Production Management: Its Meaning, Definition, Function and Scope!

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.

The application of management to the field of production has been the result of at least three developments:

(i) First is the development of the factory system of production. Until the emergence of the concept of manufacturing, there was no such thing as management as we know it. It is true that people operated business of one type or another, but for the most part, these people were owners of business and did not regard themselves as managers as well.

(ii) Essentially stems from the first, namely, the development of the large corporation with many owners and the necessity to hire people to operate the business.

(iii) Stems from the work of many of the pioneers of scientific management who were able to demonstrate the value, from a performance and profit point of view, of some of the techniques they were developing.

Definition of Production Management: It is observed that one cannot demarcate the beginning and end points of Production Management in an establishment. The reason is that it is interrelated with many other functional areas of business, viz., marketing, finance, industrial relations, policies, etc.

Alternatively, Production Management is not independent of marketing, financial and personnel management due to which it is very difficult to formulate some single appropriate definition of Production Management.

The following definitions try to explain main characteristics of production management:

(i) In the words of Mr. E.L. Brech: “Production Management is the process of effective planning and regulating the operations of that section of an enterprise which is responsible for the actual transformation of materials into finished products.” This definition limits the scope of production management to those activities of an enterprise which are associated with the transformation process of inputs into outputs. & the definition does not include the human factors involved in a production process. It lays stress on materialistic features only.

(ii) Production Management deals with decision-making related to production process. So that the resulting goods and services are produced in accordance with the quantitative specifications and demand schedule with minimum cost.

According to this definition design and control of the production system are two main functions of production management.

(iii) Production Management is a set of general principles for production economies, facility design, job design, schedule design, quality control, inventory control, work study and cost and budgetary control. This definition explains the main areas of an enterprise where the principles of production management can be applied. This definition clearly points out that production management is not a set of techniques.

It is evident from above definitions that production planning and its control are the main characteristics of production management. In the case of poor planning and control of production activities the organization may not be able to attain its objectives and may result in loss of customer’s confidence and retardation in the progress of the establishment.

In short, the main activities of production management can be listed as:

(i) Specification and procurement of input resources namely management, material, and land, labour, equipment and capital.

(ii) Product design and development to determine the production process for transforming the input factors into output of goods and services.
(iii) Supervision and control of transformation process for efficient production of goods and services.

**Functions of Production Management:** The definitions discussed above clearly shows that the concept of production management is related mainly to the organizations engaged in production of goods and services. Earlier these organizations were mostly in the form of one man shops having insignificant problems of managing the productions. But with development and expansion of production organizations in the shape of factories more complicated problems like location and layout, inventory control, quality control, routing and scheduling of the production process etc. came into existence which required more detailed analysis and study of the whole phenomenon.

This resulted in the development of production management in the area of factory management. In the beginning the main function of production management was to control labour costs which at that time constituted the major proportion of costs associated with production.

But with development of factory system towards mechanization and automation the indirect labour costs increased tremendously in comparison to direct labour costs, e.g., designing and packing of the products, production and inventory control, plant layout and location, transportation of raw materials and finished products etc. The planning and control of all these activities required more expertise and special techniques.

**In modern times production management has to perform a variety of functions, namely:**

(i) Design and development of production process.  
(ii) Production planning and control.  
(iii) Implementation of the plan and related activities to produce the desired output.  
(iv) Administration and co-ordination of the activities of various components and departments responsible for producing the necessary goods and services.

However, the responsibility of determining the output characteristics and the distribution strategy followed by an organization including pricing and selling policies are normally outside the scope of Production Management.

**Scope of Production Management:** The scope of production management is indeed vast. Commencing with the selection of location, production management covers such activities as acquisition of land, constructing building, procuring and installing machinery, purchasing and storing raw materials and converting them into saleable products. Added to the above are other related topics such as quality management, maintenance management, production planning and control, methods improvement and work simplification and other related areas.

1. **Facility Location** - Selecting appropriate location for the production.
2. **Plant layouts and material handling** - Deciding upon the machines, equipment and necessary devices which could lead to effectual and desired production in the most economic way. Preparation of plan layout for the establishment of machines in the required sequence. Storage of material and handling it in most effective way to avoid the wastage and delivery at the work centers as and when required.
3. **Product design** - Designing the product and conceive the idea about its production.
4. **Process design** - Determination of the production process which is most relevant and efficient in the given state of affairs.
5. **Production and planning control** - Planning the production and its various aspects how, when and where producing a particular product or its assembly will be done.
6. **Quality control** - Controlling the production and ensuring the quality by setting the check points and taking the periodic measurements of the current performance.
7. **Materials management** - Managing the inventories of raw material, semi-finished and finished goods in a way that neither excessive money may block in this non-productive operation nor the required material.
8. **Maintenance management** - Analysis the deviations and formulating the corrective measures to stay in track with planned quality, time-schedule and predetermined cost schedules.

**Nature And Scope Of Operations Management**

tion Relates To The Evolution Of The Subject. Operation Management Is The Term That Is Used Now A Days. Production Management Precedes Operations Management In The Historical Growth Of The Subject. The Two Distinctions Not Withstanding, The Terms Production Management And Operations Management Are Used Interchangeably.

**Scope Of Production And Operation Management**

The Scope Of Production And Operations Management Is Indeed Vast. Commencing With The Selection Of Location Production Management Covers Such Activities As Acquisition Of Land, Constructing Building, Procuring And Installing Machinery, Purchasing And Storing Raw Material And Converting Them Into Saleable Products. Added To The Above Are Other Related Topics Such As Quality Management, Maintenance Management, Production Planning And Control, Methods Improvement And Work Simplification And Other Related Areas.

**Evolution Of Production Function**


**The Industrial Revolution** - Since Times Ancient Production Systems Were Used In One Form Or Another. The Egyptian Pyramids, The Greek Parthenon, The Great Wall Of China And The Aqueducts And The Roads Of The Roman Empire, Dams And Anicuts Built By The Chola Kings Attest To The Ingenuity And Industry Of The People Of Ancient Times But The Ways The People In The Ancient Days Produced Goods Were Different From The Production Methods Of Today. Production Systems Prior To The 1700s Are Often Referred To As The Cottage System, Because The Production Of Goods Took Place In Homes Or Cottages, Where Craftsmen Directed Apprentices In Performing Hand Work On, Products. From 1770 To The Early 1800s Series Of Events Took Place In England Which Together Are Called The Industrial Revolution. Industrial Revolution Resulted In Two Major Developments: Widespread Substitution Of Machine Power For Human Power And Establishment Of The Factory System. The Events That Took Place From 1770 To The 1800s Are Characterized By Great Inventions. The Great Inventions Were Eight In Number, With Six Of Them Having Been Conceived In England, One In France And One In The United States. The Eight Inventions Are—Hargreaves Spinning Jenny, Arkwright’s Water Frame, Crompton’s Mule, Cartwright’s Power Loom, Watt’s Steamengine, Berthollet’s Chlorine Bleaching Discovery. Mandslay’s Screw-Cutting Lathe And Eli Whitney’s Interchangeable Manufacture. As Observed From Eight Inventions, Most Of Them Have To Do With The Spinning Of Yarn And Weaving Of Cloth. This Is Logical From The Point Of View That Cloth Was The Principal Export Commodity Of England At That Time And Was In Short Supply Owing To The Considerable Expansion Of England’s Colonial Empire And Its Commercial Trade. The Availability Of Machine Power Greatly Facilitated The Gathering Of Workers In Factories That Housed The Machines. The Large Number Of Workers Congregated In The Factories, Created The Need For Organizing Them In Logical Ways To Produce Goods. The Publication Of Adam Smith’s Wealth Of Nations In 1776 Advocated The Benefits Of The Division Of Labor Or Specialization Of Labor, Which Broke Production Of Goods Into Small Specialized Tasks That Were Assigned To Workers On Production Lines. Thus, The Factories Of Late 1700s Not Only Had Developed Production Machinery, But Also Ways Of Planning And Controlling The Output Of Workers. The Impact Of The Industrial Revolution Was First Felt In England. From Here, It Spread To Other European Countries And To The United States.

**Factors influencing operations management**

**Focus**. The energy management manager team needs to ensure that the overall manufacturing operation has a clear sense of direction and strategic focus. Frontline managers also need to ensure correct interpretation of the goals by the workforce. Once the workforce in the plant is clear about goals and focus, the energy manager and the frontline managers need to delegate responsibility and decision-making authority to the required people, making them accountable for results.

**Planning**. It is the energy manager’s responsibility to chalk out a strategy to achieve goals with maximum input from the people who will implement the plan. Effective strategic and operational planning on the management team is a must for optimal performance of the manufacturing operation. For frontline managers, the strategic plan should aid operational improvements and the operational plan should focus on activities like maximum efficiency while maintaining/improving production schedules, maintenance activities, training and the like.

**Resources**. The energy manager should be able to garner enough financial support for his/her operation, deploy appropriate technologies and take steps to put together an effective team. It is then extremely important that the energy management team work directly with frontline management to ensure that financial resources and technologies are properly used for opera-
tions and maintenance. Don’t forget to work with Human Resource to formulate and implement policies for an effective workforce. Resource management should not be overlooked when targeting optimal performance of a manufacturing operation.

**Processes.** Without appropriate processes, focus, planning, and resources are of no use. I can’t stress how vital it is for the energy management team to have an efficient operating system in place, which closely monitors the operations and triggers a corrective action if the performance of the operation falls below expected efficiency and/or production levels. The energy management team has to ensure that the operating systems serve their design purpose, promote teamwork and monitor workgroup performance, as well as initiate corrective action when performance is below desired levels.

**People.** An effective and motivated workforce can be a blessing to any energy management effort. The energy management team should share a good working relationship with the frontline management group. To have the desired working relationship sharing information, listening and coaching are important skills the energy management team needs to possess. They should be able to initiate change in the operations as well as prevent political infighting. The same applies for the entire management team. They also should share a good working relationship with their workgroup and be able to implement the change initiated by the energy management team.

Besides the energy management team and front line management, their superiors should also understand the implications of the five factors discussed above. Though, for a plant’s energy manager to succeed a lot depends on the personal skills of the manager, the support of the top management goes a long way to help the energy manager achieve organizational goals.

**Three Factors That Influence a Company’s Operational Planning**

Operational planning is a critical part of a manager or small business owner’s job in a small company. A company's leaders must set goals and develop a plan for work activities, or operations, required to accomplish those goals. This requires extensive knowledge of internal and external conditions. Operational plans in business organizations are affected by common factors.

**Definition of Operational Planning** - According to the book "Business Principles and Management," operational planning concerns three aspects of a company's work: how work will be performed, who will perform the work and what resources are required to complete work in each business area. Managers are not alone in making operational decisions; they get help from engineers and employees with technical expertise in specific work tasks.

**Work Processes** - In operational planning, consider the routines that make up each work process. For example, in a bicycle factory, each manager oversees at least one work process such as building a particular bicycle model from start to finish. It is a manager's job to ensure every routine in the process of building the bicycle is cost-effective and efficient in terms of employee labour hours and machine hours.

**Employee Training** - Employee training affects operational planning. Managers must develop employees' skills and use them as resources just like computer programs and machines. They must continuously assess employees' skills and readiness to perform tasks. This type of planning includes shifting employees around to different task roles until the best arrangement for maximum production is found. Once managers understand the workflow and how employees work well in this flow, they can shift to fine-tuning the work routines.

**Scheduling** - Managers create a production schedule including the number of hours worked by each employee and the rate of production for each machine. This kind of coordination of resources helps to ensure that the company’s products are made to satisfy customer demand. Scheduling also includes other types of coordination, such as ordering shipments of raw materials and scheduling pickups by distributors.

**Objectives of Production Management:**

1. **Right Quality**
2. **Right Quantity**
3. **Predetermined time**
4. **Pre-established cost**

**1. Right Quality:** - The quality of the product is established based upon the customers’ needs. Customer’s needs are translated into product specifications by the design or engineering department. The manufacturing department then translates these specifications into measurable objectives.

Thus the cost quality trade off decides the final quality of the product. Thus a proper balance must be obtained such that the product quality offered to the customer should be within the pre-established manufacturing cost.

**2. Right Quantity:** The manufacturing organisation should produce the products at the right number.

If the products are produced in quantity excess of demand the capital will block up in the form of inventory and if it is produced in quantity short of demand, there will be shortages of products. Thus a decision is to be taken regarding how much to produce. (Right quantity)

**3. Manufacturing Costs:** Manufacturing costs are established before the product is actually manufactured. The manufacturing department has to manufacture the products at the pre-established cost. In any case, any variation between the actual costs and the standard (pre-established) should be kept at minimum.

**4. Manufacturing Schedule:** Timeliness of delivery (schedule) is one of the important parameter to judge the effectiveness of production department. There are many reasons like non-availability of materials at right time, absenteeism, machine break
down etc. Which affect the timely completion of the products? So the manufacturing department should organize its activities in such a way that the products will be manufactured as per schedule.

To achieve the above objective, the manufacturing/production department has to make the optimum utilization of various inputs like men, material, and machine. So to have a better utilization of resources, the production department has to achieve the other objectives, which are lower in the hierarchy. These objectives are called intermediate objectives and are going to optimize the utilization of resources.

Intermediate Objectives: The intermediate objectives can be stated in terms of:

1. **Machinery and Equipment's:** The objective concerned to these areas is that the machine and equipment should be such that they should be able to produce the products as per the specifications and accuracy required. The total cost of procurement and running cost should be minimum. Once the machines are procured and put to productive use, then the next objective is to utilize these resources to the maximum extent.

2. **Materials:** The materials should be made available when required as per the specifications (shape, size, quality etc.) and at the most economical price. The production department should aim at maximum utilisation of the material with minimum wastage and scrap.

3. **Manpower:** Manpower is an important resource or input to production and the success of production depends to a greater degree upon the type of manpower an organisation possesses. Thus, there should be a perfect matching between the workers & jobs and the manufacturing department climate should be such that the potential skills and energies of the workers should be channelized in to constructive outputs. The objectives are set with respect to productivity per worker labour turnover rate, safety and industrial relations etc.

4. **Supporting Services:** This helps indirectly to achieve the other objectives and adequate provision of the services helps to utilize other inputs effectively. The objectives should be set for each of the services like water steam, power, material handling, etc. Thus intermediate objectives are supporting to the primary objectives. The achievement of these objectives helps the company to satisfy the customer needs and increase the market share resulting in increased profitability.

**Types of Production: with it’s Characteristics and Limitations**

Some of the most important types of production are: (i) Job Production (ii) Batch production and (iii) Mass or flow production!

A production manager will have to choose most appropriate method for his enterprise. The final decision regarding any particular method of production is very much affected by the nature of the products and the quantity to be produced. Production methods may be broadly classified as Job Production, Batch production and Mass or Flow Production.

(i) **Job Production:** – Under this method peculiar, special or non-standardized products are produced in accordance with the orders received from the customers. As each product is non-standardized varying in size and nature, it requires separate job for production. The machines and equipment’s are adjusted in such a manner so as to suit the requirements of a particular job.

Job production involves intermittent process as the work is carried as and when the order is received. It consists of bringing together of material, parts and components in order to assemble and commission a single piece of equipment or product.

Ship building, dam construction, bridge building, book printing are some of the examples of job production. Third method of plant layout viz., Stationery Material Layout is suitable for job production.

**Characteristics:** – The job production possesses the following characteristics.

1. A large number of general purpose machines are required.
2. A large number of workers conversant with different jobs will have to be employed.
3. There can be some variations in production.
4. Some flexibility in financing is required because of variations in work load.
5. A large inventory of materials, parts and tools will be required.
6. The machines and equipment setting will have to be adjusted and re-adjusted to the manufacturing requirements.
7. The movement of materials through the process is intermittent.

**Limitations:** – Job production has the following limitations:

1. The economies of large scale production may not be attained because production is done in short-runs.
2. The demand is irregular for some products.
3. The use of labour and equipment may be an inefficient.
4. The scientific assessment of costs is difficult.

(ii) **Batch production:** – Batch production pertains to repetitive production. It refers to the production of goods, the quantity of which is known in advance. It is that form of production where identical products are produced in batches on the basis of demand of customers’ or of expected demand for products. This method is generally similar to job production except the quantity of production. Instead of making one single product as in case of job production, a batch or group of products are produced at one time. It should be remembered here that one batch of products may not resemble with the next batch.

Under batch system of production the work is divided into operations and one operation is done at a time. After completing the work on one operation, it is passed on to the second operation and so on till the product is completed. Batch production can be explained with the help of an illustration. An enterprise wants to manufacture 20 electric motors.

The work will be divided into different operations. The first operation on all the motors will be completed in the first batch and then it will pass on to the next operation. The second group of operators will complete the second operation before the next and so on. Under job production the same operators will manufacture full machine and not one operation only.

Batch production can fetch the benefits of repetitive production to a large extent, if the batch is of a sufficient quantity. Thus batch production may be defined as the manufacture of a product in small or large batches or lots by series of operations, each operation being carried on the whole batch before any subsequent operation is operated. This method is generally adopted in case of biscuit and confectionery and motor manufacturing, medicines, tinned food and hardware’s like nuts and bolts etc.
The batch production method possesses the following characteristics:

1. The work is of repetitive nature.
2. There is a functional layout of various manufacturing processes.
3. One operation is carried out on whole batch and then is passed on to the next operation and so on.
4. Same type of machines is arranged at one place.
5. It is generally chosen where trade is seasonal or there is a need to produce great variety of goods.

Types of Manufacturing Systems

Custom Manufacturing System - Custom manufacturing systems represent one of the oldest and most widely used forms of product making. In this system, a single craftsman produces one item at a time by hand or by machine. If machines are used in this system, they are often highly specialized, and capable of producing only a single line of merchandise. This system offers the lowest level of efficiency and highest cost per unit, and results in very low levels of production.

Intermittent Manufacturing System - Intermittent manufacturing systems, often called "job shops," are capable of producing multiple items at the same time. These objects must be identical, or very similar, and cannot be customized for individual buyers. This type of system works best for limited production runs, or for companies looking to produce a low volume of goods.

Continuous Manufacturing System - Continuous manufacturing systems allow for mass production of products. In this system, the product moves from station to station along an assembly line, with different workers performing various production tasks along the way. Continuous systems were first used during the Industrial Revolution, and are often associated with the Ford Company's Model T production. This type of system allows companies to meet high production goals, and results in a lower per-unit cost. Because of the large amount of equipment required to create an assembly line, as well as the level of labor, this type of system is often associated with large capital investments.

Flexible Manufacturing System - Flexible manufacturing systems represent one of the most widely used modern production systems. In this type of setup, companies invest in a variety of machinery that can be quickly and easily reconfigured to produce a large number of products. Flexible manufacturing often incorporates robots or automatic vehicles to help move products through the production process, eliminating the need for skilled labor.

This type of system allows for a high degree of flexibility in terms of product mix, and helps the company maintain high volume in each production run. Because robots replace human labor in this type of system, products tend to be fairly consistent and quality remains high. This system requires a high degree of capital investment as well as frequent maintenance and oversight.

The process of designing a manufacturing system therefore must engage upon the design of each of the above four components AND their integration. Notice that this figure is pretty much consistent with Prof Sohlenius’ architecture of Manufacturing systems, which is partially reproduced in the following figure.

While the following figure implicitly assumes the important role of the human in each of the modules, I have explicitly placed it
separately in the figure above, partly because it helps in highlighting the importance of planning the human aspects of the system.

(source: Lecture notes, Prof Gunnar Sohlenius)

We first look broadly at these four elements, and subsequently, we shall study each of these aspects in somewhat more detail.

**Informal definitions:**

**Physical Systems** refer to all physical aspects of a manufacturing system, including the factories, including the facilities, machines, tools etc., the raw materials, the material handling systems, the work in process, as well as the products.

**The Operation** refers to all aspects of decision structures that determine how the system functions. For example, does it use a Toyota style pull production, or does it depend on an MRP II system with forecasts driven production? How does the plant manager determine the size and sequence of the jobs to be done on each machine, on each day?

