determine the sources of variation, as this will result in degraded process performance. A process that is stable but operating outside desired (specification) limits (e.g., scrap rates may be in statistical control but above desired limits) needs to be improved through a deliberate effort to understand the causes of current performance and fundamentally improve the process.

The control chart is one of the seven basic tools of quality control. Typically control charts are used for time-series data, though they can be used for data that have logical comparability (i.e. you want to compare samples that were taken all at the same time, or the performance of different individuals); however the type of chart used to do this requires consideration

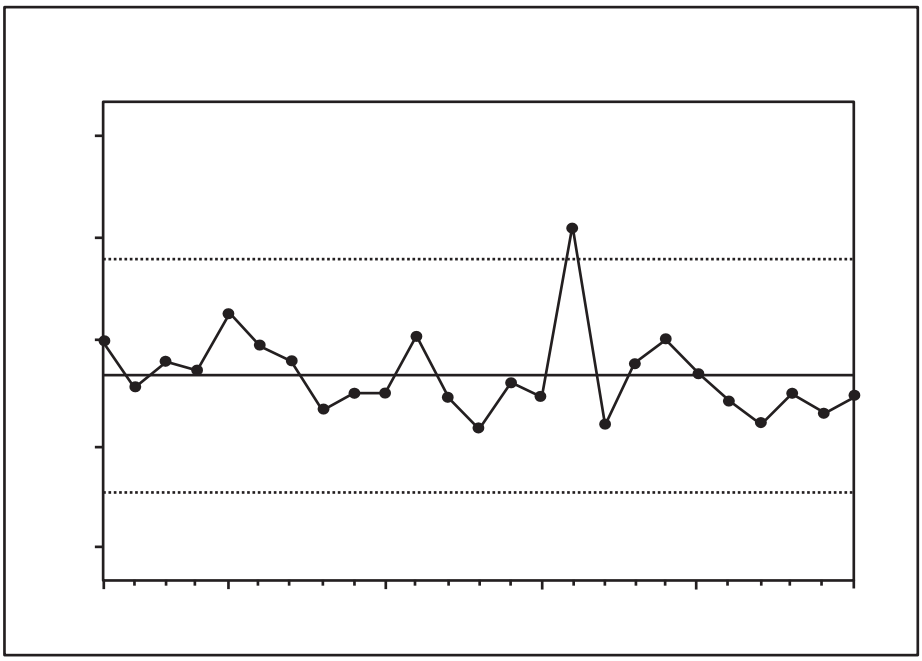
A control chart is a method for measuring change. If you have information about your business that you want to measure and analyze, such as manufacturing defects, patient wait times or how long customers take to pay, the control chart can map out the data over time. One of the advantages of control charts is that the chart makes it easy to see when your performance has run into problems.

Statistical Process Control

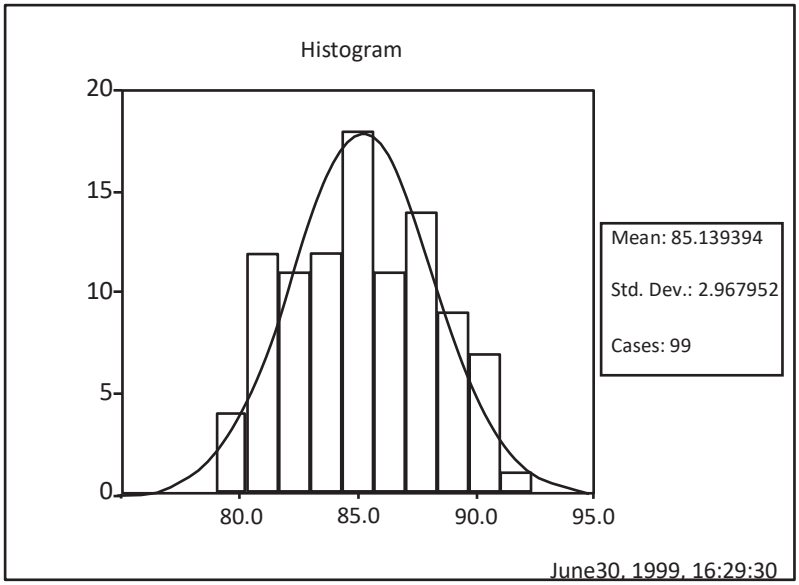
Statistical Process Control is an analytical decision making tool, which allows you to see when a process is working correctly and when it is not. Variation is present in any process, deciding when the variation is natural and when it needs correction is the key to quality control.

Process control charts:

- Control charts show the variation in a measurement during the time period that the process is observed.



- In contrast, bell- curve type charts, such as histograms or process capability charts, show a summary or snapshot of the results.



Process control charts are fairly simple looking connected point charts. The points are plotted on an x/y axis usually representing time. The plotted points are usually averages of subgroups or ranges of variation between subgroups, and they can also be individual measurements.

Some additional horizontal lines representing the average measurement and control limits are drawn across the chart. Notes about the data points and any limit violations can also be displayed on the chart.