**The Information** in a manufacturing system refers to all data that will be accessed by some function/person/decision-maker/software etc., and whose value may be used deciding upon an action. Examples include design data, machine data, tool data, inventory status, process data, vendors, clients, and personnel data and so on. It is likely that for any MS of reasonable complexity, one will need automated data handling facilities, e.g. a DBMS. I will also loosely include in this definition, mechanisms that are required for the flow of information, that is, Information Technology (IT). This includes communication protocols (such as MAP, TOP, and ISO-OSI), etc.

**Humans** refer to all personnel, vendors, customers, etc. Personnel related issues include: what is the capability level of available labour, what is the working culture (1-shift, 2-shift availability), how many do we need to hire for a given MS, what is the level of training needed, what policies will lead to better working environment etc. Customers are another essential human element in the design of MS.

We begin the study with the physical systems. I will use the following classification of manufacturing systems, which uses the **material flow type as its basis:**

- **Product based:** These are manufacturing systems that are designed specifically for a fixed product (or product type). The underlying principles are those of interchange ability, and division of labour. These systems may be highly automated or human-labour intensive. However, in every case, they must operate at relatively high throughput rates.
  - **Further divided into:**
    - Continuous production (e.g. chemicals, food processing etc.)
    - Discrete part production. Further divided into:
      - Assembly lines
      - Transfer Lines
  - **Process-based:** these are facilities where machines of the same type are grouped together physically. Some examples may be seen in job shops, workshops, prototype makers, tool makers.
  - Flexible Manufacturing systems may loosely be categorized as highly automated versions of process-based systems.

- **Cellular:** Cells are formed using GT, and typical cells are small clusters of a mixed bunch of machines that can handle a particular family of products. Such layouts are used when the batch sizes of orders are not large, but throughput times required are lower.

- **Fixed position:** For single units of a large item (e.g. construction project, MTR line, ship building etc.)

The above are all the physical production systems. In addition, we shall look at material handling systems, including transportation machines and inventory handling systems.

Once we have a physical system all installed, we need to worry about the operational aspects. This includes, among other things, **Production Control.** Several important things here include:

- **Lot sizing;**
- **Scheduling;**
- **Process Planning;**

When we design the physical systems, we are concerned with the capability to produce the designed part. When studying the operational aspects, we are more concerned with the **efficiency** at which we are working. Therefore, it is essential for us to know our goals, when we make operational decisions. Some typical descriptors used for Manufacturing Systems include:

- **WIP (Work in Process):** The number of parts that are currently in the shop floor, either being worked upon by a machine/operator, or waiting at a buffer or in a queue.

- **Production rate:** number of finished parts being produced by the system in unit time.
Factors Affecting Plant Location


1. Selection of Region: - The selection of a region or area in which plant is to be installed requires the consideration of the following:

   - Availability of Raw Materials: - Proximity of sources of raw materials is the obvious explanation of the location of majority of sugar mills in Uttar Pradesh. This means that the raw material should be available within the economical distance. Easy availability of supplies required for maintenance and operation of the plant should also be considered.

   - Proximity to Markets: - Cost of distribution is an important item in the overhead expenses. So it will be advantageous to be near to the center of demand for finished products. Importance of this is fully realized if the material required for the manufacturing of products are not bulk and freight charges are small.

Consumer industries like cycles, sewing machines, radio televisions and other luxury goods etc. are set up near the marketing centers whereas producer industries like steel mills are located near the vicinity of raw material.

Factors Affecting Plant Location

For this purpose market analysis should be carried out keeping in view the following points:

(a) Market trend and competition regarding product to be manufactured.
(b) Industrial market
(c) Consumer habits and income
(d) Population
(e) Scope of export to neighbouring countries.

Transport Facilities: - Since freight charges of raw materials and finished goods enter into the cost of production, therefore transportation facilities are becoming the governing factor in economic location of the plant. Depending upon the volume of the raw materials and finished products, a suitable method of transportation like rail, road, water transportation (through river, canals or sea) and air transport is selected and accordingly plant location is decided. Important consideration should be that the cost of transportation should remain fairly small in comparison to the total cost of production.

Availability of Power, Fuel or Gas: - Because of the wide spread use of electrical power the availability of fuel or gas has not remained a deciding factor in most of the cases for plant location. The location of thermal power plants (like Bokaro Thermal Plant) and steel plants near coal fields are for cutting down cost of the fuel transportation. The reliability of continuous supply of these facilities is an important factor.
Water Supply: - Water is required for processing as in chemical, sugar and paper industries and is also used for drinking and sanitary purposes. Investigation for quality and probable source of supply is important, since the cost of treating water is substantial so the chemical properties like hardness, alkalinity and acidity. Presence of dissolved gases and organic material etc. should be thoroughly investigated. In case of water supply form an external source such as municipality, dependability of the source, pumping and storage capacity for present and future demands should be found out.

Disposal Facility for Waste Products: - Thorough study should be made regarding disposal of water like effluents, solids, chemicals and other waste products likely to be produced during the production process.

Climatic and Atmospheric Conditions: - The climate of the region/ area where the plant is to be located has an important bearing on both the capital and operational costs.

Normally following aspects are considered:
(a) Rain fall or snow fall in the area concerned
(b) Ambient temperatures
(c) Humidity
(d) Wind velocities and direction
(e) Incidence of cyclones, storms etc.

Availability of Labour: - Potential supply of requisite type of labour governs plant location to major extent. Some industries need highly skilled labour while other need unskilled and intelligent labour. But the former type is difficult in rural areas in comparison with industrially developed location.

Momentum of an Established Industry: - Already established industry in a certain area will produce skilled labour in that trade. Thus future industries in that area will have no difficulty with respect to the skilled labour e.g. Ludhiana is famous for cycle industries and Faridabad for engineering industries.

Preference of Outstanding Businessmen and Government Subsidies: - Some of the factory locations do not consider the above factors but locate industries in a particular district or area just to develop that area. It may be due to State Government policies regarding workers, pollution and smoke control requirements, waste disposal rules for industries etc.

2. Township Selection: - The factors to be considered regarding township selection are:
(i) Availability of men power of requisite skill
(ii) Competitive wage rates of workers
(iii) Other enterprises which are complementary or supplementary regarding raw materials, other input, labour and skill required.
(iv) Moderate taxes and the absence of restricting laws.
(v) A favourable cooperative and friendly attitude towards the industry.
(vi) Favourable living conditions and standards keeping in view the availability of medical and educational facilities, housing, fire service, recreational facilities, cost of living etc.

3. Question of Urban and Rural Area: - Question of urban and rural area should be decided in view of the following:

Advantages of Rural Area: -
(i) The initial cost of land, erection cost of building and plant is less in rural area as compared to urban or city area.
(ii) Acquisition for additional area for extension work expansion of plant is possible without much difficulty whereas urban area being congested; the additional land is not easily available.
(iii) Rural areas are free from labour trouble which is most common in towns and cities.
(iv) Over crowding of working class population in cities is avoided.

Advantages of Urban Area:
(i) Better modes of transportation for collection and distribution of materials and finished products.
(ii) Availability to requisite type of labour for special and specific jobs is there.
(iii) Utilities like water, power, fuels etc. are easily available.
(iv) Industries do not need to construct colonies to provide residential facilities to their workers since houses are available on rental basis whereas in rural areas, houses have to be build for workers.

4. Location of a Factory in a Big City: - Generally factories are located in big cities for obvious reasons of skilled labour, market proximity for both raw materials and end products.

Its advantages and disadvantages are mentioned below:
Advantages:
(i) Existence of educational and recreational facilities is advantageous for children and dependents of workers.
(ii) Facilities for technical/ industrial education and training for children of workers are available.
(iv) Discussion opportunities and facilities for exchange of thoughts are available for interested people in societies and clubs.
(x) Better transport facilities for movement of raw materials, finished products and workers are available.
(vi) Repair, maintenance and service facilities for various utilities are available in abundance.
(vii) Banking facilities regarding finance (loan etc.) for industry in case of necessity are available.
Advantages:
(i) Big markets for sale of products available.
(ii) Evening classes facilities are available.
(iii) All types of skilled man power is available.
(iv) Many similar industries/plants exist in nearby areas.
(v) Housing facilities workers & employees.

Disadvantages:
(i) Insurance and taxation rates are high.
(ii) Due to higher living standards, cost of consumer goods and wage rates are high.
(iii) Cost of land is more if needed for expansion of the plant etc.
(iv) Building costs very high in comparison to rural or semi urban areas.
(v) Atmospheric conditions not very pleasant rather suffocating.
(vi) Local bye laws present a problem for future, working & expansion etc.
Thus, small plants may find location in big cities that too in upper stories of the buildings. Such accommodation may be utilized in view of availability of requisite type of labour in big cities.

5. Location of an Industry in Small Town:
- There are some industries which are located in the rural areas or small towns specifically for the want of raw material and cheap labour.
Its advantages and disadvantages are mentioned below:

Advantages:
(i) Less labour trouble and co-ordinal employee-employer relation.
(ii) Suitable land for current and future requirements easily available.
(iii) Local bye laws do not impose problem in working of the unit.
(iv) No resistance from existing industries.
(v) Possibility of tax exemptions exist.
(vi) Not much congestion.
(vii) Lower rents in comparison to big cities and urban areas.
(viii) Lower wage rates for labour/employees/workers.
(ix) Less fire risks.
(x) Noise not much problem.

Disadvantages:
(i) Scarcity of skilled labour of requisite type.
(ii) Lack of recreational and amusement facilities for staff.
(iii) Facilities like evening classes and industrial training do not exist.
(iv) Employees, workers do not get accustomed to factory life easily.
(v) Specialized services needed for various purposes are not available.
(vi) Police and fire protection less satisfactory.
(vii) Transportation and marketing facilities not satisfactory as required.

6. The Sub-urban Location for a Factory:
- Such a location generally provides advantages of both the large city and small towns.
Benefits of such a locality may be summarized as follows:
(i) Land is easily and cheaply available in comparison to big cities.
(ii) Lower tax rates in comparison to big cities and urban areas.
(iii) Transportation facilities equal to big cities available.
(iv) Good living accommodation to enjoy advantages of big cities available for workers/employees.
(v) Unskilled labour cheaply available.
(vi) Recreational facilities of cities available due to easy transport facilities.

7. Site Selection:
- The third step is to select the exact plant site with the following considerations:
(i) The cheap availability of land for current and future requirements, soil characteristics sub soil water, availability or possibility of economic drainage and waste disposal system are desirable parameters.
(ii) The site should be easily accessible to various modes of transport as required so that apart from input materials, employees can also reach the site conveniently.
(iii) The site should be free from zonal restrictions like from railways or civil aviation restrictions.

8. Current Trends in Plant Location:
1. Location in Proximity of Cities:
- First tendency is to locate the industries or enterprises in the proximity of cities rather than in rural or urban areas. These sub-urban sites offer today practically all advantages, facilities and services available in cities and towns with the added advantage of land required for future expansion on cheap rates.
2. Planned Industrial Centres: - While industrial towns may be planned and developed by big industrial houses or govt., the late trend is to develop areas as industrial estates and sell these to people interested in starting their units at various places. Noida and Faridabad are the examples of this type of development.

3. Competition for Development of Industries: - In order to generate the employment opportunities the state and central govt. offer concessions to attract industrialists to set up industries in their states or territories.

9. Appropriate Site Selection: - Appropriate site selection is important because of the following:

(i) A good location may minimize the cost of production and distribution to a considerable extent. Such reduction in the cost of production helps in elevating either the competitive strength or the profit margin of the business.

(ii) Initiation of an enterprise involve a relatively large permanent investment. If the selected site is not proper, all the money invested on factory building, installation of machinery etc. will go waste and the owner will have to suffer a great loss.

(iii) Location put constraints for the physical factors of the overall plant designs heating, ventilation requirements, storage capacity for raw materials, transportation requirements for input material and finished products, energy requirements cost of labour, taxes and construction costs.

(iv) Location of plant decides the nature of investment cost to be incurred.

(v) Government policies sometimes play an important role in site selection.

(vi) Probably no location is so perfect as to guarantee success but locations can be so bad as to bankrupt an enterprise.

10. The Design of Factory Plant Building: - After a plant location has been decided upon, management’s next problem deals with the design of building. A building is designed and built to protect the property and employees of an organization. This basic fact is mostly overlooked in planning the requirement for building structures.

For those plants where employees, materials and infrastructure facilities require protection, the problems involved in designing and constructing effective and economical structures are many.

**Good building design and planning can reduce manufacturing cost due to following reasons:**

1. Reduction of work-in-process inventory.
2. Lowering down material handling cost.
3. Reducing storage costs.
4. Reducing the manufacturing cycle time.
5. Simplifying manufacturing and employees control procedure.
7. Decreasing work stoppage and interruptions during production cycle.
8. Increasing plant flexibility and utilization.
9. Reducing employee hiring and training cost.
10. Increasing morale of workers and reducing employee turnover.

Practically in all industrial situations, plants or building is composed of rectangular or square area. The combinations result commonly in building of the shape L, T, U, G, H, F, E, I, O and polygonal. Generally speaking a square building is cheaper to construct than a rectangular building because the square will have less perimeter per square meter of usable area. This reduction in perimeter length results in lower foundation and outside site and boundary wall costs.

At the same time however the square shape of the building normally does not suit to efficient production or assembly lines patterns. Furthermore, the cost of structural steel for floor and roof supports in the square building will likely to exceed that for a rectangular building and may offset the possible savings in foundation and wall costs.

**Factors affecting the location of an industrial unit are:** (i) Primary factors and (ii) Secondary factors:

Decision with regard to location of an industrial unit involves a careful study of many factors. Proper and right choice of location is instrumental in future success of the business. The various factors are divided into two categories viz., ‘primary factors’ and ‘secondary factors’.

These factors are explained as follows:

**1) Primary Factors:**

(i) Availability of Raw Materials: - Raw material form major proportion of the finished product. Unrestricted and regular supply of raw material is very necessary for carrying out unrestricted production. Nearness to the source of raw material is very economical for an industrial unit. On account of this consideration many industries have been set up near the source of supply of raw material.

Sugar factories in Uttar Pradesh, Textile units in Maharashtra and Gujarat, Cement factories in Madhya Pradesh and Jute industry in West-Bengal. Nearness to raw material is important in case of heavy and bulky materials having lesser value such as coal and other weight losing materials.

**Raw materials can be divided into three:**

(a) raw materials which are weight losing and cannot be preserved for a long time e.g., fruits for juice making
(b) raw materials which are bulky, heavy and weight losing in nature, like iron ore etc.
(c) raw materials which are not heavy and can be preserved for a longer period of time, e.g., raw cotton.
Industry using third type of raw material can be located anywhere. Alford Weber has given another type of raw materials called ubiquitous like clay sand and water which are found everywhere and as such do not affect the location of an industry. Another important point to be kept in mind that only nearness of raw materials is not sufficient; it must also be easily accessible. Adequate transportation facilities should be available for carrying the material from the source of supply. A guiding principle should be followed in this regard i.e., “higher the proposition of the cost of raw materials to the total cost, the greater is the possibility of choosing a site near the source of raw materials.”

(ii) Availability of labour: - Labour cost is one of the main constituents of the total cost of production. It influences the total cost of production. Labour implies both the skilled and unskilled workers needed for different types of activities. The supply of unskilled labour does not create any serious problem because such labour is available everywhere. Skilled labour is available only at specific centres. Industries requiring highly skilled labour have to select such sites which ensure adequate and regular supply of required labour. Availability of skilled and efficient labour is mainly responsible for the development of various industries in a particular region e.g., cotton textile industry of Great Britain developed at Lancashire mainly on account of availability efficient labour. On account of mobility of labour, this factor does not materially affect the location of an industrial unit. The labour can be attracted by providing various facilities and incentives like housing, canteen, rest rooms, incentive wage plans etc.

In actual practice, if required skilled labour is not available in a particular region, the available labour can be trained in the required skill or alternatively skilled and trained labour can be migrated from other regions to the plant. But both these methods are time consuming and involve a lot of expenditure which ultimately increase the cost of production.

(iii) Availability of Power and Fuel: - Availability of cheap power and fuel supply sources is another decisive factor in selecting proper location of an industrial unit. In the past, coal was the main sources of power supply for various types of heavy and large scale industries like iron and steel, cement and aluminium etc., the industrial units which used to be located near coal supplying centres. But at present, there are several other sources of power, e.g. electricity, gas, oil and water power etc. On account of these various alternative sources of power supply, coal, as a main source of power is getting lesser recognition. Rapid development of hydro-electric power has provided wider choice for location of industrial units even at far flung and remote areas. Modern industrialisation could not have been possible without the growth of hydroelectric generating units.

(iv) Availability of Transport and Communication facilities: - Adequate and quick facilities of transport must be kept in mind for quick delivery of raw materials to the factory and finished products to the market. Kimball and Kimball have rightly pointed out that “The ideal plant is one centrally located and directly served by water, rail, trucking and air facilities”.

In certain type of industries transportation is the sole factor which is taken into consideration in deciding location of an industrial unit. For example, a cement factory is always situated near the source of lime stone which is carried usually with the help of trolleys to the factory.

Transportation is the life line of modern industry. The basic aim of selecting a particular mode of transportation should be minimum transportation cost with maximum transportation service. An industry should be located in the areas where there are already developed means of transportation. Faridabad in Haryana developed as an industrial town on account of availability of both rail and road transportation. Phagwara serves another very good example of this type. Certain port towns like Calcutta, Bombay and Madras have attained significant importance on account of availability of excellent water and rail transportation facilities.

In modern times different modes of transportation and their increased efficiency and flexibility have provided ample choice to the industrialists in the matter of location. Besides transportation, communication services are also used to be of immense importance in deciding the location of an industrial unit. A businessman needs regular information with regard to changes in the price of raw materials and finished products and other valuable information. On account of development of internet, mobile phones etc., this factor does not affect the location of plant now a days.

(v) Nearness to Market: - Market greatly affects the establishment of an industrial unit and is in fact, dominant factor in locating an industrial unit in modern times. The production of goods is undertaken with the aim of selling them quickly which is possible only on account of nearness to market. Industries using pure raw material (which do not lose their weight when turned into finished products) may be situated away from the source of such raw materials. For example, wool is primarily produced in Australia, but woollen hosierys are found throughout the world.

On the other hand, market as a factor of location will not affect much the location of industries using heavy and weight losing raw material. For example, iron and textile units are situated near the coal supplying centres. Similarly sugar factories are located very near the sources of raw materials. Nearness to market is important in case of industries producing consumer goods rather producers’ goods, this is because production of consumer goods require constant ad-
The film industry has developed. It is easier and cheaper to produce a film in Bombay than in any other part of the country. Not only men, but women and children have also engaged themselves in this industry directly or indirectly. Similarly, at Bombay, a film technician works in a small establishment so that he can have the contact with directors and producers. There is a complete industrial atmosphere. Carpet industry at Bhadohi and Mirzapur serves a very good example of this kind.

(vi) Industrial atmosphere:

- Concentration of industries in a particular region viz., (i) availability of required type of labour in a particular region, (ii) facilities of repairs and maintenance on account of many repair shops and workshops operating in the areas, (iii) Availability of transport and communication, banking and insurance facilities, (iv) Facilities of managerial consultations and advice are also available.

(vii) Industrial atmosphere:

- This factor refers to the thinking of the people with regard to a particular industry in a particular area. They involve themselves completely in the intricacies and various operations of the machines and implements being used in the industry. There is a complete industrial atmosphere. Carpet industry at Bhadohi and Mirzapur serves a very good example of this kind. Major population of these cities is engaged in carpet processing, carpet washing, carpet weaving and carpet finishing. Not only men, but women and children have also engaged themselves in this industry directly or indirectly. Similarly, at Bombay, film industry has developed. It is easier and cheaper to produce a film in Bombay than in any other part of the country.
(viii) Personal factors: - Sometimes personal likes had dislikes also influence location of a particular industrial unit. Henry Ford started manufacturing motor cars in Detroit because he belonged to that place. Certain merchants belonging to Ahmedabad have made that place a leading textile centre of India. But such personal likes and dislikes cannot influence location of an industrial unit in the long run.