Purpose of control charts:

Control charts are an essential tool of continuous quality control. Control charts monitor processes to show how the process is performing and how the process and capabilities are affected by changes to the process. The information is then used to make quality improvements.

Control charts are also used to determine the capability of the process. They can help identity special or assignable causes for factors that impede peak performance.

Steps involved in using statistical process control:

Proper statistical process control starts with planning and data collection. Statistical analysis on the wrong or incorrect data is rubbish, the analysis must be appropriate for the data collected. Be sure to "Plan", and then constantly re-evaluate your situation to make sure the plan is correct. The key to any process improvement program is the PDSA cycle described by Walter Shewart.

Plan: Identify the problem and the possible causes.

Do: Make changes designed to correct or improve the situation.

Study: Study the effect of these changes on the situation. This is where control charts are used; they show the effects of changes on a process over time. Evaluate the results and then replicate the change or abandon it and try something different.

Act: If the result is successful, standardise the changes and then work on further improvements or the next prioritised problem. If the outcome is not yet successful, look for other ways to change the process or identify different causes for the problem. Control charting is one of a number of steps

involved in statistical process control. The steps include discovery, analysis, prioritisation, clarification, and then charting. Quality is a "cycle" of continuous improvement.

➔ Control charts evaluate the patterns of variation for stability through the use of tests for special causes. If you detect special cause variation, you should seek out the factors that contribute to this variation so that you can implement corrective actions.

XBAR/S Chart vs. XBAR/R Chart

Both, XBar/S charts and XBar/R charts measure subgroup variability. The S chart uses the "standard deviation" to represent the spread in the data and the R chart uses the "range". Both the charts lead to a similar estimate of the process standard deviation and similar control limits for the charts. The calculation of the range uses only two data points, the largest and smallest values, while the calculation of the standard deviation uses all the data from the sub – group. R charts are not as sensitive to small amounts of variation as the S chart. You must decide what is most important for your specific requirements when deciding between an S chart and an R chart.

XBar chart (averages):

The XBar chart is where the sub – group averages or mean values are plotted. Probability shows us that the averages of our processes tend to stay constant unless special cause is present. A process can be behaving normally for the averages and at the same time be considered out of control for the R and S charts. The reverse is also true, R and S charts can remain in control while the averages become out of control.

S Charts (Standard Deviations)

Use the S chart when the subgroup sizes are nine or greater. S charts use all the data collected to calculate the subgroup and process standard deviations. S charts provide a more accurate indication of the process variation and result in a chart that is very sensitive to small changes in the process average. You should consider using S charts for processes with a high rate of production, when data collection is quick and inexpensive, or when increased sensitivity to variation is desired. S charts can detect smaller amounts of variation when compared to R charts. The only negative aspect in

managing an S chart is the need to perform the more difficult calculations for the standard deviation which typically are accomplished by using a computer.

R Chart (Ranges)

Use the R chart when your subgroup sizes are eight or less. R charts are efficient for small subgroup sizes and are easier to manage due to basic shop math calculations that need to be performed. R charts can be highly influenced by a single data value from the subgroup.

I Chart (Individuals)

When collecting samples to learn about a process, it is sometimes easier to combine the samples into subgroups, if it makes sense to group the samples together. When grouping is not appropriate, then a subgroup size of one (1) provides a method for evaluating the process. Samples that cannot logically be grouped together are good candidates for individuals (I) and moving range (MR) charts.

Examples of conditions that make using subgroups unfeasible or undesirable could be similar to the following:

- when each sample is unique with respect to a specific period of time
- when each sample represents one distinct batch or group
- when there are extremely long time intervals between each sample and production cycle time is extended
- when sampling or testing is destructive or may be cost prohibitive due to expense
- when the output is continuous and homogenous
- when the measurements (results) are not necessarily related in time to each other

Attribute Control Charts

Attributes control charts represent a rational sample of data sampled from the process and are either counts (n) of the number of defectives or defects per sample, or proportions of the defectives or defects per sample (%).

- Control process only exhibits random variation which will remain within the control chart limits.
- An out of control process exhibits non random variation due to the presence of special causes.

P Chart vs. NP Chart

An attribute defect is a product or service in which a nonconformity (or flaw) renders the product or service unusable. Examples of this type of defect include broken articles, late deliveries, unanswered calls, scratched paint and flat tires. Attributes can have only one of two outcomes, pass/fail, good / bad, go/no-go, etc.

C Charts

The purpose of C chart is to generate a (Poisson) counts control chart. A C chart is a data analysis technique for determining if a measurement process has gone out of statistical control. The C chart is sensitive to changes in the number of defective items in the measurement process. The "C" in C control chart stands for "counts" as in defectives per lot. The C control chart consists of:

- Vertical axis - the number defective for each sub – group
- Horizontal axis - sub – group designation

U Chart

U chart generates a (Poisson) proportion control chart. A U chart is a data analysis technique for determining if a measurement process has gone out of statistical control. The U chart is sensitive to changes in the normalised number of defective items in the measurement process. Normalised means that the number of defectives is divided by the unit area. You can also normalise to compensate for unequal sample sizes. The "U" in U chart stands for "units" as in defectives per lot. The U control chart consists of:

- Vertical axis - the normalised number of defectives for each sub- group
- Horizontal axis - sub-group designation

Advantages of a good flowchart analysis:

Most of these advantages also apply to most of the other quality tools.