(xl) Tastes and preferences of people: - Before establishing an industrial unit in a particular region, buying habits, tastes, likes and dislikes of people in that area must be taken into consideration. Purchasing power of the people and composition of population in that region should be carefully studied. These studies and surveys render valuable information which is greatly helpful in establishing and industrial unit in particular region.

(x) Political and economic situation: - Political harmony and peace in a particular region encourage the establishment of industrial units. On the other hand, disturbed political and economic set up discourages the growth of industries in the region. On account of Naxalites movement in West Bengal, Industries started moving out of West Bengal. Similarly is the case in certain other states where, on account of political disturbances, manufacturers have started thinking to settle elsewhere and further industrial expansion has been greatly affected.

(xi) Possibilities of future expansion: - The area for location should be such as to provide all possible opportunities for future development and expansion of the industrial unit without involving extra cost. Every industrial undertaking is established with the aim to expand in future.

(xii) Existence of competitive industries: - Limited and healthy competition encourages the growth of industrial units in a particular region. On the other hand, unhealthy competition retards the industrial growth in a region.

(xiii) Availability of research facilities: - The main aim of any industrial undertaking is to have maximum production with minimum cost. Constant research and experimentation is undertaken to develop products and improved methods of production. Large concerns can afford to have a separate research department to meet this end, but in case of small and medium industrial units such facilities may be provided by specialised scientific and research institutions. Existence of such specialised institutions must be kept in mind before starting an industrial unit.

PLANT LOCATION AND SITE SELECTION

The geographical location of the final plant can have strong influence on the success of the industrial venture. Considerable care must be exercised in selecting the plant site, and many different factors must be considered. Primarily the plant must be located where the minimum cost of production and distribution can be obtained but, other factors such as room for expansion and safe living conditions for plant operation as well as the surrounding community are also important. The location of the plant can also have a crucial effect on the profitability of a project.

The choice of the final site should first be based on a complete survey of the advantages and disadvantages of various geographical areas and ultimately, on the advantages and disadvantages of the available real estate. The various principal factors that must be considered while selecting a suitable plant site, are briefly discussed in this section. The factors to be considered are:

1. Raw material availability.
2. Location (with respect to the marketing area.)
3. Availability of suitable land.
4. Transport facilities.
5. Availability of labors.
6. Availability of utilities (Water, Electricity).
7. Environmental impact and effluent disposal.
8. Local community considerations.
9. Climate.
10. Political strategic considerations.
11. Taxations and legal restrictions.

RAW MATERIALS AVAILABILITY: - The source of raw materials is one of the most important factors influencing the selection of a plant site. This is particularly true for the sulphuric acid plant because large volumes of sulphur are consumed in the process which will result in the reduction of the transportation and storage charges. Attention should be given to the purchased price of the raw materials, distance from the source of supply, freight and transportation expenses, availability and reliability of supply, purity of raw materials and storage requirements.

LOCATION: - The location of markets or intermediate distribution centers affects the cost of product distribution and time required for shipping. Proximity to the major markets is an important consideration in the selection of the plant site, because the buyer usually finds advantageous to purchase from near-by sources. In case of sulfuric acid plant, the major consumers are fertilizer industries and hence the plant should be erected in close proximity to those units.

AVAILABILITY OF SUITABLE LAND: - The characteristics of the land at the proposed plant site should be examined carefully. The topography of the tract of land structure must be considered, since either or both may have a pronounced effect on the construction costs. The cost of the land is important, as well as local building costs and living conditions. Future changes may make it desirable or necessary to expand the plant facilities. The land should be ideally flat, well drained and have load-bearing characteristics. A full site evaluation should be made to determine the need for piling or other special foundations.
TRANSPORT - The transport of materials and products to and from the plant will be an overriding consideration in site selection. If practicable, a site should be selected so that it is close to at least two major forms of transport: road, rail, waterway or a seaport. Road transport is being increasingly used, and is suitable for local distribution from a central warehouse. Rail transport will be cheaper for the long-distance transport. If possible, the plant site should have access to all three types of transportation. There is usually need for convenient rail and air transportation facilities between the plant and the main company head quarters, and the effective transportation facilities for the plant personnel are necessary.

AVAILABILITY OF LABORS - Labors will be needed for the construction of the plant and its operation. Skilled construction workers will usually be brought from outside the site, but there should be an adequate pool of unskilled labors available locally; and labors suitable for training to operate the plant. Skilled tradesmen will be needed for plant maintenance. Local trade union customs and restrictive practices will have to be considered when assessing the availability and suitability of the labors for recruitment and training.

AVAILABILITY OF UTILITIES - The word “utilities” is generally used for the ancillary services needed in the operation of any production process. These services will normally be supplied from a central facility and includes Water, Fuel and Electricity which are briefly described as follows:

Water - The water is required for large industrial as well as general purposes, starting with water for cooling, washing, steam generation and as a raw material in the production of sulfuric acid. The plant therefore must be located where a dependable water supply is available namely lakes, rivers, wells, seas. If the water supply shows seasonal fluctuations, it’s desirable to construct a reservoir or to drill several standby wells. The temperature, mineral content, slit and sand content, bacteriological content, and cost for supply and purification treatment must also be considered when choosing a water supply. Demineralized water, from which all the minerals have been removed is used where pure water is needed for the process use, in boiler feed. Natural and forced draft cooling towers are generally used to provide the cooling water required on site.

Electricity - Power and steam requirements are high in most industrial plants and fuel is ordinarily required to supply these utilities. Power, fuel and steam are required for running the various equipments like generators, motors, turbines, plant lightings and general use and thus be considered as one major factor is choice of plant site.

ENVIRONMENTAL IMPACT AND EFFLUENT DISPOSAL - Facilities must be provided for the effective disposal of the effluent without any public nuisance. In choosing a plant site, the permissible tolerance levels for various effluents should be considered and attention should be given to potential requirements for additional waste treatment facilities. As all industrial processes produce waste products, full consideration must be given to the difficulties and coat of their disposal. The disposal of toxic and harmful effluents will be covered by local regulations, and the appropriate authorities must be consulted during the initial site survey to determine the standards that must be met.

LOCAL COMMUNITY CONSIDERATIONS - The proposed plant must fit in with and be acceptable to the local community. Full consideration must be given to the safe location of the plant so that it does not impose a significant additional risk to the community.

CLIMATE - Adverse climatic conditions at site will increase costs. Extremes of low temperatures will require the provision of additional insulation and special heating for equipment and piping. Similarly, excessive humidity and hot temperatures pose serious problems and must be considered for selecting a site for the plant. Stronger structures will be needed at locations subject to high wind loads or earthquakes.

POLITICAL AND STRATEGIC CONSIDERATIONS - Capital grants, tax concessions, and other inducements are often given by governments to direct new investment to preferred locations; such as areas of high unemployment. The availability of such grants can be the overriding consideration in site selection.

TAXATION AND LEGAL RESTRICTIONS: - State and local tax rates on property income, unemployment insurance, and similar items vary from one location to another. Similarly, local regulations on zoning, building codes, nuisance aspects and others facilities can have a major influence on the final choice of the plant site.

PLANT LAY OUT - After the flow process diagrams are completed and before detailed piping, structural and electrical design can begin, the layout of process units in a plant and the equipment within these process unit must be planned. This layout can play an important part in determining construction and manufacturing costs, and thus must be planned carefully with attention being given to future problems that may arise. Thus the economic construction and efficient operation of a process unit will depend on how well the plant and equipment specified on the process flow sheet is laid out. The principal factors that are considered are listed below:

1. Economic considerations: construction and operating costs.
2. Process requirements.
3. Convenience of operation.
4. Convenience of maintenance.
5. Health and Safety considerations.
6. Future plant expansion.
7. Modular construction.
8. Waste disposal requirements
Nonetheless, regardless of the type of business/enterprise, there are host of factors but not confined to the following only that influence the selection of the location of an enterprise:

(i) Availability of Raw Materials
(ii) Proximity to Market
(iii) Infrastructural Facilities
(iv) Government Policy
(v) Availability of Manpower
(vi) Local Laws, Regulations and Taxation
(vii) Ecological and Environmental Factors
(viii) Competition
(ix) Incentives. Land costs. Subsidies for Backward Areas
(x) Climatic Conditions
(xi) Political conditions.
(i) 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.

(ii) Proximity to Market: - If the proof of pudding lies in eating, the proof of production lies in consumption. Production has no value without consumption. Consumption involves market that is, selling goods and products to the consumers. Thus, an industry cannot be thought of without market.

Therefore, while considering the market an entrepreneur has not only to assess the existing segment and the region but also the potential growth, newer regions and the location of competitors. For example, if one’s products are fragile and susceptible to spoilage, then the proximity to market condition assumes added importance in selecting the location of the enterprise.

Similarly if the transportation costs add substantially to one’s product costs, then also a location close to the market becomes the more essential. If the market is widely scattered over a vast territory, then entrepreneur needs to find out a central location that provides the lowest distribution cost. In case of goods for export, availability of processing facilities gains importance in deciding the location of one’s industry. Export Promotion Zones (EPZ) are such examples.

(iii) Infrastructural Facilities: - Of course, the degree of dependency upon infrastructural facilities may vary from industry to industry, yet there is no denying of the fact that availability of infrastructural facilities plays a deciding role in the location selection of an industry. The infrastructural facilities include power, transport and communication, water, banking, etc.

Yes, depending upon the types of industry these could assume disproportionate priorities. Power situation should be studied with reference to its reliability, adequacy, rates (concessional, if any), own requirements, subsidy for standby arrangements etc.

If power contributes substantially to your inputs costs and it is difficult to break even partly using your own standby source, entrepreneur may essentially have to locate his/her enterprise in lower surplus areas such as Maharashtra or Rajasthan.

Similarly adequate water supply at low cost may become a dominant decisional factor in case of selection of industrial location for leather, chemical, rayon, food processing, chemical and alike. Just to give you an idea what gigantic proportions can water as a resource assumes. Note that a tone of synthetic rubber requires 60 thousand gallons, a tone of aluminum takes 3 lakhs gallons, and a tone of rayon consumes 2 lakh gallons of water.

Similarly, location of jute industry on river Hooghly presents an example where transportation media becomes a dominant decisional factor for plant location. Establishing sea food industry next to port of embarkation is yet another example where transportation becomes the deciding criteria for industrial location.

(iv) 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.

(v) Availability of Manpower: - 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.

While one can get cheaper labour in industrially backward areas, higher cost of their training and fall in quality of production may not allow the entrepreneur to employ the cheap manpower and, thus, establish his/her enterprise in such areas.

(vi) 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 classic example of such laws prohibiting putting up polluting industries in prone areas. Therefore, in order to control industrial growth, laws are enforced to decongest some areas while simultaneously encourage certain other areas.

For example, while taxation on a higher rate may discourage some industries from setting up in an area, the same in terms of tax holidays for some years may become the dominant decisional factor for establishing some other industries in other areas.

Taxation is a Centre as well as State Subject. In some highly competitive consumer products, its high quantum may turn out to be the negative factor while its relief may become the final deciding factor for some other industry.

(vii) 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...
Plant Layout: Concept, Objectives, Principles and Types

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.

**(viii) 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.

**(ix) Incentives, Land Costs, Subsidies for Backward Areas:** - With an objective to foster balanced economic development in the country, the Government decentralizes industries to less developed and backward areas in the country. This is because the progress made in islands only cannot sustain for long. The reason is not difficult to seek.

“Poverty anywhere is dangerous for prosperity everywhere.” That many have-nots will not tolerate a few haves is evidently clear from ongoing protests leading to problems like terrorism. Therefore, the Government offers several incentives, concessions, tax holidays, cheaper lands, assured and cheaper power supply, price concessions for departmental (state) purchases, etc. to make the backward areas also conducive for setting up industries.

It is seen that good number of entrepreneurs considers these facilities as decisive factor to establish industries in these locations. However, it has also been observed that these facilities can attract entrepreneurs to establish industries in backward areas as provided other required facilities do also exist there. For example, incentives and concessions cannot duly compensate for lack of infrastructural facilities like communication and transportation facilities. This is precisely one of the major reasons why people in spite of so many incentives and concessions on offer by the Government, are not coming forward to establish industries in some backward areas.

**(x) 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. As such, these can be established in Kashmir experiencing humidity-less climate. On the other hand, industrial units manufacturing precision goods like watches require cold climate and hence, will be established in the locations having cold climate like Kashmir and Himachal Pradesh.

**(xi) Political Conditions:** - Political stability is essential for industrial growth. That political stability fosters industrial activity and political upheaval derails industrial initiatives 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.

Besides, an entrepreneur will have also to look into the availability of community services such as housing, schools and colleges, recreational facilities and municipal services. Lack of these facilities makes people hesitant and disinterested to move to such locations for work.

Very close to political conditions is law and order situation prevalent in an area also influences selection of industrial location. Hardly any entrepreneur will be interested to establish his / her industry in an area trouble-torn by exalts and terrorists like Jharkhand, Nagaland and Jammu & Kashmir.

People will be interested to move to areas having no law and order problem to establish their industries like Maharashtra and Gujarat. It is due to this law and order problem the Nano car manufacturing unit shifted from Nandi gram in West Bengal to Gujarat.

There are many qualitative and quantitative techniques adopted to interpolate the above factors to arrive at a logical decision. The simplest and most commonly adopted is weight rating method illustrated in Figure below.

Besides above factors, the location of certain industries also depends upon the delivery of emergency services like fire, police, hospital, etc.

It seems in the fitness of the context to present the real cases of locational considerations of the entrepreneurs of small-scale industries in India. Based on extensive research study, one researcher has found the following most important considerations that entrepreneurs consider for selecting the location of their enterprises.
Concept of Plant Layout: - Plant layout is a plan for effective utilisation of facilities for the manufacture of products; involving a most efficient and economical arrangement of machines, materials, personnel, storage space and all supporting services, within available floor space.

More defines plant layout as follows: - “Plant layout is a plan of optimum arrangement of facilities including personnel, equipment’s, storage space, material handling equipment and all other supporting services along with the decision of best structure to contain all these facilities.”

Points of comment: - Certain useful observations on the concept of plant layout are as follows:
(i) Plant layout is very complex in nature; because it involves concepts relating to such fields as engineering, architecture, economics and business management.
(ii) Most of managers now realize that after the site for plant location is selected; it is better to develop the layout and build the building around it – rather than to construct the building first and then try to fit the layout into it.

Objectives/Advantages of Plant Layout: - Following are the objectives/advantages of plant layout:
(i) Streamline flow of materials through the plant
(ii) Minimise 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 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 Plant Layout: - Four Main Types of Plant Layout
1. Product or Line Layout
2. Process or Functional Layout.
4. Combination type of Layout.

1. Product or Line Layout: - If all the processing equipment and machines are arranged according to the sequence of operations of the product, the layout is called product type of layout. In this type of layout, only one product of one type of products is produced in an operating area. This product must be standardized and produced in large quantities in order to justify the product layout.

The raw material is supplied at one end of the line and goes from one operation to the next quite rapidly with a minimum work in process, storage and material handling. Fig. 8.3 shows product layout for two types of products A and B.

Fig. 8.3.

Advantages offered by Product Layout:
(i) Lowers total material handling cost.
(ii) There is less work in processes.
(iii) Better utilization of men and machines,
(iv) Less floor area is occupied by material in transit and for temporary storages.
(v) Greater simplicity of production control.
(vi) Total production time is also minimized.
Limitations of Product Layout:
(i) No flexibility which is generally required is obtained in this layout.
(ii) The manufacturing cost increases with a fall in volume of production.
(iii) If one or two lines are running light, there is a considerable machine idleness.
(iv) A single machine break down may shut down the whole production line.
(v) Specialized and strict supervision is essential.

2. Process or Functional Layout:
- The process layout is particularly useful where low volume of production is needed. If the products are not standardized, the process layout is more low desirable, because it has creator process flexibility than other. In this type of layout, the machines and not arranged according to the sequence of operations but are arranged according to the nature or type of the operations. This layout is commonly suitable for non repetitive jobs.

Advantages of Process Layout:
(i) There will be less duplication of machines. Thus, total investment in equipment purchase will be reduced.
(ii) It offers better and more efficient supervision through specialization at various levels.
(iii) There is a greater flexibility in equipment and man power thus load distribution is easily controlled.
(iv) Better utilization of equipment available is possible.
(v) Break down of equipment can be easily handled by transferring work to another machine/work station.
(vi) There will be better control of complicated or precision processes, especially where much inspection is required.

Limitations of Process Layout:
(i) There are long material flow lines and hence the expensive handling is required.
(ii) Total production cycle time is more owing to long distances and waiting at various points.
(iii) Since more work is in queue and waiting for further operation hence bottle necks occur.
(iv) Generally, more floor area is required.
(v) Since work does not flow through definite lines, counting and scheduling is more tedious.
(vi) Specialization creates monotony and there will be difficult for the laid workers to find job in other industries.

3. Fixed Position Layout:
- This type of layout is the least important for today’s manufacturing industries. In this type of layout the major component remain in a fixed location, other materials, parts, tools, machinery, man power and other supporting equipment’s are brought to this location.

Advantages Offered by Fixed Position Layout:
(i) Material movement is reduced
(ii) Capital investment is minimized.
(iii) The task is usually done by gang of operators, hence continuity of operations is ensured
(iv) Production centers are independent of each other. Hence, effective planning and loading can be made. Thus total production cost will be reduced.
(v) It offers greater flexibility and allows change in product design, product mix and production volume.

Limitations of Fixed Position Layout:
(i) Highly skilled man power is required.
(ii) Movement of machines equipment’s to production centre may be time consuming.
(iii) Complicated fixtures may be required for positioning of jobs and tools. This may increase the cost of production.

4. Combination Type of Layout:
- Now a days in pure state any one form of layouts discussed above is rarely found. Therefore, generally the layouts used in industries are the compromise of the above mentioned layouts. Every layout has got certain advantages and limitations. Therefore, industries would to like use any type of layout as such.
Flexibility is a very important factory, so layout should be such which can be molded according to the requirements of industry, without much investment. If the good features of all types of layouts are connected, a compromise solution can be obtained which will be more economical and flexible.

6 Most Important Techniques of Plant Layout - Some of the important techniques of plant layout are:

(a) Process chart: - It is a graph containing details regarding various activities and operations taking place in the organisation from start to the last stage of the work.

(b) Process flow diagram: - This is an aid to process chart. This relates to details regarding position of machines, area covered by each machine, internal transportation and other operations pertaining to production. This model diagram is prepared on the paper.

(c) Templates: - The area covered by a machine is cut to scale from a thick paper to form a template. Not only machines but space covered by furniture, equipment and other components can also form a template. These can be well arranged representing the actual plan of layout to be undertaken.

(d) Models: - Three dimensional wooden models of machinery, equipment and other devices and components can be prepared. By seeing these models even a layman can form an idea about the layout of the plant. But this technique is very costly and only big concern can afford to install such a measure.

(e) Drawings: - Layout drawings can be got prepared by drafts men showing walls, stairways, machines and equipment etc.

(f) Machine data card: - These cards are tied with different machines operating in the plant. These obtain valuable information regarding various salient features or characteristics of machines viz., efficiency, capacity space area covered by the machine and technique of operating the machine etc.

7 Major Factors Affecting Plant Layout | Industrial Management

Some of the major factors which affect plant layout are: (1) Policies of management (2) Plant location (3) Nature of the product (4) Volume of production (5) Availability of floor space (6) Nature of manufacturing process and (7) Repairs and maintenance of equipment and machines.

(1) Policies of management: - It is important to keep in mind various managerial policies and plans before deciding plant layout. Various managerial policies relate to future volume of production and expansion, size of the plant, integration of production processes; facilities to employees, sales and marketing policies and purchasing policies etc. These policies and plans have positive impact in deciding plant layout.