- The people involved begin to better understand the process in the same terms.
- Helps to control the process, rather than the process controlling the people.
- Improves communications. People can now visualise their suppliers and customers as a part of the overall process, of which they also are a part.
- Better support of the entire quality effort, especially from those directly involved in the flowcharting activity.
- Better training of new employees. The flowchart is an excellent training tool.
- Happier employees. They now feel in better control of their own destinies; they feel more like an integral and important part of the team and not just a cog in the machinery; and they get a better feeling of approval for their efforts.
- Reduces confusion. The goal is to get workers so well versed in what is expected of them that the thought of deviating just doesn't occur.
- Assists in reducing organisational slack.
- Assists in reducing the chance for errors.
- Assists in reducing throughout time.

Check Sheets

Check sheets are basically a list of items inspected. The list is usually organised in a standardised format designed to facilitate information gathering and later quantitative analysis. It also assures that different people will collect required information in the same way. Table 2.1 shows a simple tally sheet of errors, which is the simplest of all check sheets. Fig. 2.6 and Table 2.2 show two other types of check sheets, where the errors are categorised as they are observed.

The data gathering procedure is extremely simple. It is only necessary to note what is occurring, categorise it into one of the categories on the check sheet, and mark a tally in the proper column. The only really difficult part knows categories to use on the check sheet. That comes with knowledge of the process, and some pre-analysis.

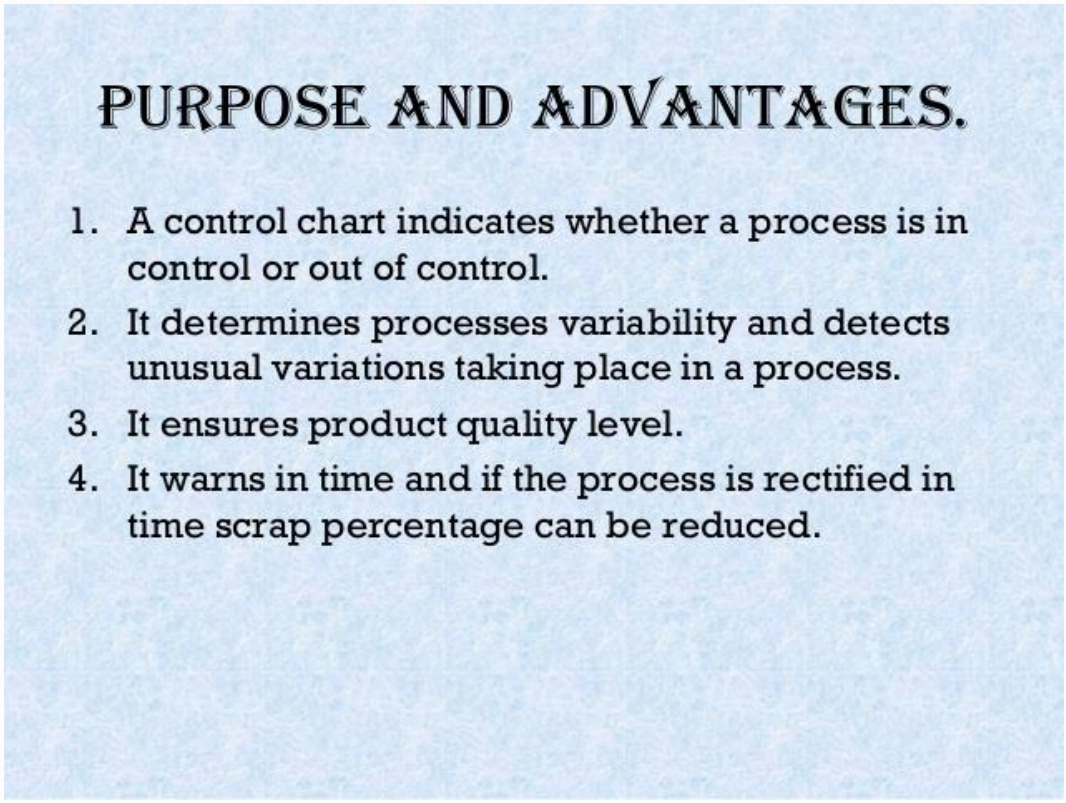
- **CONTROL CHART RULES:**

- Define what you want to control or measure, such as customer satisfaction, employee productivity or how often your legal firm settles cases out of court

- Identify how you'll collect and measure the data.
- Create a control chart.
- Collect data and chart it.

Once you have the data mapped, you can decide whether there's a problem. If not, you're done. If you spot trouble, you can implement a fix.

➢ ADVANTAGES OF CONTROL CHARTS



➢ DISADVANTAGES OF CONTROL CHARTS

1. False Alarms

Control charts are designed to measure variation in processes, including common cause variation and special cause variation. Common cause variation is considered normal, random variation within

a process, while special cause variation is due to broken machinery or some other process defect. A control chart sometimes may indicate that a process is out of control and that there is special cause variation where none exists. These false alarms can cause unnecessary downtime and delays, which can cost a business money.

2. Flawed Assumptions

There are two main assumptions underlying control charts, which dictate the accuracy of the information provided to users. The first is that the measurement function monitoring a process parameter has a normal distribution. In reality, though, this may not be the case, meaning a control chart will fail to produce meaningful data. The second assumption is that measurements are independent of each other, which also may not be true. If both assumptions are in some way flawed, then control charts will fail to be useful.

4. Special Training

Although control charts are not difficult to understand mathematically, they do require special training to create and use. Control charts use basic statistics, such as mean and standard deviations. Small organizations with limited training resources and limited experience with quality-assurance techniques will likely have difficulty implementing and using control charts. Businesses have to decide whether or not they can train their employees on lean and Six Sigma tools before using these quality tools to help improve their processes.

5. Misplaced Control Limits

Upper and lower control limits are added to control charts to help determine when a process is out of control. Control limits may be set too close or too far away from the process mean, distorting the information produced by control charts. If control limits are set too far away, then operators may be unaware that special cause variation is affecting the quality of process outputs. Similarly, limits that are too close to the mean may set off false alarms when a process is still in control.

ACCEPTANCE SAMPLING

Acceptance sampling uses statistical sampling to determine whether to accept or reject a production lot of material. It has been a common quality control technique used in industry. It is usually done as products leaves the factory, or in some cases even within the factory

- **CLASSIFICATION OF ACCEPTANCE SAMPLING:**

Depending upon the type of inspection acceptance sampling may be classified in two ways:

(i) Acceptance sampling **on the basis of attributes** i.e. GO and NOT GO gauges, and

(ii) Acceptance sampling on **the basis of variables.**

In acceptance sampling by attributes, no actual measurement is done and the inspection is done by way of GO & NOT GO gauges. If the product conforms to the given specifications it is accepted, otherwise rejected. The magnitude of error is not important in this case.

For example if cracks is the criteria of inspection/the products with cracks will be rejected and without cracks accepted the shape and size of the cracks shall not be measured and considered.

- **ADVANTAGES OF ACCEPTANCE SAMPLING:**

(i) The method is applicable in those industries where there is mass production and the industries follow a set production procedure.

(ii) The method is economical and easy to understand.

(iii) Causes less fatigue boredom.

(iv) Computation work involved is comparatively very small.

(v) The people involved in inspection can be easily imparted training.

(vi) Products of destructive nature during inspection can be easily inspected by sampling.

(vii) Due to quick inspection process, scheduling and delivery times are improved.

- **LIMITATIONS OF ACCEPTANCE SAMPLING:**

(i) It does not give 100% assurance for the confirmation of specifications so there is always some likelihood/risk of drawing wrong inference about the quality of the batch/lot.

(ii) Success of the system is dependent on, sampling randomness, quality characteristics to be tested, batch size and criteria of acceptance of lot.

IMPORTANT QUESTIONS

1. Discuss the factors one should consider while selecting a location for setting up a hotel.
2. What do you mean by production control? Discuss its functions.
3. Define production and operations management and how it is related with other functional areas.
4. What is location decision? How important it is in the functioning of the organization?
5. What are the functions and concept of operations management?
6. Discuss the product development process?
7. Define Operations Management. Discuss various activities involved in Production and operations management.
8. Explain batch production and mass production along with its advantages and disadvantages.
9. Explain product and process layout in detail with its advantages and disadvantages.
10. Explain types of layout with examples.
11. What are the routing, dispatching, prioritization and expediting? Explain.

12. Explain in detail Elements of Production planning and control.
13. Write in detail about production planning and control.
14. What is production planning and control? Explain its objectives and functions.
15. Briefly explain the duties and responsibilities of production manager and comment on their emerging role in POM.

LONG QUESTIONS:

1. Discuss the functions of operations management.
2. What is the relationship of operations management with other departments?
3. What is meant by capacity planning?
4. What is meant by scheduling?
5. How is motion study useful to a production manager?
6. Explain the different types of layouts.
7. Discuss the different points to be kept in mind while choosing a location for a plant?
8. What is the significance of planning and routing in production management?
9. Discuss the factors affecting the facility location analysis. Also explain the factors which could affect the decision to set up a bottling plant in Punjab.
10. How do planning and scheduling help in optimizing production?