(2) Plant location: - Location of a plant greatly influences the layout of the plant. Topography, shape, climate conditions, and size of the site selected will influence the general arrangement of the layout and the flow of work in and out of the building.

(3) Nature of the product: - Nature of the commodity or article to be produced greatly affects the type of layout to be adopted. In case of process industries, where the production is carried in a sequence, product layout is suitable. For example, soap manufacturing, sugar producing units and breweries apply product type of layout. On the other hand in case of intermittent or assembly industries, process type of layout best suited. For example, in case of industries manufacturing cycles, typewriters, sewing machines and refrigerators etc., process layout method is best suited.

Production of heavy and bulky items need different layout as compared to small and light items. Similarly products with complex and dangerous operations would require isolation instead of integration of processes.

(4) Volume of production: - Plant layout is generally determined by taking into consideration the quantum of production to be produced. There are three systems of production viz.,

(a) Job production: - Under this method peculiar, special or non-standardized products are produced in accordance with the orders received from the customers. As each product is non-standardized varying in size and nature, it requires separate job for production. The machines and equipment’s are adjusted in such a manner so as to suit the requirements of a particular job. Job production involves intermittent process as the work is carried as and when the order is received. Ship building is an appropriate example of this kind. This method of plant layout viz., Stationery Material Layout is suitable for job production.

(b) Mass production: - This method involves a continuous production of standardized products on large scale. Under this method, production remains continuous in anticipation of future demand. Standardization is the basis of mass production. Standardized products are produced under this method by using standardized materials and equipment. There is a continuous or uninterrupted flow of production obtained by arranging the machines in a proper sequence of operations. Product layout is best suited for mass production units.

(c) Batch production: - It is that form of production where identical products are produced in batches on the basis of demand of customers or of expected demand for products. This method is generally similar to job production except the quality of production. Instead of making one single product as in case of job production a batch or group of products is produced at one time. It should be remembered here that one batch of products has no resemblance with the next batch. This method is generally adopted in case of biscuit and confectionary manufacturing, medicines, tinned food and hardware’s like nuts and bolts etc.
(5) Availability of floor space: - Availability of floor space can be other decisive factor in adopting a particular mode of layout. If there is a scarcity of space, product layout may be undertaken. On the other hand more space may lead to the adoption of process layout.

(6) Nature of manufacturing process: - The type of manufacturing process undertaken by a business enterprise will greatly affect the type of layout to be undertaken.

A brief mention of various processes is given as under:
(i) Synthetic process: - Under this process two or more materials are mixed to get a product. For example, in the manufacture of cement, lime stone and clay are mixed.
(ii) Analytical process: - This is just the reverse of synthetic process. Under this method different products are extracted from one material. For example, from crude oil, petroleum, gas, kerosene and coal tar etc. are extracted.
(iii) Conditioning process: - Under this process the original raw material is given the shape of different products and nothing is added to it. Jute is an important example of this kind.
(iv) Extractive process: - This method involves the extraction of a product from the original material by the application of heat or pressure. This involves the process of separation, for example, aluminium is separated from bauxite

(7) Repairs and maintenance of equipment and machines: - The plant layout should be designed in such a manner as to take proper care with regard to repairs and maintenance of different types of machines and equipment being used in the industry. The machines should not be installed so closely that it may create the problems of their maintenance and repairs. It has been rightly said that “Not only should access to parts for regular maintenance such as oiling, be considered in layout but also access to machine parts and components when replacement and repair are fairly common”.

Material Control: Meaning, Objectives, Necessity and Importance

Meaning: - Material control is the main component of the process of material management. Control over materials is of utmost importance for smooth and uninterrupted functioning of an organisation.

A few definition of the term are given as under: - "Material control is a systematic control over purchasing, storing and consumption of materials, so as to maintain a regular and timely supply of materials, at the same time, avoiding overstocking.”

“Material control refers to the management function concerned with acquisition, storage, handling and use of materials so as to minimise wastage and losses, derive maximum economy and establish responsibility for various operations through physical checks, record keeping, accounting and other devices.”

In simple words, material control refers to the various measures adopted to reduce the amount of loss of materials at the time of receiving, storing and issuing the raw materials. Material control in practice is exercised through periodical records and reports relating to purchase, receipt, inspection, storage and issuing direct and indirect materials. Proper control over material can contribute substantially to the efficiency of a business.

Objectives of Materials Control: - The following are the main objectives of materials control:

(a) To enable uninterrupted production: - The main object of material control is to ensure smooth and unrestricted production. Production stoppages and production delays cause substantial loss to a concern.

(b) To ensure requisite quality of materials: - The quality of finished products depends mainly on the quality of raw materials used. If quality of the raw materials is not up to desired standards, the end product will not be of desired quality which affects the sale of the product in the market resulting in loss of profits as well as goodwill of the concern. It is of vital importance to exercise strict control and supervision over the purchases, storage and handling of materials.

(c) To minimise wastage: - The loss of material may occur on account of rust, dust, dirt or moisture, bad and careless handling of materials, poor packing and many other reasons. The causes responsible for such losses must be brought to light and utmost efforts should be made to minimise the wastage of raw materials. This is possible only by introducing an efficient materials control system.

(d) To fix responsibility: - A proper system of materials control also aims at fixing responsibility of operating units and individuals connected with the purchase, storage and handling of materials.

(e) To provide information: - Another objective of materials control is to provide accurate information regarding material cost and inventory whenever needed by management.

Necessity and importance of material control: - In a productive undertaking the need of materials control arises on account of the following reasons:

1. For keeping the stock of raw materials within limits in the stores i.e., to avoid overstocking and understocking of raw materials, materials control is significant.
2. It ensures proper storage of materials. For the proper preservation and safety of materials, adequate storage facilities are to be provided. With the help of proper storing of materials, quantity of materials as and when required can be issued to various jobs.
3. For knowing proper cost of production, control over materials is indispensable.
4. Certain techniques and methods are developed under the system of materials control thereby ensuring optimum utilisation of materials.
5. In order to undertake continuous checking of materials, the necessity of a proper system of materials control cannot be ignored.
6. A well managed system of materials control ensures the availability of different kinds of materials without delay.

As already pointed out while explaining the scope of material management that it includes purchases of materials, storekeeping and inventory control etc.

**Functions and Objectives of Material Handling**

Following are the important functions of material handling:

(i) To select machines/equipment and plant layout to eliminate or minimize material handling requirements. To select most efficient, safe and appropriate material handling equipment, which can fulfill material handling requirement at minimum cost?
(ii) To minimize the material handling cost by way of:
   (a) Minimization of movement of semi-finished items during the production process.
   (b) Planning movement of optimum necessary places in one unit.
   (c) Minimization of distance moved.
   (d) Increasing speed of material handling operation through mechanization.
   (e) By elimination/ minimization of back tracking and duplicate handling.
   (f) By utilization of gravity for material handling.
   (g) To employ mechanical aids instead of manual labour to accelerate material movements.

**Objectives of Material Handling**: - The common hand shovel and the baskets were the only material handling tools, until some years ago, but now due to increasing demand for sophisticated handling equipment, material handling system has been revolutionized all over the world.

The main objective of the efficient materials handling is to decrease the costs. Materials handling equipment does not come under the production machinery but is an auxiliary equipment which can improve the flow of materials which in turn shall reduce the stoppages in production machines and thus increases their production. **In brief followings are the objectives:**

(1) **Cost reduction by:**
   (i) Decreasing Inventory level
   (ii) Utilizing space to better advantage
   (iii) Increasing productivity.

(2) **Waste Reduction by:**
   (i) Eliminating damage to material during handling
   (ii) Being flexible to meet specific handling requirements of different nature.
   (iii) Making proper control over stock during in and out handling.

(3) **Improve Working Conditions by:**
   (i) Increasing productivity per man-hour
   (ii) Increase in machine efficiency through reduction of machine down time
   (iii) Smoothing out workflow
   (iv) Improving production control.

(4) **Improve Working Conditions by:**
   (i) Providing safe working conditions
   (ii) Reducing worker's fatigue
   (iii) Improving personal comfort
   (iv) Upgrading employees/workers to productive work.

(5) **Improve Distribution by:**
   (i) Decreasing damage to products during handling and shipping.
   (ii) Improving location of storage facilities.
   (iii) Increasing the efficiency of shipping and receiving.

**Classification of Material Handling Equipment’s**

(i) **Transportation Equipment or Devices**: - These devices are useful only for horizontal movement or motion. These devices include trucks and other similar vehicles. These vehicle are powered by hand, gasoline or electric power, and have the capability of transporting material and manpower in a horizontal direction.

These also include variable path equipment’s and can be utilized so long as travelling surfaces are available and the route is obstruction free. Thus these vehicles occupy the space intermittently and as soon as the work is over the space is free for some other operation.

The simplest among these are wheel barrows and trucks. But these devices need large amount of manpower for relatively small load. These involve easy portability, greater flexibility and low cost. When movement from one work station to other is required. Tractors and trailers are the other popular modes of horizontal transportation.

Great flexibility is provided by these methods. Trailers can be left loaded and can be picked up later by other different tractors. This is considered as one of the most convenient and important methods of material handling inside the plant.

Skids can be used with lift trucks. These are the improvements over wheel barrows and hand trucks. For horizontal transportation of commodities like natural gas, oil and water etc. pipelines and pumps can also be used.

(ii) **Lifting and Lowering Equipment or Devices**: - These are meant for vertical transportation of material. Block and Tackle arrangement of lifting loads through vertical distance is one of the oldest and simplest devices. It is still used today by moving men
in hoisting machinery into position. Which is another device used to lift loads vertically by winding rope or cable on a drum. Cranes and Hoist are the common means of vertical movement.

The equipment is able to move material vertically and laterally in a space of limited length width as well as height. If mounted on carriers like trucks and tractors etc. they can also move from one location to the other. Hoists are power driven devices, often operated between fixed guiderails.

Two types of cranes i.e. pillar and overhead cranes are generally used for light duty jobs and in various workshops (such as boundaries and power houses and chemical plants etc.) respectively. Hydraulic and electric operated elevators also fall under this category of material handling devices.

(iii) Combination of Transportation and Lifting plus Lowering: - Simplest amount these devices are conveyors which move materials or people in either vertical or horizontal direction between two fixed points. In conveyors, the transportation is affected by friction between materials being transported by the belt. These conveyors have the advantage that they largely save labour cost but have disadvantage that take up considerable space and are relatively fixed and in majority of cases the investment is high. Other devices under this category of combination devices are Chute, Lift Truck, Crane Truck, Auto Truck etc.

**Material Handling in Retail Store (4 Principles)**

There is no best criterion to perform material handling activities successfully. But if material handling is planned and well integrated with production activities, it results in maximum overall operating efficiency.

1. **Planning Principle:** - Efficient material handling is the result of efficient planning. Planning not only involves the strategic objectives of the organization but also the existing methods and problems, physical and economic constraints, and future requirements and goals. Therefore, retailers should plan a detailed layout which includes retail’s basic requirements, various alternatives, and the emergency plans for all possible activities related to material handling and storage.

It also includes following supportive principles such as:

(i) Preparation and selection of best operational sequence and layout with regard to shelves, racks, and cabins which includes the store’s possible operations and has potential of arranging material in an effective way. (Layout Principle)

(ii) To effectively utilized the available space in the best possible manner. (Space Utilization Principle)

(iii) To minimize unpleasant effects on the environment while selecting any material handling devise or equipment. (Ecology Principle)

(iv) Delegate planning responsibility of material handling to a separate department/ person. (Delegation of Responsibility Principle)

2. **Operating Principles:** - A material handling is the system developed and accepted for controlling the investments in inventory. The investment in material handling is normally soaring in most of the retail stores. Material handling is a broad concept which includes merchandise buying, retail positioning, selling and distribution. With proper planning and control, the material handling complications can be drastically solved.

This requires a system approach and it should include the followings:

(i) Arrange and move the materials in unit loads rather than on individual basis. (Unit load handling principle)

(ii) Shifting materials from one place to another within the store while considering limitations related to material safety, floor damage and loss. (Gravity principle)

(iii) Re-handling and backtracking movements should be avoided. Therefore, need is to prepare an operational plan and positioning blueprint for the entire feasible solutions. It will help in selection of alternate arrangements that best integrate resources and capabilities. (Flow of Materials principles)

3. **Equipment Principle:** - Material handling equipment is used for the movement and storage of material within a store. There are several types of equipment available, whose suitability depends on several factors like nature of job, load capacity, ease of operation, speed of operation, space available etc.

**Equipment principle can basically be described as:**

(i) Select appropriate material handling equipment to ensure safe working conditions. (Safety principle)

(ii) Opting those techniques and equipment which are able to perform a number of operations and tasks at a time without disturbing other arrangements. (Flexibility Principle)

(iii) To standardize material handling techniques and equipment in the store whenever and wherever deemed fit. (Standardization Principle)

(iv) To mechanize the material handling methods whenever it is feasible and to increase store’s economy and efficiency. (Mechanization Principle)

(v) Be ready with a preventive maintenance plan and pending repairs for all material handling equipment’s. Purpose is that prevention is always better then cure. (Maintenance Principle)
(vi) Make handling simple that should eliminate wastes, accidents, errors and omissions by separating or combining some homogeneous activities. (Simplification Principle)

(vii) Organize a long term and cost effective for replacing obsolete and abandoned techniques and methods. This will result in increase efficiency and increased productivity. (Obsolescence Principle)

4. Costing Principle: - This principle implies that a store should always compare the cost justification of selected/short listed equipment’s by its economic life and effectiveness when measured in terms of rupee per unit handled.

(i) Selection of equipment for total lowest cost. (Economic Principle)

(ii) Amortize the equipment/machinery within a reasonable period of time. (Amortization Principle)

(iii) Calculate your handling cost in advance (Handling Cost Appraisal)

Materials Handling, Useful notes on Materials Handling

Material Handling refers to the movements of materials and handling there in store. Handling of materials is an integral part of the production process. Handling can be manual or mechanical. The movement can be horizontal, vertical or the combination of these two.

Usually a large part of indirect labour is engaged in material handling. Also, the average material handling cost in nearly 25-30% of the total production cost. It has become clear that total or net cost of the production process can be lowered by making a saving in material handling cost.

Following are some of the important principles of economical handling:

(i) Using the principles of containerization, unit load or palletization, materials to be moved should be aggregated into a larger unit size and the unit size should also be same for all the materials. The materials and typically carried on a pallet for convenience in handling.

(ii) Proper positioning of purchased material for the purpose of storage.

(iii) Transportation during process from one machine to other.

(iv) Unloading the imported materials from trucks or trolley.

(v) To make the economical use of floor space.

(vi) To maintain suitable flexibility of arrangements and layouts.

Material handling puts emphasis on the need of the installing efficient and economical methods for material handling. A material handling equipment is not considered production machinery. A material handling system should be able to move and store the material effectively with minimum effort, maximum safety and in the shortest time.

The selection of material handling equipment’s depends upon the followings.

(i) Nature of product and its portability.

(ii) Value of production.

(iii) Shape and size of products.

(iv) Methods of production.

(v) Sequence of operations.

(vi) The production rate of the industrial unit.

(vii) Space availability and type of layout used.

(viii) Distance to be covered by the material.

(ix) Power availability.

(x) Initial cost of installation, operation and maintenance costs.

(xi) Depreciation Costs.

(xii) Availability and wages of unskilled labour.

(xiii) Design of material handling equipment its capacity.

It is clear from above that the selection of material handling equipment’s depend on so many factors and it is difficult to make any recommendation without taking into consideration the practical aspects of the problem. So at this stage, it is relevant to define the basic requirements of material handling equipment’s.

The various requisites of material handling equipment’s are as follows.

(i) It must be able to perform the basic function of material handling like storage and transportation.
Production Planning and Control

Concept of Production Planning and Control Defined: - Production planning and control could be defined as under:

Production planning and control is a device that regulates the movements of materials, performance of machines and operation of labour in the best technical and economical manner; so as to obtain right quantity of production of required quality – at a time which is promised for delivery of goods to customers.

Spriegel and Lansburgh define production control as follows: - “Production control is the process of planning production in advance of operations, establishing the exact route of each individual item, part or assembly; setting starting and finishing dates for each important item, assembly and the finished products, and releasing the necessary orders as well as initiating the required follow-up to effectuate the smooth functioning of the enterprise.”

Steps in Production Planning and Control: - Production control involves the following steps:

(i) Planning
(ii) Routing
(iii) Scheduling
(iv) Dispatching
(v) Follow-up or checking the progress
(vi) Inspection

Out of these six steps involved in production control, the first three steps relate to planning; the fourth relates to execution of plan and the last two refer to the control aspect of planning.

The above idea is depicted by means of the following diagram:

Broadly, at the stage of planning the following issues are considered on which bases charts and written plans are prepared:

(a) What work should be done?
(b) How shall the work be done?
(c) Where shall the work be done?
(d) When shall the work be done?

(2) Routing: - Routing involves the determination of the path that work shall follow and the order in which various operations will be carried out. The objective of routing is to find out the best and the cheapest sequence of operations. While preparing the route card, it must be kept in mind that machines in the plant are operated at their full capacity; and manpower and other facilities are best utilized.

(3) Scheduling: - Scheduling is the determination of the time that should be required to perform each operation and also the time necessary to perform the entire series, as routed, making allowance for factors concerned. It involves the preparation of a time-table, indicating the total time needed for the manufacture of a product as also the time expected to be spent at each machine and process.

In preparing schedules, the persons concerned will have to take into consideration the various types of orders on hand and the dates by which their completion has been promised. Some orders may be such as will require over-time work; because completion is not possible according to the delivery dates set for them, in the regular course of production.

(4) Dispatching: - Dispatching literally means sending something towards a particular destination. Here, it means taking all such steps, as are necessary to implement the programme of production chalked out as per routing and scheduling steps.

In particular, dispatching refers to:

1. Procurement of necessary tools, jigs and fixtures etc.; before they are actually required by the workmen.
2. Giving workers the necessary work orders, instructions, drawings etc. for initiating the work.

(5) Follow-Up (or Checking the Progress):

Follow-up is the control aspect of production planning and control. It involves taking steps to check up whether work proceeds according to plans and how far there are variances from standards; and also taking necessary corrective steps to set things in order.

(6) Inspection: - Inspection is the quality control aspect of production planning and control. It ensures that goods produced are of the right quality. The inspectors may inspect materials, semi-finished and finished products either at the work bench or in special laboratories or testing rooms.

To ensure maintenance of high standards of quality, a programme of SQC (Statistical Quality Control) may be fused with a system of production planning and control.
Objectives/Advantages of Production Planning and Control: Following are the objectives (advantages) of production planning and control:

(i) Continuous Production: - Production control ensures continuous production with least possible interruptions; as it eliminates all sources of interruptions in production like-non-availability of materials, tools, poor maintenance of machines etc.

(ii) Cost Control and Profit Maximization: - Production control helps in cost control (and thus in profit maximization) by optimizing use of productive resources and eliminating waste and spoilage.

(iii) Customer Satisfaction: - Production control ensures better service to customers due to timely delivery of goods and qualitative products. It, thus, leads to customer satisfaction and better business relations with customers.

(iv) Planning of Resource Requirements and Inventory Control: - Production control seeks to assess in advance requirements of manpower, machinery and other facilities to meet the desired targets of production. It also helps to maintain regular supply of raw-materials, work-in-progress and finished goods with minimum investment in inventories.

(v) Minimum Material Handling and Storage Costs: - Production control helps in minimization of material handling and storage costs.

(vi) Economy in Production Time: - Production control reduces the loss of time by the workers waiting for materials, and causes improvement in plant morale.

(vii) Equipment Utilization: - Production control makes for the most effective use of equipment.

Elements of Production Planning and Control in an Organization

Some of the important elements involved in the process of production planning and control in organization are: (a) Planning; (b) Routing; (c) Scheduling; (d) Despatching; (e) Checking the progress or follow-up and (f) Inspection.