UNIT-I & UNIT-II

MULTIPLE CHOICE QUESTIONS

1. What type of process would a Cement plant be most likely to use?

a. Continuous flow

b. Project c

c. Job shop

d. Flow shop

Answer: (a)

2. Process selection is primarily considered during:

a) Planning

b) Organizing

c) Leading

d) Controlling

Answer: (a)

3. What type of process would a fertilizer plant be most likely to use

a. Continuous

b. Project

c. Job

d. Flow shop

Answer: (a)

4. The inputs to a transformation process include all of the following except

a. Material

b. People

c. Information

d. Transportation

Answer: (d)

5. Product layout is preferably used for:

a) Repetitive processing

b) Intermittent processing

c) Both (a) and (b)

d) Neither (a) nor (b)

Answer: (a)

6. What are the two basic types of production systems?

a. Automated and manual

b. Intermittent and non-intermittent process

c. Normal and continuous process

d. Continuous process and batch

Answer: (b)

7. Process layout is used for:

a) Repetitive processing

b) Intermittent processing

c) Both (a) and (b)

d) Neither (a) nor (b)

Answer: (a)

8. Location decisions are viewed primarily as part of:

a) Marketing strategy

b) Growth factors

c) Financial aspect

d) Both (a) and (b)

Answer: (d)

9. Regional factors for location planning include all of the following except:

a) Raw materials

b) Markets

c) Labor considerations

d) Attitudes

Answer: (d)

10. What type of process would a paper mill be most likely to use?

a. Continuous flow

b. Project

c. Job shop

d. Flow shop

Answer: (a)

11. A product performing consistently refers to which of the following dimensions of quality:

a) Safety

b) Conformance

c) Durability

d) Reliability

Answer: (d)

12. Which of the following is not a type of operations?

a) Goods production

b) storage/transportation

c) Entertainment

d) All the above involve operations

Answer: (d)

13. What name is often given to processes which involve the manufacture of a unique item from beginning to end?

a. Jobbing processes

b. Continuous processes.

c. Lean production processes.

d. Batch processes.

Answer: (b)

14. Product design and process selection are examples of _____ decisions.

a) financial

b) tactical

c) system design

d) system operation

Answer: (c)

15. The responsibilities of the operations manager are:

a) planning, organizing, staffing, procuring, and reviewing

b) planning, organizing, staffing, directing, and controlling

c) forecasting, designing, planning, organizing, and controlling

d) forecasting, designing, operating, procuring, and reviewing

Answer: (b)

16. Which of these layouts is most suitable for processing sugar from sugar beets or sugar cane?

a. process-oriented layout

b. fixed-position layout

c. focused factory

d. product-oriented layout

Answer: (a)

17. Which of these layouts is most suitable for processing sugar from sugar beets or sugar cane?

a. process-oriented layout

b. fixed-position layout

c. focused factory

d. product-oriented layout

Answer: (a)

18. Which of the following is an example of a Service Business?

a. Law firm

b. Hospital

c. Bank

d. Retail store

e. All of the above

Answer: (e)

19. Production systems with customized outputs typically have relatively:

a) high volumes of output

b) low unit costs

c) high amount of specialized equipment

d) skilled workers

Answer: (d)

20. Which is not a significant difference between manufacturing and service operations?

a) cost per unit

b) uniformity of output

c) labor content of jobs

d) Measurement of productivity.

Answer: (d)

21. Which of the following is not a characteristic of service operations?

a) intangible output

b) high customer contact

c) high labor content

d) easy measurement of productivity

e) low uniformity of output

Answer: (d)

22. Which of the following is a recent trend in business?

a) pollution control

b) total quality management

c) supply chain management

d) competition from foreign manufacturers

e) technological change

Answer: (c)

23. The process of comparing outputs to previously established standards to determine if corrective action is needed is called:

a) planning

b) directing

c) controlling

d) budgeting

Answer: (c)

24. Which of the following does not relate to system design?

a) altering the system capacity

b) location of facilities

c) inventory management

d) selection and acquisition of equipment

Answer: (c)

25. Product design and process selection are examples of _____ decisions.

a) Financial

b) Tactical

c) system design

d) system operation

e) Forecasting.

Answer: (c)

26. Which of the following is not an advantage of using product layout?

(a) Minimum material handling cost

(b) Minimum inspection requirement

(c) Specialized supervision requirement

(d) None of these

Answer: (c)

27. In which of the following layout type, materials are fed into the first machine and finished products come out of the last machine?

(a) Product layout

(b) Process layout

(c) Fixed position layout

(d) Cellular manufacturing layout

Answer: (a)

28. Which of the following facility layout is best suited for the intermittent type of production, which is a method of manufacturing several different products using the same production line?

(a) Product layout

(b) Process layout

(c) Fixed position layout

(d) Cellular manufacturing layout

Answer: (b)

29. Process layout is also known as _____.

(a) Functional layout

(b) Batch production layout

(c) Straight line layout

(d) Both (a) and (b)

Answer: (d)

30. Which of the following does not cause to production delay?

(a) Shortage of space

(b) Long distance movement of materials

(c) Spoiled work

(d) Minimum material handling

Answer: (d)

31. Which of the following explain the need for facility location selection?

(a) When the existing business unit has outgrown its original facilities and expansion is not possible.

(b) When a business is newly started.

(c) When the lease expires and the landlord does not renew the lease.

(d) All of these

Answer: (a)

32. When capacity is relatively fixed, services are sold in advance, and the marginal cost of making a sale is relatively low, which of the following capacity plans may be most appropriate?

a. Level capacity plan
b. Yield management
c. Chase demand plan
d. Mixed plans

Answer: (b)

33. When all three 'pure' capacity plans are used in combination, this called a:

a. Aggregate strategy
b. Composite plan
c. Composite strategy
d. Mixed plan

Answer: (d)

34. What type of capacity plan focuses on the demand side rather than supply side of the capacity 'equation'?

a. Level capacity plan
b. Aggregated capacity plan
c. Demand management
d. Chase demand plan

Answer: (c)

35. Utilisation is measured by:

a. Actual output / Effective capacity
b. Effective capacity / Design capacity
c. Design capacity / Actual output
d. Actual output / Design capacity

Answer: (d)

36. For a hospital, which of the following is NOT an output measure of capacity?

a. The number of items sold in the hospital shop.
b. The number of patients treated by the A&E department.
c. The number of scans provided.
d. The number of beds available.

Answer: (d)

37. Point out the correct statement:

a. Capacity planning seeks to match demand to available resources

b. Capacity planning examines what systems are in place, measures their performance, and determines patterns in usage that enables the planner to predict demand

c. Resources are provisioned and allocated to meet demand

d. All of the mentioned

Answer: (d)

38. What is the relation of capacity attribute to performance?

a. same
b. different
c. similar
d. None of the mentioned

Answer: (b)

39. The correct sequence of operations in production planning and control is

a. Routing-Scheduling-Dispatching-Follow up
b. Scheduling-Routing- Dispatching-Follow up
c. Dispatching-Routing-Scheduling- Follow up
d. Routing-Scheduling-Follow up-Dispatching

(Ans: a)

40. Which of the following is true for 'Routing'?

a. It is flow of work in the plant
b. Route sheets include list of machine tools that are to be followed
c. It depends upon material handling facilities
d. All of the above

(Ans: d)

41. Procurement cycle time is time consumed for

a. Receiving of raw material
b. Inspection of various raw materials
c. Inspection of purchased components parts
d. All of the above

(Ans: d)

42. The transit time consist of

a. Time taken by raw material from machine to machine
b. Time consumed in moving the work between various departments
c. Time taken by a worker to machine a component
d. None of the above

(Ans: b)

43. Master schedule is prepared for

a. Single product continuous production
b. Multi product batch production
c. Assembly product continuous production
d. Single product batch production

(Ans: c)

44. Which of the following chart is drawn Machine vs time?

a. Man machine chart
b. The load chart
c. The progress chart
d. Curve chart

(Ans: b)

45. Centralized and decentralized are the types of

a. Routing
b. Dispatching
c. Scheduling
d. Follow up

(Ans: b)

46. Dispatching authorizes the start of production operations by

i. Release of material and components from stores to first process
ii. Release of material from process to process
iii. Issue of drawings instruction sheets

Which of the following is (are) true?

a. Only i

b. Only ii
c. i & ii
d. i , ii & iii

(Ans: d)

47. Which of the following is not a part of Five M's?

a. Material
b. Machine
c. Motion
d. Method

(Ans: c)

48. A number of manufacturing systems have been developed to improve the planning and control of operational capacity. Operations management systems are classified into:

A. Material requirements planning (MRP) and manufacturing resource planning II (MRPII)
B. Enterprise resource planning (ERP)
C. Optimized production technology (OPT)
D. All of the above

ANS: D

49. _____ is the capability of manufacturing to produce goods and services.

a. Capacity
b. Priority
c. Planning
d. Control

ANS: A

50. _____ must satisfy the demands of the marketplace. It does so by using plants, machinery, equipment, labor, and materials as efficiently as possible.

a. Marketing
b. Finance
c. Production
d. Engineering

ANS: C

UNIT-III & IV (IMPORTANT MCQs)

Q1. To achieve _____ in purchasing and transportation, goods may be purchased in larger quantities than the actual demand.
A. Continuation
B. Quality
C. Cost efficiency
D. Potential value
ANS: C

Q2. Which among the following models is used to calculate the timing of the inventory order?
A. Economic order quantity model
B. Fixed order quantity model
C. Reorder point model
D. Fixed order inventory model
ANS: C

Q3. The type of inventory method that comprises more number of accounting transactions is known as _____.
A. Periodic inventory method
B. Perpetual inventory system
C. Finished goods inventory method
D. Fixed order period inventory system

ANS: B

Q4. In the ABC Analysis system the B category stands for_____.
A. Outstanding importance in value
B. Comparatively unimportant in value