(a) Planning: - This is the first and the most important element of production planning and control. Planning refers to deciding in advance what is to be done in future. A separate planning department is established in the organisation which is responsible for the preparation of policies and plans with regard to production to be undertaken in due course.

While explaining the concept of scientific management, F.W. Taylor emphasised the need of separating planning function from the function of actual operation in an organisation. For successful implementation of production control, production planning is of utmost importance. The planning department prepares various charts, manuals production budgets etc., on the basis of information received from management.

These plans and charts or production budgets are given practical shape by carrying various elements under production control. If production planning is defective, production control is bound to be adversely affected. For achieving the production targets, production planning provides sound basis for production control.

(b) Routing: - Production routing is a process concerned with determining exact route or path, a product has to follow right from raw material till its transformation into finished product. A few definitions of routing can be cited here:—

“Routing may be defined as the selection of paths or routes over which each piece is to travel in being transformed from raw material into finished product”. —Kimball and Kimball Jr.

“Production routing involves the planning of the exact sequence of work stations to be used in processing a part of product. Once a layout has been established the routing of an item is the determination of the path that item should follow as it is manufactured”. —James C. Lundy

“Routing is the specification of the flow or sequence of operations and processes to be followed in producing a particular manufacturing lot”. —Alford and Beatty

“Routing includes the planning of where and by whom work shall be done, the determination of the path that work shall follow and the necessary sequence of operations; it forms a groundwork for most of the scheduling and dispatching functions of planning department.” —Spriegel and Lansburgh

The above mentioned definitions clearly lay down that routing is concerned with the selection of the most economical and appropriate path for the product in the process of final completion from raw material to finished product.

Objects of routing: - The main objective of routing is to lay down the best and the most economical sequence of operations to be undertaken in the process of production. Another objective of routing is to determine proper tools and equipments and the required number of workers required for doing or carrying total production processes in an organisation.

Routing becomes automatic and continuous in case of continuous manufacturing units where standardized products are produced by undertaking standardized production operations.

On the other hand, in case of job order units or intermittent- process industries such as ship building, every product requires different designs and varying sequences of operations.

Procedure followed in routing: - In case where a new product is going to be produced, different steps are involved in a total routing procedure. These steps are:
A number of factors viz. human considerations, plant layout, type of production undertaken and processes employed and type of equipment being undertaken must be kept in mind before selecting a proper route for production.

**(c) Scheduling:** Scheduling in simple words means fixation of time and date when each operation is to be commenced and completed. It is an important part of production control as all future process of production is based on it. Scheduling lays down ground work for all subsequent steps in production process.

**A few definitions of scheduling are given as under:**

“The determination of the time that should be required to perform each operation and also the time necessary to perform the entire series as routed, making allowance for all factors concerned.” —Kimball and Kimball Jr.

“Scheduling involves establishing the amount of work to be done and the time when each element of the work will start, or the order of work. This includes allocating the quality and rate of output of the plant or department and also the date or order of starting each unit of work at each station along the route prescribed.” —Spiegel and Lansburgh

“Work Scheduling consists of the assignment of starting and completion times for the various operations to be performed.” —James C. Lundy

“The detailed planning of material, labour and machine time, so that materials and parts will be at the right place and at the right time so that a job can be completed within the time planned and in accordance with the requirements.” —John D. Mclellan

From the above mentioned definitions, it is clear that scheduling is concerned with allocating time for each operation of production and finally total time in the completion of production.

**Types of scheduling:** Scheduling is of three types viz:

(a) Master scheduling;
(b) Manufacturing or operation scheduling;
(c) Retail operation scheduling.

(a) **Master scheduling:** It relates to a specified period; say a month, a week or a fortnight. It contains production requirements of a single product or different products during the specified period of time. It is easier to prepare master schedule for a single product, but difficulty arises where the number of products are more. It is also known as over-all schedule. The preparation of master schedule varies from industry to industry according to type of production undertaken by them. Master schedule usually contains information pertaining to direct material requirements, estimated requirements in man-hours per product at various work centres and estimated overhead expenses etc.

(b) **Manufacturing or operation scheduling:** Manufacturing schedules are prepared in case of process or continuous type of industries. In case of mass production industries, where uniform products of same size, colour and design etc., are produced, manufacturing schedules can be easily prepared.
But in case where a product is produced in different sizes, quantity, colour and design, it is bit difficult to prepare manufacturing schedule. The important information contained in this schedule relates to name, number of the product, quantity to be produced each day, week or any other stipulated time.

(c) Detail operation scheduling: - This type of schedule relates to allocation of time for each production operation within each machine and manufacturing process in the organisation.

Both routing and scheduling are important elements in the process of product control. They are interdependent on each other. Proper route cannot be assigned to a product without proper schedule, at the same time schedules cannot be prepared properly without the knowledge of exact route of production.

(d) Dispatching: - Dispatching relates to the process of initiating production in accordance with pre-conceived production plan. It is concerned with giving practical shape to the production plan. This includes issuing necessary orders and instructions and other important guidelines and information pertaining to work.

Some important definitions of dispatching are enumerated here: “A good definition of dispatching is the routine of setting productive activities in motion through the release of orders and instructions, in accordance with previously planned times and sequences, embodied in route sheet and schedule charts.” — Afford and Beatty

“Despatches put production in effect by releasing and guiding manufacturing orders in the sequence previously determined by route sheets and schedules.” — John A. Shu bin

“The despatching function involves the actual granting of permission to proceed according to plans already-laid down. This is similar in case of the traveller, to his employer finally approving his vacation leave.” — James L. Lundy

By reading the above mentioned definitions, it can be laid that despatching is concerned with putting the production plan into action. It is concerned with the attainment of production orders by supplying materials, arranging machines and required workers, for different production orders.

Procedure or steps followed in dispatching: Following steps are undertaken in discharging the function of dispatching’:

1. Issuing materials from stores to different production processes.
2. Assignment of work to various machines and work places.
3. Procuring necessary tools, equipment and fixtures to be issued to workmen as and when needed.
4. Issuing necessary work orders, giving instructions and other information with regard to work to the workers.
5. To record and maintain the time taken from starting to completion of each job and also recording the total production time.
6. After the completion of work, all tools, implements, drawings and charts etc., to be returned to respective issuing departments.
7. Recording idle time of machines and workers.
a. To have liaison with routing and scheduling departments for effective performance.

Types of Despatching: - Despatching is of two types viz.,
(a) Centralised and
(b) Decentralised.

(a) Centralised despatching: - Under this system there is a centralised despatching section from where orders and instructions are directly issued to workmen and machines. This system of despatching ensures greater control and flexibility in its operation.

(b) Decentralised despatching: - This is just the reverse of the first method. Under this system, work orders are sent to the foreman of each department. It is the duty of the departmental head to adjust the process and sequence of work in accordance with the requirements of the department.

This system minimises production delays, duplication of postings and other drawbacks involved in centralised dispatching. The most important drawback of this system is that there are difficulties in achieving co-ordination in different departments and more clerical work is involved.

Various cards and forms used in carrying the functions of dispatching are:

(i) Material requisitions: - These are sent by workers working on different jobs for getting supply of materials from stores.

(ii) Job Cards: - These cards are issued to each individual worker who enters his performance and time taken on a job.

(iii) Move tickets: - These tickets authorize the movement of materials in between various production operations.

(iv) Tool and gauge tickets: - These tickets authorize the issue of various tools and equipment from stores.

(v) Inspection Cards: - These cards show the quantity of work passed and rejected at each inspection point.

(e) Checking the progress or Follow-up: - Follow-up or expediting function relates to evaluation and appraisal of work performed. If goods are to be produced as planned, proper follow up or expediting must be undertaken. A properly planned follow up procedure is helpful in finding errors and defects in the work and it also suggests remedial measures.

In the words of Bethel, Atwater etc.,

“Follow up or expediting is that branch of production control procedure which regulates the progress of materials and part through the production process” The function of follow-up is carried by ‘follow-up men’. These men act as intermediaries be-
tween various departments bringing about co-ordination between them. ‘Follow-up men’ are also referred as expeditors, ‘go-betweens’, ‘stock chasers’ and ‘progress-men’ etc.

Follow-up function can be applied in accordance with product or process layout. Follow up under product layout is easier to undertake as the follow-up men are responsible for the progress of a single product from inspection to packing. On the other hand, follow-up under process layout is difficult to carry on account of scattered departments. Different follow-up men are appointed in different department’s viz., lathe department, welding department and finishing department etc.

In brief the element of follow up is concerned with the following three steps viz.,
(a) To review the present situation with regard to materials, work-in-progress and finished products.
(b) Expediting the performance of those departments which lag behind.
(c) Removing obstacles in the way of production for smooth and uninterrupted flow of production.

(f) Inspection: - This is the last but not the least component in the process of production planning and control. The function of inspection is primarily carried to ensure whether desired quality of products has been achieved or not. Inspection is carried out at different levels of production activity.

In the words of Kimball and Kimball Jr. “Inspection is the art of comparing materials, product or performance with established standards.” Inspection of product at every stage viz., raw material, work in progress or semi finished goods and finished goods may be undertaken. Plant, machinery, equipment and tools used in production may also be inspected. For conducting inspection, specialised laboratories may be set up. The most important benefit derived from inspection is that it ensures predetermined quality and minimises wastage and rejected products.

Production Planning and Control: (10 Functions)

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 (standardisation) 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 authorise timely start of operations.
Production planning and control are essential for customer delight and overall success of an organization. Production control cannot be same across all the organizations. Production control is dependent upon the following factors:

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.

**Production Planning and Control**

**Introduction** – For efficient, effective and economical operation in a manufacturing unit of an organization, it is essential to integrate the production planning and control system. Production planning and subsequent production control follow adoption of product design and finalization of a production process.

Production planning and control address a fundamental problem of low productivity, inventory management and resource utilization.

Production planning is required for scheduling, dispatch, inspection, quality management, inventory management, supply management and equipment management. Production control ensures that production team can achieve required production target, optimum utilization of resources, quality management and cost savings.

**Planning and control are an essential ingredient for success of an operation unit. The benefits of production planning and control are as follows:**

- It ensures that optimum utilization of production capacity is achieved, by proper scheduling of the machine items which reduces the idle time as well as over use.
- It ensures that inventory levels are maintained at optimum levels at all time, i.e. there is no over–stocking or under–stocking.
- It also ensures that production time is kept at optimum level and thereby increasing the turnover time.
- Since it overlooks all aspects of production, quality of final product is always maintained.

**Production Planning** – Production planning is one part of production planning and control dealing with basic concepts of what to produce, when to produce, how much to produce, etc. It involves taking a long-term view at overall production planning. Therefore, objectives of production planning are as follows.

- To ensure right quantity and quality of raw material, equipment, etc. are available during times of production.
- To ensure capacity utilization is in tune with forecast demand at all the time.
- Organization can deliver a product in a timely and regular manner.
- Supplier are informed will in advance for the requirement of raw materials.
- It reduces the investment in inventory.
- It reduces overall production cost by driving in efficiency.

Production planning takes care of two basic strategies’ product planning and process planning. Production planning is done at three different time dependent levels i.e. long-range planning dealing with facility planning, capital investment, location planning, etc.; medium-range planning deals with demand forecast and capacity planning and lastly short term planning dealing with day to day operations.

**Production Control** – Production control looks to utilize different type of control techniques to achieve optimum performance out of the production system as to achieve overall production planning targets. Therefore, objectives of production control are as follows.

- Regulate inventory management
- Optimum utilization of resources and production process
- Organize the production schedules
- Control wastage of resources
- Ensure smooth flow of all production processes
- It maintains standard of quality through the production life cycle
- Ensure production cost savings thereby improving the bottom line
- Nature of production (job oriented, service oriented, etc.)
- Size of operation

Production planning and control are essential for customer delight and overall success of an organization.
Aggregate capacity planning

What is Aggregate Planning? - Importance and its Strategies

Introduction - An organization can finalize its business plans on the recommendation of demand forecast. Once business plans are ready, an organization can do backward working from the final sales unit to raw materials required. Thus annual and quarterly plans are broken down into labor, raw material, working capital, etc. requirements over a medium-range period (6 months to 18 months). This process of working out production requirements for a medium range is called aggregate planning.

Factors Affecting Aggregate Planning

Aggregate planning is an operational activity critical to the organization as it looks to balance long-term strategic planning with short term production success. Following factors are critical before an aggregate planning process can actually start;

- A complete information is required about available production facility and raw materials.
- A solid demand forecast covering the medium-range period
- Financial planning surrounding the production cost which includes raw material, labor, inventory planning, etc.
- Organization policy around labor management, quality management, etc.

For aggregate planning to be a success, following inputs are required;

- An aggregate demand forecast for the relevant period
- Evaluation of all the available means to manage capacity planning like sub-contracting, outsourcing, etc.
- Existing operational status of workforce (number, skill set, etc.), inventory level and production efficiency

Aggregate planning will ensure that organization can plan for workforce level, inventory level and production rate in line with its strategic goal and objective.

Aggregate planning as an Operational Tool - Aggregate planning helps achieve balance between operation goal, financial goal and overall strategic objective of the organization. It serves as a platform to manage capacity and demand planning.

In a scenario where demand is not matching the capacity, an organization can try to balance both by various alternatives such as

- Laying off/hiring excess/inadequate workforce until demand decrease/increase.
- Including overtime as part of scheduling there by creating additional capacity.
- Hiring a temporary workforce for a fix period or outsourcing activity to a sub-contractor.

Importance of Aggregate Planning

Aggregate planning plays an important part in achieving long-term objectives of the organization. Aggregate planning helps in:

- Achieving financial goals by reducing overall variable cost and improving the bottom line
- Maximum utilization of the available production facility
- Provide customer delight by matching demand and reducing wait time for customers
- Reduce investment in inventory stocking
- Able to meet scheduling goals there by creating a happy and satisfied work force

Aggregate Planning Strategies - There are three types of aggregate planning strategies available for organization to choose from. They are as follows.

1. Level Strategy - As the name suggests, level strategy looks to maintain a steady production rate and workforce level. In this strategy, organization requires a robust forecast demand as to increase or decrease production in anticipation of lower or higher customer demand. Advantage of level strategy is steady workforce. Disadvantage of level strategy is high inventory and increase back logs.

2. Chase Strategy - As the name suggests, chase strategy looks to dynamically match demand with production. Advantage of chase strategy is lower inventory levels and back logs. Disadvantage is lower productivity, quality and depressed work force.

3. Hybrid Strategy - As the name suggests, hybrid strategy looks to balance between level strategy and chase strategy.

Capacity Planning - The production system design planning considers input requirements, conversion process and output. After considering the forecast and long-term planning organization should undertake capacity planning.

Capacity is defined as the ability to achieve, store or produce. For an organization, capacity would be the ability of a given system to produce output within the specific time period. In operations, management capacity is referred as an amount of the input resources available to produce relative output over period of time. In general, terms capacity is referred as maximum production capacity, which can be attained within a normal working schedule.

Capacity planning is essential to be determining optimum utilization of resource and plays an important role decision-making process, for example, extension of existing operations, modification to product lines, starting new products, etc.

Strategic Capacity Planning - A technique used to identify and measure overall capacity of production is referred to as strategic capacity planning. Strategic capacity planning is utilized for capital intensive resource like plant, machinery, labor, etc.
Strategic capacity planning is essential as it helps the organization in meeting the future requirements of the organization. Planning ensures that operating cost are maintained at a minimum possible level without affecting the quality. It ensures the organization remain competitive and can achieve the long-term growth plan.

**Capacity Planning Classification** - Capacity planning based on the timeline is classified into three main categories long range, medium range and short range.

**Long Term Capacity**: Long range capacity of an organization is dependent on various other capacities like design capacity, production capacity, sustainable capacity and effective capacity. Design capacity is the maximum output possible as indicated by equipment manufacturer under ideal working condition. Production capacity is the maximum output possible from equipment under normal working condition or day. Sustainable capacity is the maximum production level achievable in realistic work condition and considering normal machine breakdown, maintenance, etc. Effective capacity is the optimum production level under pre-defined job and work-schedules, normal machine breakdown, maintenance, etc.

**Medium Term Capacity**: The strategic capacity planning undertaken by organization for 2 to 3 years of a time frame is referred to as medium term capacity planning.

**Short Term Capacity**: The strategic planning undertaken by organization for a daily weekly or quarterly time frame is referred to as short term capacity planning.

**Goal of Capacity Planning** - The ultimate goal of capacity planning is to meet the current and future level of the requirement at a minimal wastage. The three types of capacity planning based on goal are lead capacity planning, lag strategy planning and match strategy planning.

**Factors Affecting Capacity Planning** - Effective capacity planning is dependent upon factors like production facility (layout, design, and location), product line or matrix, production technology, human capital (job design, compensation), operational structure (scheduling, quality assurance) and external structure (policy, safety regulations)

**Forecasting vs Capacity Planning** - There would be a scenario where capacity planning done on a basis of forecasting may not exactly match. For example, there could be a scenario where demand is more than production capacity; in this situation, a company needs to fulfil its requirement by buying from outside. If demand is equal to production capacity; company is in a position to use its production capacity to the fullest. If the demand is less than the production capacity, company can choose to reduce the production or share it output with other manufacturers.

**Job, Batch or Mass Production**

Identifying a production system that suits products and services is an essential decision that all manufacturers must make early on.

Each of the three major production systems, **job production**, **batch production** and **flow production**, carry their own pros and cons, and their compatibility with a company/product varies depending on circumstance.

**What is your budget for labour? How adaptable must your production be to generate the greatest profitability?** These are factors to consider when determining which system you qualify for. In this article, we outline what each of these production systems entail, and how you can identify which system is best suited for your company and product offers.

**Job Production** - Job production is production on a product-by-product basis; time is spent on each individual product, carefully creating unique and high quality products from project start to finish. Creating unique standalone products in this way requires far greater labour than the other two production systems featured in this article, but the products made this way are generally far more valuable as well.

Overall production, from first steps to sale, can take a long time, but the rewards are great for products built this way with high marketplace demand. In these markets, however, it’s not typically feasible, economically, to scale up production in accordance with demand, as this balance between labour, cost and returns would be unsustainable.

Job production is common in the following industries:

- Handmade furniture goods
- Various craft industries
- Custom clothing

**Batch Production** - Batch production is the manufacturing of objects along stages, typically configured with various workstations and manufacturing steps. At each of these stages, product batches are created and modified per-batch with variants such as color, material or size.

Batch production is ideal for companies that require greater yield than what one-off, job production provides, but lack the capital to pursue mass production. Batch production is also useful for younger companies introducing new product types to market: if a product performs poorly, they can stop manufacturing that batch; if a product performs well, production can continue as planned.
Properly purchased, stored and used.

Importance of Materials Management

Every organization uses a number of materials. It is necessary that these materials are properly purchased, stored and used. The need for materials management was first felt in manufacturing undertakings. The servicing organizations also started feeling the need for this control. And now even non-trading organizations like hospitals, universities etc. have realized the importance of materials management. Every organization uses a number of materials. 

Mass/Flow Production - Mass production, unlike job or batch systems, is manufacturing on the large-scale; standardized goods, assembly lines and automation are the norm for mass production. Mass production consumes a significant amount of energy and capital investment, but also churns out vastly higher, more repeatable product yields. Per unit cost is a fraction of products created with batch or job production, but mass production as a whole requires larger investment in technologies and manufacturing automation systems. In mass production, workers are typically only required for quality assurance tasks, and automation is heavily featured throughout the product lifecycle.

Advantages & Disadvantages of Jobbing Processes

Variety - One of the key advantages to jobbing processes in manufacturing is that they lead to product variety. Because resources are allocated to a variety of projects at the same time, the end result will be more than one product, but not necessarily a high volume of those products. In many cases, jobbing processes are used to create a product that is completed en masse, but only one time. This works best for individual orders. For instance, if the circus comes to town and the sponsors of the circus want a local printer to print off the tickets, it is a one-time job for that printer. The printer still produces a variety of other products as part of his regular job duties.