C. Comparatively important in value
D. Average importance in value

ANS: D

Q5. Which among the following is a quantity of a specific item that is ordered from the supplier and issued as a standard quantity to the production process?
A. Safety stock
B. Lot size
C. Standard deviation
D. Inventory control

ANS: B

Q6. Which among the following components is calculated as the sum of the fixed costs that happen each time an item is ordered?
A. Carrying cost
B. Order cost
C. Holding cost
D. Storing cost

ANS: B

Q7. The price reductions offered to customers for large orders, to encourage them to purchase in large quantities is known as _____.
A. Freebies
B. Quantity discounts
C. Normal discounts
D. Premiums

ANS: B

Q8. Companies that maintain a sufficient safety margin by having extra inventory against certain situations are termed as _____.
A. inventory
B. lot size
C. safety stock
D. lead

ANS: C

Q9. Which among the following costs is the expense of storing inventory for a specified period of time?
A. Purchasing cost
B. Carrying cost
C. Financial cost
D. Storing cost

ANS: B

Q10. Which among the following is the ratio of net profit to net sales?
A. Net Operating ratio
B. Gross profit ratio
C. Pretax Profit ratio
D. Net profit ratio

ANS: D

Q11. Which of the following costs is estimated by multiplying the quantity determined in the bill of materials to the cost of each component?
A. Operating
B. Production
C. Labour
D. Material

ANS: D

Q12. Manufacturers actually print the labels provided to them and serial numbers to aid in _____.
A. Quality audit
B. Quality control
C. Auditing process
D. Product quality

ANS: B

Q13. The expense of shifting the packed orders into vehicles that would ship them is known as _____.
A. Shipping cost
B. Packing cost
C. Loading cost
D. Picking cost

ANS: C

Q14. The company should be prepared for any future demand from the customer by storing them _____ in the distribution centres.
A. Delivery stock
B. Strategic stock
C. Safety stock
D. Overhead stock

ANS: C

Q15. Which among the following improves the overall performance of the organisation and helps to achieve efficient distribution and delivery system?
A. Just-in-Time
B. Master Production System
C. Customer responsiveness
D. Lead-time offsetting

ANS: A

Q16. Which among the following is a computerized system that controls the kind of items to be purchased and also decides on the quantity that needs to be purchased?
A. Order point system
B. Material Requirements Planning
C. Time Phased Order Point
D. Enterprise Resource Planning

ANS: B

Q17. State True or False:
1. Raw materials can be produced and extracted by a firm or can be purchased from outside the firm.
2. Work in process items are the inventory items that are not ready to be used by the customer.
A. 1-True, 2-True
B. 1-False, 2-False
C. 1-True, 2-False
D. 1-False, 2-True

ANS: A

Q18. The objective of maximizing _____ conflicts with minimizing _____ in inventory.
A. Purchase, investment
B. Production, cost-efficiency
C. Profit, negative cash flow
D. Storage capacity, loss

ANS: A

Q19. The time period between placing two successive orders is called _____ and the time period between ordering an item for replenishment and actually receiving the item into the inventory is called as _____.
A. Lead time, order cycle
B. Order cycle, lead time
C. OTC cycle, idle time
D. Idle time, OTC cycle

ANS: B

Q20. Reorder point = _____ + _____
A. Lead time demand, safety stock
B. Forecasted daily unit sale, lead time
C. Reorder point, lead time demand
D. Safety level of stock, demand per day

ANS: A

Q21. Inventory carrying costs consists of _____ and _____.
A. Shipping cost, storage cost
B. Handling cost, storage space cost
C. Vendor cost and physical management cost
D. Storage cost, physical management cost

ANS: D

Q22. Identify the two components that make up the EOQ equation.
A. Order cost, setup cost
B. Quality cost and setup cost

C. Annual usage and carrying cost
D. Quality cost and annual usage

ANS: C

Q23. State True or False
1. Safety stock can be set in weeks or units of stock at the simplest level.
2. The larger the lot size, fewer is the number of lots required and hence higher is the annual set-up cost.
A. 1-False, 2-True
B. 1-True, 2-True
C. 1-True, 2-False
D. 1-False, 2-False

ANS: C

Q24. Inventory turnover ratio = _____ / _____.
A. Beginning inventory, total goods sold
B. Average inventory at cost, ending inventory
C. Cost of goods sold, average inventory at cost
D. Total goods sold, cost of goods sold

ANS: C

Q25. ……. is the term associated with inventory is called
A. Re-order costs
B. Purchase price of the inventory
C. Inventory holding costs, Shortage costs
D. All of the above

ANS: D

Q26. Re-order costs are the costs of making orders to purchase a quantity of a material item from a supplier. Re-order costs include costs of which one of the followings:
A. the costs associated with placing an order, such as the costs of telephone calls
B. Costs associated with checking the inventory after delivery from the supplier
C. The cost of delivery of the purchased items, if these are paid for by the buyer
D. Batch set up costs if the inventory is produced internally
E. All of the above