Flexibility - Another advantage to having a business that uses jobbing processes for manufacturing is that it will provide you with a great deal of flexibility as to what you can produce. By not limiting yourself to one particular type of product and utilizing your general manufacturing know-how, you can increase your client base by remaining flexible in the types of products you produce. This can translate into more and more profitable opportunities for your business.

Quantity - One of the major disadvantages to jobbing processes is that they do not necessarily allow for the mass production on a grand scale. Projects created through jobbing processes are not normally reproduced once the project has been completed. Exceptions exist, but jobbing processes are not really intended for long-term large-scale production. This also means that the workers you utilize must have a wide variety of skills and a great deal of flexibility so that they can move from one type of job to the next.

Cost - Because jobbing processes require specialized skills but are not necessarily suitable for long-term mass manufacturing, they can be more costly to produce a product. This higher cost is, however, absorbed by the person or company purchasing the product produced. The inability to standardize labor costs or the production process makes it difficult to keep prices down. As a result, it may be difficult to compete with some manufacturers who find ways to lower cost or standardize production.
Any avoidable amount spent on materials or any loss due to wastage of materials increases the cost of production. The object of materials management is to attack materials cost on all fronts and to optimize the overall end results. Materials management connotes controlling the kind, amount, location and turning of the various commodities used in and produced by the industrial enterprises. It is the control of materials in such a manner that it ensures maximum return on working capital.

**L.J. De Rose:** - “Material management is the planning, directing, controlling and co-ordination of all those activities concerned with material and inventory requirements, from the point of their inception to their introduction into manufacturing process.”

As per De Rose all those functions which start with the procurement of materials and end with completion of manufacturing are a part of material management.

**N.K. Nair:** - “Material management is the integrated functioning of the various sections of an organization dealing with the supply of materials and allied activities in order to achieve maximum co-ordination.”

N.K. Nair has emphasized the co-ordination of all those activities which are related to the efficient use of materials.

**Importance of Material Management:** - Material management is a service function. It is as important as manufacturing, engineering and finance. The supply of proper quality of materials is essential for manufacturing standard products. The avoidance of material wastage helps in controlling cost of production. Material management is essential for every type of concern.

The importance of material management may be summarized as follows:

1. The material cost content of total cost is kept at a reasonable level. Scientific purchasing helps in acquiring materials at reasonable prices. Proper storing of materials also helps in reducing their wastages. These factors help in controlling cost content of products.
2. The cost of indirect materials is kept under check. Sometimes cost of indirect materials also increases total cost of production because there is no proper control over such materials.
3. The equipment is properly utilized because there are no break downs due to late supply of materials.
4. The loss of direct labour is avoided.
5. The wastages of materials at the stage of storage as well as their movement is kept under control.
6. The supply of materials is prompt and late delivery instances are only few.
7. The investments on materials are kept under control as under and over stocking is avoided.
8. Congestion in the stores and at different stages of manufacturing is avoided.

**Functions of Material Management:** - Material management covers all aspects of material costs, supply and utilization. The functional areas involved in material management usually include purchasing, production control, shipping, receiving and stores.

The following functions are assigned for material management:

1. **Production and Material Control:** - Production manager prepares schedules of production to be carried in future. The requirements of parts and materials are determined as per production schedules. Production schedules are prepared on the basis of orders received or anticipated demand for goods. It is ensured that every type or part of material is made available so that production is carried on smoothly.
2. **Purchasing:** - Purchasing department is authorized to make buying arrangements on the basis of requisitions issued by other departments. This department keeps contracts with suppliers and collects quotations etc. at regular intervals. The effort by this department is to purchase proper quality goods at reasonable prices. Purchasing is a managerial activity that goes beyond the simple act of buying and includes the planning and policy activities covering a wide range of related and complementary activities.
3. **Non-Production Stores:** - Non-production materials like office supplies, perishable tools and maintenance, repair and operating supplies are maintained as per the needs of the business. These stores may not be required daily but their availability in stores is essential. The non-availability of such stores may lead to stoppage of work.
4. **Transportation:** - The transporting of materials from suppliers is an important function of materials management. The traffic department is responsible for arranging transportation service. The vehicles may be purchased for the business or these may be chartered from outside. It all depends upon the quantity and frequency of buying materials. The purpose is to arrange cheap and quick transport facilities for incoming materials.
5. **Materials Handling:** - It is concerned with the movement of materials within a manufacturing establishment and the cost of handling materials is kept under control. It is also seen that there are no wastages or losses of materials during their movement. Special equipment’s may be acquired for material handling.
6. **Receiving:** - The receiving department is responsible for the unloading of materials, counting the units, determining their quality and sending them to stores etc. The purchasing department is also informed about the receipt of various materials.

**Materials Management: Objectives, Scope and Functions**
Materials management is concerned with management functions supporting the complete cycle of material flow, from the purchase and internal control of production materials to planning and control of work in process, to warehousing, shipping and distribution of the finished product. An effective materials management process ensures that the right kinds of materials are at the right place whenever needed.

Materials management is concerned with planning, directing and controlling the kind, amount, location, movement and timing of various flows of materials used in and produced by the process.

**Objectives of Materials Management:**
- Materials management objectives are categorized into:
  1. Primary objective
  2. Secondary objectives

**1. Primary Objectives:**
- "Making available (supply) of materials in specified quantity and quality at economic cost and maintaining the continuity of supply. Minimization of investments in materials and inventory costs, and assuring high inventory turnover."

**2. Secondary Objectives:**
- Secondary objectives help to achieve the primary objectives.

The secondary objectives can be stated as:
1. Purchasing the items from a reliable source at economic price.
2. Reduction of costs by using various cost reduction techniques such as variety reduction, standardization and simplification, value analysis, inventory control, purchase research etc.
3. Co-ordination of the functions such as planning, scheduling, storage and maintenance of materials.

**Scope of Materials Management:**
- Materials management encompasses all the aspects of the materials i.e. material costs, material supply and material utilization. Materials management is concerned with material planning and materials control activities. The details of planning and control activities are represented in table 1.3.

**Integrated Materials Management:**
- Materials required for production purpose are normally procured and stored in the plant and issued to manufacturing when there is a requisition. Materials are to be purchased in advance and stored to ensure uninterrupted supply.
- There should be a proper co-ordination and co-operation among different functional heads of materials department to optimise the operations of materials management. The materials function to be effective, the objective must be to maximise materials productivity. An integrated approach to materials management i.e. materials planning and control must look in to the problem areas in a co-ordinated manner in order to maximise the effectiveness of materials management.

An integrated materials management will result in the following advantages:
- a. Better accountability for materials and material concerned costs.
- b. Better co-ordination within the materials functions and also other functional areas of business.
- d. Adaptability to automated and computerised systems.

The important areas to improve materials planning and control are:
1. Value analysis and purchase price analysis.
2. Materials planning and control (Inventory Control).
3. Stores control.

Various elements of integrated materials management are represented in table 1.4.

**Table 1.4: Elements of Integrated Materials Management**

<table>
<thead>
<tr>
<th>1. Materials Planning</th>
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<tbody>
<tr>
<td>• Forecasting materials and parts requirements.</td>
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<tr>
<td>• Preparation of material budgets.</td>
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<tr>
<td>• Forecasting material, inventory levels.</td>
</tr>
<tr>
<td>• Scheduling orders and monitoring of performance.</td>
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<th>2. Inventory Control</th>
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<tr>
<td>• Selective control of materials.</td>
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<tr>
<td>• Determining economic order quantity (EOQ).</td>
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<td>• Fixing level of safety stock or reorder level.</td>
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<td>• Lead time analysis.</td>
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<th>3. Purchasing</th>
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<tr>
<td>• Selection of source and supplier evaluation.</td>
</tr>
<tr>
<td>• Finalization of terms and conditions of supply (negotiation).</td>
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<tr>
<td>• Planning orders and follows up.</td>
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<th>4. Stores Management</th>
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<tbody>
<tr>
<td>• Receipts, issue and storage of materials.</td>
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<tr>
<td>• Preservation of stores.</td>
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<tr>
<td>• Efficient handling and disposal.</td>
</tr>
<tr>
<td>• Maintenance of stores records.</td>
</tr>
</tbody>
</table>
Flow of Materials in Manufacturing: - In any manufacturing organisation, there is a flow of materials at various stages of manufacturing i.e. from input to output. The flow of tangible materials from input through manufacturing to output of a manufacturing operation is represented in the fig (1.10).

The flow with reference to inputs involves such activities as purchasing, traffic control and receiving. The activities associated with flow within the factory include the material handling activities at different workstations as per the order of processing. Output related activities include packaging, shipping and distribution.

Irrespective of the type of the organisation, the basic material related functions performed at the organisation are:

1. Purchasing
2. Inbound traffic from suppliers to company
3. Receiving
4. Inventory Control
5. Production control
6. In plant storage
7. Material handling
8. Packaging and shipping
9. Outbound traffic
10. Warehousing and distribution.

Purchasing:

Purchasing plays a crucial role in the materials management because it is concerned from input stage up to the consumption in manufacturing. Purchasing functions as a monitor, clearing house and a pipeline to supply materials needed for production.

Dr. Walters defines scientific purchasing as:

"Procurement by purchase of the proper materials, machinery and equipment and supplies of stores used in manufacturing of the product, adopted to marketing in the proper quantity and quality at the proper time and at the lowest price consistent with quality desired."

Purchasing Cycle:

The purchase procedure followed varies from company to company and also from one industry to other. The purchasing cycle is represented as shown in fig (1.11).

The basic elements in purchasing are:

1. The origin of demand for materials and components based upon the requisitions made to purchase department by user departments with all the details like descriptions, quantity and quality specifications.
2. Specifications are checked and verified and purchase plan is made for items demanded
3. Selection of source of supply.
4. Preparation of purchase order by supplier (order acceptance) and acceptance of terms and conditions.
5. Follow up to ensure prompt delivery of right quality and quantity of materials.
6. Incoming inspection of materials (both to check quality and quantity) to ensure correct material as per specification.
7. Checking supply invoice against purchase order and goods received and payments are made.

**Methods of Buying:** Methods of purchasing will vary according to the nature of demand and the market conditions.

The principle methods of buying are:
1. Purchasing by requirement (Hand to mouth buying).
2. Purchasing for a specified future period.
3. Market purchasing.
4. Speculative buying.
5. Contract buying.
6. Group purchasing of small items.
7. Forward buying.
8. Hedging.

**Source Selection (Vendor Selection):**
The selection of right source of supply is an important aspect in materials management. The vendor is to be examined with respect to his capability and competency to supply right quality of material at right time and at a competitive price.

The buyer looks for the following details before a decision regarding vendor selection is made:

1. **Production Capabilities:**
   a. Capacity to manufacture the products as per the specifications and required quantities.
   b. Availability of spare capacity.
   c. Capability to understand the needs of Buyer Company both technical and commercial.

2. **Financial Position of the Vendor:**
   d. The type of the company – Private limited, Partnership or Sole proprietorship.
   e. Company’s capital structure.
   f. Financial position and profitability of the company since last 3-4 years.

3. **Technical Capabilities:**
   g. Whether the available plant and equipment’s are in a position to meet the quality and quantity specifications of the customer.
   h. Whether there are enough technically skilled and trained people.
   i. Whether R&D facilities are available.
   j. What is the market standing of the vendor with respect to quality and delivery commitments (Reliability of supply).
   k. Whether he has enough storing and warehousing facilities.
   l. Quality control procedures – whether an ISO-9000 certified supplier.

4. **Other Conditions:**
   m. Working conditions in the vendor company.
   n. Industrial relations and bargaining power of unions.

**Vendor Relations:** Purchase department should establish a sound relationship with vendors based on mutual trust and benefit to ensure smooth supply of materials/parts as per the quality and quantity required. So, apart from a formal commercial relationship as a customer, a long lasting and mutually rewarding relationship is to be established.

A strategic partnership between the buyer and supplier is defined as a continuing relationship involving a commitment over an extended time period, an exchange of information and acknowledgment of risks and rewards of the partnership. A sound relationship emerges from the proper help and co-ordination on the part of both buyer and supplier.

**The expectations from buyers include:**
- Promptness in delivery.
- Meets the quality and quantity requirements.
- Entertains occasional rush orders.
- Flexibility in quantity to be supplied.
- Can wait for the bills.
- Competitive pricing.

**The expectations from the vendors:**
- Consistent orders.
- Prompt payment of the bills.
- Extend help during difficulty both financial and technical.
- Continuity of orders.

**Vendor Rating (Evaluation of Suppliers):** The appraisal of the vendor performance is a continues process.

The vendor can be rated on various characteristics such as:
1. Delivery (To deliver as on time as per the order).
2. Quality (To delivery as per specifications).
4. Other factors such as capability to meet urgent/rush orders readiness to try out new designs or new methods etc.

In vendor rating, one usually gives weightage to these various characteristics and measures the performance of the vendors periodically on the basis of certain norms and procedures. Every company should have a formal vendor rating system. It is not only beneficial to the buyer company but also for the supplier company. Vendors will get the feedback based on objective evaluation.
Establishing proper purchase procedures. 5. Inventory turnover ratios. and 6. ABC analysis.

The features of JIT purchasing are:

a. Reduced lot sizes
b. Frequent and reliable delivery schedules.

c. Reduced and highly reliable lead times.
d. High quality level of purchased parts.

The reduction of number of suppliers in JIT purchasing has the following advantages:

1. Consistent quality
2. Minimum investment and resources such as buyer’s time, travel and engineering
3. Focused attention on vendors
4. Savings on tooling
5. Establishment of long-term relationship.

For making JIT work, the following conditions are put on purchasing department:

1. Reduction in number of suppliers.
2. Locating the suppliers who are nearby.

The success of JIT purchasing depends on how well the firm establishes the strategy of single sourcing. The suppliers should be seen as “Outside” partners who can contribute to the long run well fare buying firm.

Inventory: It’s Meaning and Types!

**Meaning of Inventory:** - An inventory is a stock of goods maintained for the purpose of future production or sales. In broad sense, the term inventory refers to all materials, parts, supplies, tools, in-process or finished products recorded in the books by an organization and kept in its stocks, warehouse or plant for some period of time. It is a list or schedule of materials held on behalf of an enterprise. The quantity and value of every item is also mentioned in such list.

According to R.L. Ackoff and M.W. Sasieni, “Inventory consists of usable but idle resources. The resources may be of any type; for example, men, materials, machines or money. When the resources involved are materials or goods in any stage of completion, inventory is referred to as stock.”

In a nutshell, the term inventory may be defined as “the stock of goods, commodities or other economic resources that are stored or reserved at any given period for future production or for meeting future demand.

**Types/Classification of Inventory:** The term inventory may be classified into two types namely:

1. **Direct Inventories:** - Direct inventories are those inventories that play a major role in the production and constitute a vital part of finished goods. These inventories can be easily assigned to specific physical units. Direct inventories may be categorised into four groups.

   - **(i) Raw materials:** - Raw materials are the physical resources to be used in the manufacture of finished products. They include materials that are in their natural or raw form. For example, cotton in the case of textile mill, sugarcane in the case of sugar factory, oil seeds in the case of an oil mill etc. The chief objective of keeping raw material is to ensure uninterrupted production in the event of delays in delivery and also to enjoy the economies of large scale buying.

   - **(ii) Semi-finished Goods:** - Semi-finished goods are those materials which are not cent per cent (100%) complete in all respects i.e., some processing still remains to be done before the product can be sold. For example, a person who is engaged in the manufacture of furniture, may purchase unpolished furniture from market and sell it after polishing the same.

   - **(iii) Finished Goods:** - Finished goods are complete products that are ready for sale or distribution. For instance, in case of a hosiery factory, sweaters, shawls etc. are finished products.

   - **(iv) Spare Parts:** - Spare parts means duplicate parts of a machine. Usually, almost all the industrial concerns maintain spare parts of various machines which they use for manufacture. This will enable them to ensure smooth running of machines which in turn provide for uninterrupted production.

2. **Indirect Inventories:** - Indirect inventories include those items which are necessary for manufacturing but do not become component of the finished goods. They normally include petrol, maintenance materials, office materials, grease, oil lubricants etc. These inventories are used for ancillary purposes to the business and cannot be assigned to specific, physical units. These inventories may be used in the factory, the office or the selling and distribution divisions.

**6 Most Important Techniques of Inventory Control System** - Some of the most important techniques of inventory control system are: 1. Setting up of various stock levels. 2. Preparations of inventory budgets. 3. Maintaining perpetual inventory system. 4. Establishing proper purchase procedures. 5. Inventory turnover ratios. and 6. ABC analysis.
1. Setting up of various stock levels: To avoid over-stocking and under stocking of materials, the management has to decide about the maximum level, minimum level, re-order level, danger level and average level of materials to be kept in the store. These terms are explained below:

(a) Re-ordering level: It is also known as ‘ordering level’ or ‘ordering point’ or ‘ordering limit’. It is a point at which order for supply of material should be made. This level is fixed somewhere between the maximum level and the minimum level in such a way that the quantity of materials represented by the difference between the re-ordering level and the minimum level will be sufficient to meet the demands of production till such time as the materials are replenished. Reorder level depends mainly on the maximum rate of consumption and order lead time. When this level is reached, the store keeper will initiate the purchase requisition.

Reordering level is calculated with the following formula:
Re-order level = Maximum Rate of consumption x maximum lead time

(b) Maximum Level: Maximum level is the level above which stock should never reach. It is also known as ‘maximum limit’ or ‘maximum stock’. The function of maximum level is essential to avoid unnecessary blocking up of capital in inventories, losses on account of deterioration and obsolescence of materials, extra overheads and temptation to thefts etc. This level can be determined with the following formula. Maximum Stock level = Reordering level + Reordering quantity — (Minimum Consumption x Minimum re-ordering period)

(c) Minimum Level: It represents the lowest quantity of a particular material below which stock should not be allowed to fall. This level must be maintained at every time so that production is not held up due to shortage of any material. It is that level of inventories of which a fresh order must be placed to replenish the stock. This level is usually determined through the following formula:
Minimum Level = Re-ordering level — (Normal rate of consumption x Normal delivery period)

(d) Average Stock Level: Average stock level is determined by averaging the minimum and maximum level of stock.
The formula for determination of the level is as follows:
Average level = 1/2 (Minimum stock level + Maximum stock level)

(e) Danger Level: Danger level is that level below which the stock should under no circumstances be allowed to fall. Danger level is slightly below the minimum level and therefore the purchases manager should make special efforts to acquire required materials and stores.

This level can be calculated with the help of following formula:
Danger Level = Average rate of consumption x Emergency supply time.

(f) Economic Order Quantity (E.O.Q.): One of the most important problems faced by the purchasing department is how much to order at a time. Purchasing in large quantities involve lesser purchasing cost. But cost of carrying them tends to be higher. Likewise if purchases are made in smaller quantities, holding costs are lower while purchasing costs tend to be higher. Hence, the most economic buying quantity or the optimum quantity should be determined by the purchase department by considering the factors such as cost of ordering, holding or carrying.

This can be calculated by the following formula:
Q = \sqrt{\frac{2AS}{I}}

where Q stands for quantity per order;
A stands for annual requirements of an item in terms of rupees;
S stands for cost of placement of an order in rupees; and
I stand for inventory carrying cost per unit per year in rupees.

2. Preparation of Inventory Budgets: Organisations having huge material requirement normally prepare purchase budgets. The purchase budget should be prepared well in advance. The budget for production and consumable material and for capital and maintenance material should be separately prepared.

Sales budget generally provide the basis for preparation of production plans. Therefore, the first step in the preparation of a purchase budget is the establishment of sales budget.

As per the production plan, material schedule is prepared depending upon the amount and return contained in the plan. To determine the net quantities to be procured, necessary adjustments for the stock already held is to be made. They are valued as standard rate or current market. In this way, material procurement budget is prepared. The budget so prepared should be communicated to all departments concerned so that the actual purchase commitments can be regulated as per budgets.