ANS: E

Q27. Which of the following cot includes by Inventory holding costs?
A. Insurance costs
B. Cost of capital tied up
C. Cost of warehousing, obsolescence, deterioration and theft
D. All of the above

ANS: D

Q28. Shortage costs of inventory include:
A. Lost profit on sale
B. Future loss of profit due to loss of customer goodwill
C. Costs due to production stoppage due to shortage of raw materials
D. All of the above

ANS: D

Q29. Which of the following is not an inventory?
a. Raw material
b. finished products
c. Both a and b
d. Machines

ANS: D

Q30. The cost of insurance and tax is included in which of the following costs?
a. Inventory carrying cost
b. Cost of ordering
c. Set up cost
d. None of these

ANS: A

Q31. 'Buffer stock' is the level of stock
a. Half of the actual stock
b. Minimum stock level below which actual stock should not fall
c. At which the ordering process should start
d. None of them

ANS: B

Q32.The minimum stock level is calculated as
a. Reorder level + (Normal consumption x Normal delivery time)

b. (Reorder level + Normal consumption) x Normal delivery time
c. (Reorder level + Normal consumption) / Normal delivery time
d. Reorder level – (Normal consumption x Normal delivery time)
e. None of these

ANS: D

Q33. Select the assumptions of Economic order quantity (EOQ)?
A. There are no bulk purchase discounts for making orders in large sizes. All units purchased for each item of material cost the same unit price.
B. The order lead time (the time between placing an order and receiving delivery from the supplier) is constant and known.
C. Annual demand and consumption for the inventory item is constant throughout the year.
D. All of the above

ANS: D

Q34. Which of the following is the cost for the purpose of Economic order quantity (EOQ)?
A. The annual holding cost per item per annum
B. The annual ordering costs
C. Both A&B
D. None

ANS: C

Q35. Re-ordering level is calculated by the formula
a. Minimum consumption rate x Minimum re-order period
b. Maximum consumption rate x Minimum re-order period
c. Maximum consumption rate x Maximum re-order period
d. Minimum consumption rate x Maximum re-order period

ANS: C

Q36. What is QA?
a) It is the measurement of degree to which a product satisfies the need
b) Any systematic process used to ensure quality in the process
c) Process of identifying defects
d) It is a corrective tool

ANS: B

Q37. _____ are the basic materials which have not undergone any conversion since their receipt from suppliers.
a. WIP
b. Raw Material
c. Finished Parts
d. Work Made Parts

ANS: B

Q38. The first activity of purchasing cycle is _____
a. Communicating requirement to the purchase
b. Source Selection and development
c. Recognizing the need for procurement
d. Inspection of goods

ANS: C

Q39. _____ is the task of buying goods of the right quality, in the right quantities, at the right time and at the right price.
a. Supplying
b. Purchasing
c. Scrutinizing
d. None of the above

ANS: B

Q40. The cost reduction technique in comparison to the worth of a product is known as
(A) Reverse engineering
(B) Value engineering
(C) Material engineering
(D) Quality engineering

ANS: B

Q41. Value analysis examines the
(A) Design of every component
(B) Method of manufacturing
(C) Material used

(D) All of the above

ANS: D

Q42. Value analysis is normally applied to
(A) New products
(B) Old products
(C) Future products
(D) Both (A) and (B)

ANS: B

Q43. Value can be defined as the combination of _____ which ensures the ultimate economy and satisfaction of the customer.
(A) Efficiency, quality, service and price
(B) Efficiency, quality, service and size
(C) Economy, quality, service and price
(D) Efficiency, material, service and price

ANS: A

Q44. Value is the cost directly proportionate to
(A) Price
(B) Function
(C) Product Material
(D) All of the above

ANS: B

Q45. The price paid by the buyer is
(A) Cost value
(B) Use value
(C) Esteem value
(D) Exchange value

ANS: B

Q46. The cost incurred by the manufacturer beyond use value is called
(A) Cost value
(B) Esteem value
(C) Exchange value
(D) None of the above

ANS: B

Q47. Value analysis is a ____ process
(A) Remedial
(B) Preventive
(C) Continuous
(D) None of the above

ANS: A

Q48. Value analysis should be applied when the following symptom(s) is (are) present
(A) Rate of return on investment is reducing
(B) Reduction in sales of the product
(C) Firm is unable to meet delivery promises
(D) All of the above

ANS: D

Q49. Who is named as Father of Value Analysis?
(A) Lawrence D. Miles
(B) George Terborgh
(C) Michael Jucius
(D) Edwin B. Flippo

ANS: A

Q50. The costs neither those which neither contributes to function nor the appearance of the product is called
(A) Extra cost
(B) Unnecessary cost
(C) Esteem cost
(D) Exchange cost

ANS: B

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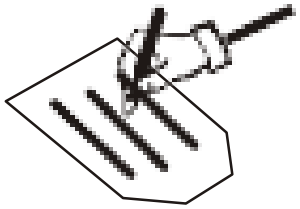

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