At periodical intervals actuals are compared with the budgeted figures and reported to management which provide a suitable basis for controlling the purchase of materials,
3. Maintaining Perpetual Inventory System: - This is another technique to exercise control over inventory. It is also known as automatic inventory system. The basic objective of this system is to make available details about the quantity and value of stock of each item at all times. Thus, this system provides a rigid control over stock of materials as physical stock can be regularly verified with the stock records kept in the stores and the cost office.

4. Establishing Proper Purchase Procedures: - A proper purchase procedure has to be established and adopted to ensure necessary inventory control. The following steps are involved.

(a) Purchase Requisition: - It is the requisition made by the various departmental heads or storekeeper for their various material requirements. The initiation of purchase begins with the receipt of a purchase requisition by the purchase department.

(b) Inviting Quotations: - The purchase department will invite quotations for supply of goods on the receipt of purchase requisition.

(c) Schedule of Quotations: - The schedule of quotations will be prepared by the purchase department on the basis of quotations received.

(d) Approving the supplier:- The schedule of quotations is put before the purchase committee who selects the supplier by considering factors like price, quality of materials, terms of payment, delivery schedule etc.

(e) Purchase Order: It is the last step and the purchase order is prepared by the purchase department. It is a written authorisation to the supplier to supply a specified quality and quantity of material at the specified time and place mentioned at the stipulated terms.

5. Inventory Turnover Ratio: - These are calculated to minimise the inventory by the use of the following formula:

\[ \text{Inventory Turnover Ratio} = \frac{\text{Cost of goods consumed/sold during the period}}{\text{Average inventory held during the period}} \]

The ratio indicates how quickly the inventory is used for production. Higher the ratio, shorter will be the duration of inventory at the factory. It is the index of efficiency of material management.

The comparison of various inventory turnover ratios at different items with those of previous years may reveal the following four types of inventories:

(a) Slow moving Inventories: - These inventories have a very low turnover ratio. Management should take all possible steps to keep such inventories at the lowest levels.

(b) Dormant Inventories: - These inventories have no demand. The finance manager has to take a decision whether such inventories should be retained or scrapped based upon the current market price, conditions etc.

(c) Obsolete Inventories: - These inventories are no longer in demand due to their becoming out of demand. Such inventories should be immediately scrapped.

(d) Fast moving inventories: - These inventories are in hot demand. Proper and special care should be taken in respect of these inventories so that the manufacturing process does not suffer due to shortage of such inventories.

Perpetual inventory control system: - In a large b essential to have information about continuous availability of different types of materials and stores purchased, issued and their balance in hand. The perpetual inventory control system enables the manufacturer to know about the availability of these materials and stores without undergoing the cumbersome process of physical stock taking.

Under this method, proper information relating to receipt, issue and materials in hand is kept. The main objective of this system is to have accurate information about the stock level of every item at any time. Perpetual inventory control system cannot be successful unless and until it is accompanied by a system of continuous stock taking i.e., checking the total stock of the concern 3/4 times a year by picking 10/15 items daily (as against physical stock taking which takes place once a year).

The items are taken in rotation. In order to have more effective control, the process of continuous stock taking is usually undertaken by a person other than the storekeeper. This will check the functioning of storekeeper also. The items may be selected at random to have a surprise check. The success of the system of perpetual inventory control depends upon the proper implementation of the system of continuous stock taking.

6. ABC analysis: - In order to exercise effective control over materials, A.B.C. (Always Better Control) method is of immense use. Under this method materials are classified into three categories in accordance with their respective values. Group ‘A’ constitutes costly items which may be only 10 to 20% of the total items but account for about 50% of the total value of the stores. A greater degree of control is exercised to preserve these items. Group ‘B’ consists of items which constitutes 20 to 30% of the store items and represent about 30% of the total value of stores.

A reasonable degree of care may be taken in order to control these items. In the last category i.e. group ‘Q’ about 70 to 80% of the items is covered costing about 20% of the total value. This can be referred to as residuary category. A routine type of care may be taken in the case of third category.
This method is also known as 'stock control according to value method', 'selective value approach' and 'proportional parts value approach'. If this method is applied with care, it ensures considerable reduction in the storage expenses and it is also greatly helpful in preserving costly items.

**Methods of Inventory Control**

Devising an efficient system of counting and maintaining a stock of inventory items has long been a difficult task for many retail managers. It is said that excess of high inventory isn’t a good sign because there is a cost associated with storing of the extra inventory. Similarly on the other side it is believed that shortage of inventory is the root cause of all retail disputes. What should be done? Answer is to find out a balance of inventory which is neither excessive nor inadequate.

**Selective Inventory Management (SIM)** - Therefore, to ensure optimum level of inventory, several classifications are employed to render selective treatment to different types of retail goods/items each classification emphasize on a particular aspect. The right choice of a method depends upon several factors like price of the item, criticality, consumption, lead time, procurement difficulties, etc.

Such application of varying levels of control to the total inventory enables retail managers to concentrate on significant matters only. For example, ABC analysis lays emphasis on usage value (consumption of the items in terms of price), VED analysis considers criticality; FSN analysis is based on demand for the items and their stock moving pattern; and HML analysis employs price criterion. Such classification helps the retail managers in controlling the inventory more systematically and scientifically.

These are discussed as follows.

1. **Economic Order Quantity (EOQ) Model.** - The primary function of inventory management is to determine
   
   (a) When to order? and
   
   (b) How much to order?

**When to order?**

This problem of inventory control deals with the issue of point of time when the order for fresh inventory is given. The problem of ‘When to Order’ is solved by fixing the appropriate re-order levels of each type of inventory. It is determined by compromising the cost of maintaining these stocks and the disservice to the customer if his orders are not delivered in time.

**Re-order level.** - 'When to order' is an important query which requires suitable answer. Buying and issuing the inventories are the foremost tasks of all types of organizations. When the inventories fall below a particular level as decided in advance, they are refilled with fresh procurement. But what should be the quantity for fresh stock is always an alarming question requires suitable answer. In short, the re-order level is that level of inventory at which the order for additional stock should be placed.

Re-order level = Average usage x Lead time

i.e., \( R = A_L \)

**Re-order point example.**

Demand = 10000 units/year

Store open = 320 days/year

Average usage \( (A_L) = \frac{10000}{320} = 31.25 \) units/day

Lead time \( (L) = 10 \) days

\( R = A_L \times L = (31.25) (10) = 312.5 \) units

Note. - This calculation exercise is the responsibility of retail managers but it is the retail staff that informs the retail managers that items in the store is about to finish, which items are in demand in a particular period. Which item should be purchased/acquired on preference basis? Because retail staff is in direct touch with the customers, therefore, is better able to read the customer’s buying nerve.

Further, retail staff at junior level, one day can/will be promoted at senior level where this calculation takes place. Therefore, concept clarity is must exercise at entry level too.

**How much to order?**

After solving the problem of ‘when to order’, next immediate issue is 'how much to order'. Considering over-buying can lead to unproductive use of working capital and under buying leads to unwanted emergency orders and ultimately increases the workload of purchase department. issue of 'how much to order' is of vital significance. Hence a balance is achieved by selecting the right quantity for each order. This quantity in short is known as Economic Order Quantity (EOQ).

EOQ is an important technique of inventory management. The EOQ refers to the optimal order size that will result in the lowest total of order and carrying costs for an item of inventory given its expected usage, carrying costs and ordering cost. By calculating an economic order quantity, the firm attempts to determine the order size that will minimize the total inventory costs.

**Inventory Costs.**

1. **Ordering costs.** - The cost of placing an order and obtaining the supplies is known as ordering cost. It includes costs related to the clerical work of preparing, calling, issuing, transportation, following and receiving orders, the physical handling of goods, inspections and machine set-up costs. This cost does not depend or vary on the number ordered.
2. Holding (or carrying) costs. – The costs which are required to be incurred on account of inventory storage, handling, insurance etc. from the date of receipt to the date of disposal. It includes store related expenses like salaries of store keepers, electricity expenses, handling, insurance, pilferage, breakage, obsolescence, depreciation, taxes, and the opportunity cost of capital.

The relationship between ordering cost and carrying cost can be understood as follows.

<table>
<thead>
<tr>
<th>Quantity and size of order</th>
<th>Ordering Cost</th>
<th>Carrying cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Few Orders of large size</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>(B) More Orders of small size</td>
<td>More</td>
<td>Less</td>
</tr>
</tbody>
</table>

EOQ is simple to understand and use but it has several restrictive assumptions which are also disadvantages in practice. Even with these weaknesses, EOQ is a good place to start to understand inventory systems.

EOQ assumes.
1. Demand rate is constant, uniform, recurring, and known.
2. Lead time is constant and known in advance.
3. Price per unit of product is constant; no discounts are given for large orders.
4. Inventory holding cost is based on average inventory.
5. Ordering or setup costs are constant.
6. All demands will be satisfied; no stock outs are allowed.

The EOQ is calculated as follows.

$$EOQ = \sqrt{\frac{2 \times D \times C_c}{P \times C}}$$

Where.

- $D$ = Annual Demand
- $C_c$ = Ordering cost per order
- $P$ = Unit price of an item
- $C$ = Percentage of annual carrying cost to the unit

A BASIC EOQ EXAMPLE – A grocery store sells 10 cases of coffee each week. Each case costs Rs. 80. The cost of placing an order is Rs. 10. Holding or carrying cost is estimated to be 30% of the inventory value per year.

So the variables are defined as.

- $D = 520$ cases/year (10 cases/week)
- $C_c = Rs. 10$ per order
- $C = 30\%$ (or 0.30)
- $P = Rs. 80$ per case
- $Q = \sqrt{\frac{2 \times 520 \times 10}{80 \times 0.3}}$
- $Q = 20.8 \approx 21$ cases per order.

How often is the coffee ordered?

520/21 = 25 orders per year. Or every 15 days (365/25 = 15)

2. ABC Analysis. – ABC analysis is a basic inventory management technique that has been used in business management for a long time. This technique is also popularly known as "Always Better Control" which is used to exercise control over inventories. Under this method various items of inventory are divided into some groups. These groups are often marked A, B, and C – hence the name.

ABC–analysis is a method originating from material requirements planning, it allows to classify materials by their portion of the overall value of materials.

The basic idea underlying ABC analysis is that every item of inventory is not equally important from the viewpoint of control.

Certain items are large in numbers but are not of high values, while certain items are very few in numbers but are costly ones. Therefore, items that are perceived as having highest priority is assigned an A, those are of average importance are labeled as B and relatively unimportant items with lowest priority are labeled C.

ABC analysis underlines a very important principle "Vital Few: Trivial Many". ABC analysis, therefore, on the basis of cost and its consumption, tends to segregate items into three categories as mentioned above. Each category should be handled in a different way, with more attention being devoted to category A, less to B, and least to C.

Under ABC analysis, generally for the purpose of controlling inventory, items are classified as follows.

<table>
<thead>
<tr>
<th>Category</th>
<th>Label</th>
<th>Quantity (%)</th>
<th>Cost (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Outstanding important</td>
<td>15</td>
<td>70</td>
</tr>
<tr>
<td>B</td>
<td>Average importance</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>C</td>
<td>Relatively unimportant</td>
<td>55</td>
<td>5</td>
</tr>
</tbody>
</table>

The purpose of classifying inventory into A, B and C category is to identify where to expend money on inventory and where should be saved. Where care should be taken more and where inventory doesn't demand extra care. During application of this concept, following points should be always considered by a retailer.

These are.
1. Category ‘A’ items are subject to strict inventory control. Therefore, continuous cooperation and interaction is must so that the time spent on placing the order and receiving the inventory should be minimum to the extent possible.

2. For category ‘B’ items moderate control should be used. As category ‘B’ items are subject to an intermediate inventory control.

3. Due to low usage value and low costs ‘C’ items should be procured infrequently and in sufficient quantities. Therefore, strict control is not recommended. Such items are normally kept in an open area inside the store, from where customers can take them according to their requirement. But a periodic monitoring mechanism is established for such items, and quantities almost double the EOQ are ordered at one time.

ABC analysis is frequently combined with ‘Pareto’ analysis. The ‘Pareto’ principle is also used in logistics and procurement for the purpose of optimizing stock of goods, as well as costs of keeping and replenishing that stock.

Assumptions of ABC Analysis:

1. Demand is known with certainty
2. Demand is relatively constant over time
3. No shortages are allowed
4. Lead time for the receipt of orders is constant
5. The order quantity is received at once

To understand the concept of analysis, we take an imaginary example.

For instance, Indian Star Company has seven different items in its inventory stock. The average number of each of these items held, along with their unit costs, is listed below in the table. The Company has decided to introduce an ABC inventory technique from this financial year. Being an expert of the subject you are supposed to suggest the proper breakdown of the items into A, B & C categories.

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Average Units in Stock</th>
<th>Average Cost per unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10000</td>
<td>30.40</td>
</tr>
<tr>
<td>2</td>
<td>5000</td>
<td>51.20</td>
</tr>
<tr>
<td>3</td>
<td>16000</td>
<td>5.50</td>
</tr>
<tr>
<td>4</td>
<td>14000</td>
<td>5.14</td>
</tr>
<tr>
<td>5</td>
<td>30000</td>
<td>1.70</td>
</tr>
<tr>
<td>6</td>
<td>15000</td>
<td>1.50</td>
</tr>
<tr>
<td>7</td>
<td>10000</td>
<td>0.65</td>
</tr>
</tbody>
</table>

Solution.

Applying ABC Analysis.

Explanation. – From the above solution one may find how the ABC system works. As per the definition, all the items are classified into three groups. ‘A’ category inventory constitutes the first 70% of total inventory and hence deserves strict control. The next is ‘B’ category where moderate control is imposed. The last one is the ‘C’ category and as per the method, requires least attention and managerial devotion.

Pareto analysis. – Pareto principle of inventory was developed by Vilfredo Pareto, an Italian economist who studied the patterns of the concentration of wealth and population in his native country. When he compared the total annual income of Italy to the number of individuals holding the bulk of the wealth, he found that a great majority of the income and the wealth was concentrated in the hands of a relatively few individuals or, conversely, that the majority of the people possessed only a minority of the wealth. In fact, Pareto found that ninety per cent of the income went to only ten per cent of the people.

From these observations he formulated a mathematical expression and a generalized principle which states “… that the significant items in any given group normally constitute a relatively small portion of the total items in the group (often called the ‘vital few’). Thus, a majority of the items in the total will, even in the aggregate, be of relatively minor significance (the ‘trivial many’)”. For many years Pareto’s principle was viewed as an interesting academic curiosity, and its practical value was unrecognized until late in the 1930s when it was brought to the attention of people by H. Ford Dickey, who for the first time applied Pareto’s law to inventory and observed that when inventory items were plotted on a cumulative percentage graph in order of descending value, Pareto’s principle seemed to emerge; that is, a small number of the inventory items comprised a very large percentage of the total inventory value. For example, twenty percent of the inventory items comprise eighty percent of the inventory value.

Today, “Pareto’s principle of inventory”, often referred to as the ‘ABC principle’, is recognized as an important management tool which affects and influences management control systems of every kind. ABC analysis is used in many areas including inventory control, capacity planning, quality control and production planning and control.
Both contribution and sales income have been used as measures of an item's importance to an organization. It is not unusual to find that some products which generate high sales income actually make very low contributions or even losses. Similarly, some products may produce most contribution but their sales income is low. Therefore, both contribution and sales income should be considered.

The following procedure is used in conducting ABC analysis.

1. Obtain the list of the items and estimate their annual consumption (in units).
2. Determine the unit price of each item of inventory.
3. Calculate annual consumption by multiplying items' annual consumption with its unit price.
4. Put together items in the descending order of their annual consumption starting with the maximum annual usage down to the minimum usage.
5. Compute the cumulative percentage for the annual usages and cumulative annual issue.

Advantages of ABC Analysis. – Inventory reduction has been a constant goal for all manufacturing concerns. Using the "ABC" concept to analyze and control inventory investment and turns is the simplest and most efficient method. The ABC analysis helps the materials managers that fewer rupees should be tied up in inventory, the more money available for capital investment and expansion. The "ABC" concept also allows a manager to devote resources where it will have the biggest positive impact.

Limitations of ABC Analysis. – In ABC analysis, items are divided into various categories for selective management control. These grades are decided on the basis of material price, its usage, availability, size and weight. Further, depending on the type of unit and situation, such classification is made. ABC analysis despite powerful inventory approach does not guarantee cent percent success. For its successful implementation, the results of ABC analysis have to be reviewed on continuous basis. Some times as advised by ABC analysis, negligence in controlling ‘C’ type item can be a costly affair during shortage of the same. Like it is common experience that ‘sugar & oil’ during Diwali will become the high value item.

3. VED Analysis. – Just like ABC Analysis for classification of inventories, there is an inventory management technique called VED. In VED analysis inventory items are classified depending upon their criticality in terms of their effect on production function. The degree of criticality states that whether the item of inventory is vital, or essential or desirable for the retail store. This classification of dividing inventory is known as VED analysis, where V stands for vital, E stands for essential and D stands for desirable items.

Objectives. – The VED analysis is applied to determine the criticality of an item for displaying in a retail store and its immediate effect on overall buying and other services. It is specially used for material management. Under this analysis, for ‘V’ items, a large stock of inventory is usually maintained, while for ‘D’ type items, minimum stock is sufficient.

4. FSN Analysis. – This classification works like this.
   
   F = Fast Moving

   S = Slow Moving

   N = Non-moving

FSN analysis is based on the assumption that all items of inventory are not required all the time in stores. Some items are required on regular basis and some once in a while. Therefore, Fast moving items must be kept near to the point of issue and similarly Non–moving items can be kept in a remote place as they are required occasionally.

Therefore for the purpose of controlling items under FSN analysis, ‘F’ type items need to be reviewed on regular basis while ‘S’ type items may be examined further and their disposal can be considered.

To conduct FSN analysis, the date of receipt or the last date of issue, whichever is later, is considered to determine the number of months, which have lapsed since the last transaction.

5. HML Analysis. – This classification works like this.

   H = High Cost Items

   M = Medium Cost Items

   L = Low Cost Items

Likewise ABC analysis, items are classified on the basis of cost of the items. The point of difference between these two techniques is that under HML analysis, for the purpose of classifying inventories into various categories, only cost of the items is considered while their annual consumption value is totally ignored.

Conducting HML analysis. – Prepare the list of all the items of inventory in the descending order of their unit value and then to employ price criterion by management for three categories.

For Example, in case of luxury retailing, the management may decide all items as follows.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Unit Price</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2000 and above</td>
<td>H</td>
</tr>
<tr>
<td>2</td>
<td>Rs.1000 - Rs. 2000</td>
<td>M</td>
</tr>
<tr>
<td>3</td>
<td>less than Rs. 1000</td>
<td>L</td>
</tr>
</tbody>
</table>

Purchasing: it's Meaning, Definition, Importance and Objectives!

Meaning and Definition:
Purchasing is the first phase of Materials Management. Purchasing means procurement of goods and services from some external agencies. The object of purchase department is to arrange the supply of materials, spare parts and services or semi-finished goods, required by the organisation to produce the desired product, from some agency or source outside the organisation. The purchased items should be of specified quality in desired quantity available at the prescribed time at a competitive price. In the words of Alford and Beatty, “Purchasing is the procuring of materials, supplies, machines, tools and services required for equipment, maintenance, and operation of a manufacturing plant”.

According to Walters, purchasing function means ‘the procurement by purchase of the proper materials, machinery, equipment and supplies for stores used in the manufacture of a product adopted to marketing in the proper quality and quantity at the proper time and at the lowest price, consistent with quality desired.’

Thus, purchasing is an operation of market exploration to procure goods and services of desired quality, quantity at lowest price and at the desired time. Supplier who can provide standard items at the competitive price are selected.

Purchasing in an enterprise has now become a specialised function. It was experienced that by giving the purchase responsibility to a specialist, the firm can obtain greater economies in purchasing. Moreover purchasing involves more than 50% of capital expenditure budgeted by the firm.

According to Westing, Fine and Zenz “Purchasing is a managerial activity that goes beyond the simple act of buying. It includes research and development for the proper selection of materials and sources, follow-up to ensure timely delivery; inspection to ensure both quantity and quality; to control traffic, receiving, storekeeping and accounting operations related to purchases.”

The modern thinking is that Purchasing is a strategic managerial function and any negligence will ultimately result into decrease in profits.

**Importance of Purchasing:**

1. Purchasing function provides materials to the factory without which wheels of machines cannot move.
2. A one percent saving in materials cost is equivalent to a 10 percent increase in turnover. Efficient buying can achieve this.
3. Purchasing manager is the custodian of his firm’s purse as he spends more than 50 per cent of his company’s earnings on purchases.
4. Increasing proportion of one’s requirements are now bought instead of being made as was the practice in the earlier days. Buying, therefore, assumes significance.
5. Purchasing can contribute to import substitution and save foreign exchange.
6. Purchasing is the main factor in timely execution of industrial projects.
7. Materials management organisations that exist now have evolved out or purchasing departments.
8. Other factors like:
   (i) Post-war shortages,
   (ii) Cyclical swings of surpluses and shortages and the fast rising materials costs,
   (iii) heavy competition, and
   (iv) Growing worldwide markets have contributed to the importance of purchasing.

**Objectives of Purchasing:**

The purchasing objective is sometimes understood as buying materials of the right quality, in the right quantity, at the right time, at the right price, and from the right source. This is a broad generalisation, indicating the scope of purchasing function, which involves policy decisions and analysis of various alternative possibilities prior to their act of purchase.

The specific objectives of purchasing are:

1. To pay reasonably low prices for the best values obtainable, negotiating and executing all company commitments.
2. To keep inventories as low as is consistent with maintaining production.
3. To develop satisfactory sources of supply and maintain good relations with them.
4. To secure good vendor performance including prompt deliveries and acceptable quality.
5. To locate new materials or products as required.
6. To develop good procedures, together with adequate controls and purchasing policy.
7. To implement such programmes as value analysis, cost analysis, and make-or-buy to reduce cost of purchases.
8. To secure high caliber personnel and allow each to develop to his maximum ability.
9. To maintain as economical a department as is possible, commensurate with good performance.
10. To keep top management informed of material development which could affect company profit or performance.
11. To achieve a high degree of co-operation and co-ordination with other departments in the organisation.

**Spare parts management**
Service parts management is the main component of a complete Strategic Service Management process that companies use to ensure that right spare part and resources are at the right place (where the broken part is) at the right time. **Spare parts**, are extra parts that are available and in proximity to a functional item, such as an automobile, boat, engine, for which they might be used for repair.

**Economic considerations** - Spare parts are sometimes considered uneconomical since:

- the parts might never be used
- the parts might not be stored properly, leading to defects

But without the spare part on hand, a company’s customer satisfaction levels could drop if a customer has to wait too long for their item to be fixed. Therefore, companies need to plan and align their service parts inventory and workforce resources to achieve optimal customer satisfaction levels with minimal costs.

**User considerations** - The user of the item, which might require the parts, may overlook the economic considerations because:

- the expense is not the user’s but the supplier’s
- of a known high rate of failure of certain equipment
- of delays in getting the part from a vendor or a supply room, resulting in machine outage
- to have the parts on hand requires less “paperwork” when the parts are suddenly needed
- of the mental comfort it provides to the user in knowing the parts are on-hand when needed
- The parts are un-economic to be repaired i.e. it’s cheaper to discard than to get it repaired

**Cost-effect compromise** - In many cases where the item is not stationary, a compromise is reached between cost and statistical probability. Some examples:

- an automobile carries a less-functional “donut” tire as replacement instead of a functionally equivalent tire.
- a member of a household buys extra light bulbs since it is probable that one of the lights in the house will eventually burn out and require replacement.
- a computer user will purchase a ream of computer paper instead of a sheet at a time.
- a race car team will bring another engine to the race track “just in case.”
- a ship carries “spare parts” for its engine in case of breakdown at sea.

**Measures of effectiveness**

The effectiveness of spares inventory can be measured by metrics such as fill rate and availability of the end item.

**Work Study: Meaning, Objectives and Types**

**Meaning of Work Study:** - According to ILO — International Labour Organisation — work study is “a term used to embrace the techniques of method study and work measurement which are employed to ensure the best possible use of human and material resources in carrying out a specified activity.” In other words, “work study is a tool or technique of management involving the analytical study of a job or operation.” Work study helps to increase productivity.

**Objectives of Work Study:**

(i) Work study brings higher productivity;
(ii) Work study improves existing method of work for which cost becomes lower;
(iii) It eliminates wasteful elements;
(iv) It sets standard of performance;
(v) It helps to use plant and human more effectively;
(vi) It improves by saving in time and loss of material also.

**Steps Involved in Work Study: The steps of work study are:**

(i) It selects the jobs which are to be studied;
(ii) It examines critically the recorded facts which are already done;
(iii) It records from direct observations all the matters which are happened;
(iv) It defines new method;
(v) It also installs the new method;
(vi) It also maintains the new standard;
(vii) It develops most economic and appropriate methods;
(viii) It measures the work content in the method, that is selected and compute a standard time.

**Types of Work Study:**

1. **Method Study:** - According to ILO, method study is “the systematic recording, analysis and critical examination of existing and proposed ways of doing work and the development and application of easier and more effective method”. In short, it is a systematic procedure to analyse the work to eliminate unnecessary operations.

**Objectives:** - The objectives of method study are:

(i) It improves the proper utilisation of manpower, machine and materials;
(ii) It also improves the factory layout, work place, etc.;
(iii) It also improves the process and procedure;
(iv) It develops better physical working environment;
(v) It reduces undesirable fatigue.

**Steps:** - The steps of method study are:
Steps:
1. Time and Motion studies eliminate wasteful movements;
2. They examine the proposed method critically and determine the most effective one;
3. They determine for each element having a stop-watch;
4. They record all the parts of a job which are done by the existing method;
5. They install the method as standard one;
6. They critically observe the workers who are engaged with the work;
7. They assess the proper speed of the operator who is working.

Few quick tips for improving the productivity of workers:

1. Human Relations: - Good human relation result in cooperative attitude of workers which increases productivity of system. Human relation can be improved by means of labour participation regarding good setting minimization of conflicts, simplification of communication techniques providing encouragement to workers for their creative talents by awarding awards and giving letters of appreciation.

2. Improvement in Existing Methods of Production and Adoption of Latest Technology: - In order to fight market competition industrialists must regularly adopt latest techniques in the field of marketing, material handling, inventory control and store management. Method study and work measurement maybe utilized to improve the existing method to select a process and machine tools etc.

3. Proper Design of the Product: - The product designs are not permanent they can be changed if improvement is possible. The consideration of following points may help in cost reduction:

   1. Reduction in number of parts leading to the product simplification.
   2. Utilization of better and economical materials
   3. Installation of efficient system of quality control
   4. Standardization of materials, processes, sequence of operations and tools used.

   These may reduce wastages in the form of scraps improve the durability and look of the production.

4. Cost Control: - Productivity can be improved by reducing the production cost. It can be achieved by keeping a close watch over expenditure, by minimization of material wastages, reduction in machines break down period or idleness of machines, reduction in waiting time for men, power and materials, avoiding executing material handling and minimization of overtime expenditure.

5. Product simplification and Standardization: - If the application of product simplification and standardization is possible in the product under consideration and thus the enterprise, it would improve the productivity of the enterprise.

6. Proper Planning Loading and Scheduling: - These industrial engineering techniques help in proper utilization of 4M’s i.e. Men, Machines, Material and Methods. Thus improvement in these techniques will lead to improve productivity.

7. Good Supervision and Management: - It avoids production inefficiency, maintenance problems, incorrect specifications, of materials and machines, provides good working environment and coordination.

8. Awareness and Training about Productivity: - Awareness should be created (workers and supervisors) among the manpower and they may be trained about measurement and advantages of productivity so that workers may start thinking and working
creatively. The training must include the process of work simplification method study, utilization of input materials, quality control, productivity and its socio-economic effects.

9. Incentives to Workers: - Incentive schemes for workers results in a considerable productivity improvement. However, the management should be aware about the correctness of the work standards, limitations of workers, short cut methods developed by workers quality of the work output and over burdening of the machines and other infrastructure facilities.

**Work Study: Method Study and Work Measurement**

Organization’s Most Important Jobs

- Finding the customers and retaining them. For this, continually provide maximum value for money (VFM) to the customers to sustain highest level of customer satisfaction.
- Improving overall productivity and thereby, minimizing the overall costs as much below the price as possible and thus maximizing profits.

**Value for Money to Customers (VFM)**

\[
\text{Value to customer (VFM)} = \frac{\text{Total quality “Q” X Total service inclusive of pre, during and post customer service “S” X Relationship with customers “R”}}{\text{Price “P” X Lead times “L”}}
\]

Therefore, value for money to customers should be continually enhanced by continual improvements in:

- Price: price being normally an outcome of the market forces of supply and demand, in order to make profits the overall costs should be kept well below those price levels. Only the price competitiveness can be achieved.
- Delivery.
- Quality.
- Service and relations.

**Productivity** - Productivity is the measure of output per unit of input.

Therefore, the equation for productivity = Output quantity/ Input quantity

It is important that the output should be an acceptable output to the users or customers. So enters the quality. Therefore, in order to reckon and emphasize qualitative changes in output and input, the equation of productivity will read as given below:

\[
\text{Productivity} = \frac{\text{Output quality and quantity}}{\text{Input quality and quantity}}
\]

Productivity, thus, can be improved by three ways:

- Increase output and keep input constant.
- Keep output constant and decrease input.
- Increase both, output as well as input making sure that the proportion of increase in output is more than that of input.

Normally, outputs are: goods (products) and/or services.

Normally, inputs are various resources: man (labor), machine (equipment), material, money (capital) and also, time and information.

**Work Study: The Pioneering Technique of Improving Value for Money and Productivity**

Work study, under the major discipline of industrial engineering, emerged as the earliest effectiveness and efficiency technique that even to date remains the basic to all other techniques that developed later. Work study was the sequel to Taylor’s famous scientific management.

Work study is defined as the systematic examination of the methods of carrying on activities so as to improve the effective use of resources and to set up standards of performance for the activities being carried out.

Work study has two major branches:

1. Method study
2. Work measurement

**Method Study**

Method study is the systematic recording and critical examination of existing and proposed ways of doing work, as a means of developing and applying easier and more effective methods and reducing costs.

It uses different sets of techniques to do so.

**Objectives of Method Study**

- Improvement in use of all the inputs i.e. men, machines, material, money and also, time and information.
- Economy in human effort and reduction of unnecessary fatigue.
- Layout improvements.
- Improvement in design of plant and equipment.
- Improvement in safety standards and procedures.
- Development of better working environment.

**Seven Steps of Carrying Out Method Study: The Process**

1. Define existing method.
2. Record existing method.
3. Examine existing method.
4. Develop new method.
5. Define new method.
6. Install new method.
7. Maintain new method.

**Different Recording Techniques**

- Outline process charts
- Flow process chart: man type, material type, equipment type
- Two handed process chart
- Multiple activity chart: using time scale
- Simo chart: using time scale
- Flow diagrams
- String diagrams
Some Details on Step 3 of the Process of Method Study i.e. Examine

Examine step uses questioning technique. Each activity of the method under examination subjected to systematic and progressive series of questions. There are two types of questions asked:

1. **Primary questions**
2. **Secondary questions**

**Primary questions:**
- Purpose: for which activity is being done.
- Place: at which activity is being carried out.
- Sequence: in which activity is being performed.

**Secondary Questions**
- Person: by whom activity is being rendered.
- Means: by which activity is being accomplished.
- Rearrange and/or Simplify the activities

This primary examination is carried out with a view to
- Eliminate,
- Combine,
- Rearrange and/or
- Simplify the activities

**Secondary Questions** During the secondary questions, answers to the primary questions are subjected to further query to determine whether possible alternatives of place, sequence, persons and means are practicable and preferred as a means of improvement upon the existing method.

1. **Purpose:**
   - What is done?
   - Why is it done?
   - What else might be done?
   - What should be done?

2. **Place:**
   - Where is it done?
   - Why is it done there?
   - Where else might it is done?
   - Where should it be done?

3. **Sequence:**
   - When is it done?
   - Why is it done?
   - When might it be done?
   - When should it be done?

4. **Person:**
   - Who does it?
   - Why does that person do it?
   - Who else might do it?
   - Who should do it?

5. **Means:**
   - How is it done?
   - Why is it done that way?
   - How else might it be done?
   - How should it be done?

Some Details on Step 5 of the Process of Method Study i.e. Define New (Improved) Method

A report on new improved method should be prepared. It should include:
- Description of the method.
- Relative costs in material, labor and overheads of the new method and the existing method and expected savings.
- Cost of installing the new method, including cost of new equipment and of re-laying out shops or working areas.
- Diagram of the work place layout.
- Tools and equipment to be used and diagrams of jigs/fixtures etc.
- Executive actions required to implement the new method.

Some Details on Step 6 of the Process of Method Study i.e. Install New (Improved) Method

- Gaining acceptance of the change by the Management.
- Gaining acceptance of the change by the workers.
- Keeping a close eye on the progress of implementation of the new method till it starts running satisfactorily.

**Motion Economy Principles** - As an important part of method study, Frank Gilbreth and his wife Lillian Gilbreth, through their various experiments, institutionalized motion and time study through their famous motion economy principles. (You may find it very interesting to refer their biographical 1950 film and book Cheaper by the Dozen).

If one can study the motions and micro motions performed in carrying out an activity and economize on them- try to reduce them, the time taken for the activity can be significantly reduced.

For this, the movements are classified in 5 classes as given below:
- Class 1: Body members moved in this class are fingers and the pivot is knuckle.
- Class 2: Body members moved in this class are hands and fingers and the pivot is wrist.
- Class 3: Body members moved in this class are forearms, hands and fingers and the pivot is elbow.
- Class 4: Body members moved in this class are upper arms, forearms, hands and fingers and the pivot is shoulder.
- Class 5: Body members moved in this class are torso, upper arms, forearms, hands and fingers and the pivot is trunk.

Further, Gilbreth came out with the idea of conducting micro motion study. To facilitate it, a set of fundamental motions required for a worker to perform a manual operation was defined. The set consists of 18 elements, each describing a standardized activity. The set is called “therblig” (read Gilbreth in reverse order and you get this term “therblig” with ‘th’ treated as one letter). These are listed below:
- Search
- Find
- Select
- Grasp
- Hold
- Position
- Disassemble
- Assemble
- Use
- Transport unloaded
- Pre-position for next operation
- Inspect
- Transport loaded
- Release load
- Unavoidable delay
- Avoidable delay
- Plan
- Rest to overcome fatigue

**Classic Example of Early Application of Motion and Time Study as Done by Gilbreth in his Bricklaying Improvement**

Frank Gilbreth designed a special scaffold and a new brick laying procedure that reduced the movements needed from 18 to 5 and in one case to 2. The worker’s productivity increased from laying 120 bricks per hour to laying 350 bricks per hour. The new procedure also decreased fatigue.

**Work Measurement** - Work measurement is the application of techniques designed to establish the time for a qualified worker to carry out a task at a defined rate of working or at a defined level of performance.

It measures the time taken in performance of an operation or a series of operations and in can separate out ineffective time from effective time. Thus ineffective time can be studied and by way of method study described in earlier paragraphs, the ineffective operations can be reduced or eliminated.

**Fair Day’s Work** - Amount of work that can be produced by a qualified worker/employee when working at normal pace and effectively utilizing his time and where work is not restricted by process limitations.

**Objectives of Work Measurement**
- Finding ineffective time in an activity or a process (series of activities).
- Setting standard (norms) for output level.
- Evaluating workers’ performance.
- Assessing and planning manpower needs.
- Determining available capacity.
- Comparing various work methods.
- Facilitating operations scheduling.
- Establishing wage incentive schemes.

**Some Techniques of Work Measurement**
- Stop-watch time study.
- Work sampling.
- Predetermined time standards (PTS).
- Standard Data.

**Conceptual Framework for Carrying Out Work Measurement**

It is essential to understand the following concepts in order to undertake work measurement exercise in any organization:

- **Qualified worker**: Qualified worker is one who is accepted as having the necessary physical attributes, who possess the required intelligence and education and who has acquired the necessary skills and knowledge to carry out the work in hand to satisfactory standards of safety, quantity and quality.
- **Standard rating**: Rating is the assessment of the worker’s rate of working relative to the observer’s concept of the rate corresponding to standard pace (or standard rate).
- **Standard performance (pace or rate)**: It is the rate of output which a qualified worker will naturally achieve without overexertion as an average over the working day or shift, provided that he knows and adheres to the specified method and provided that he is motivated to apply himself to his work. The time taken to achieve the standard performance by the qualified worker is called “standard time”.

**Steps in Carrying Out Work Measurement (Determining the Standard Time): The Process**

1. Obtain and record all available information about the job, the worker and the surrounding conditions likely to affect the execution of the work.
2. Record the complete description of the method, break it down into elements.
3. Measure with a stopwatch and record the time taken by the worker to perform each element of the operation.
4. Assess the rating of the worker.
5. Extend the observed time to “basic time” by factorizing the actual time (observed time) by the assessed rating.
6. Determine the allowances (e.g. personal allowances, relaxation allowances, allowances for the working conditions etc) to be made over and above the “basic time” for the operation.
7. Apply those allowances on the “basic time”.
8. Thus, determine the “standard time” for the operation.

**Value Engineering**

Value engineering is an approach to productivity improvement that attempts to increase the value obtained by a customer of a product by offering the same level of functionality at a lower cost.

The term **Value Engineering** is sometimes used to refer to the application of this process of cost reduction prior to manufacture, while **Value Analysis** refers to the process when applied to products currently being manufactured.

Both attempt to eliminate costs that do not contribute to the value and performance of the product or service. The approach is more common in manufacturing.
VE originated in General Electric (under Lawrence Miles) during the Second World War. They were seeking ways to make the most efficient use of war-limited funds and raw materials. They found in most cases alternative materials and processes delivered performance and cost at least as good and often better than the original. This led them to formalise the approach and devise a team-oriented technique that determines the value of each part and each product.

Value engineering critically examines the contribution made to product value by each feature of a design. It then looks to deliver the same contribution at lower cost.

**Different types of value are recognised by the approach:**

- **Use value** relates to the attributes of a product which enable it to perform its function.
- **Cost value** is the total cost of producing the product.
- **Esteem value** is the additional premium price which a product can attract because of its intrinsic attractiveness to purchasers.
- **Exchange value** is the sum of the attributes which enable the product to be exchanged or sold.

Although the relative magnitude of these different types of value will vary between products, and perhaps over the life of a product, VE attempts to identify the contribution of each feature to each type of value through systematic analysis and structured creativity-enhancing techniques.

Value engineering programs are best delivered by multi-skilled teams consisting of designers, purchasing specialists, operations personnel, and financial analysts.

**Pareto analysis** is often used to prioritise those parts of the total design that are most worthy of attention. These are then subject to rigorous scrutiny. The team analyses the function and cost of those elements and tries to find any similar components that could do the same job at lower cost.

Common results are a reduction in the number of components, the use of cheaper materials, or a simplification of the process.

**Value Analysis: Meaning, Phases, Merits and Limitations**

Value Analysis 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”.

**What is Value Analysis?**

Before understanding the meaning of phrase “value analysis” or “value engineering”, let us know about value. ‘Value’ is one of those terms having good many connotations and even contradictory definitions.

‘Value’ is a word that is very often used by individuals without being clearly understood. Forget about common people. Even different departments of the same organisation have different opinions of the ‘value’ of the product that the company manufactures.

The designer equates value with reliability; purchase people with price paid for them; production personnel with that of cost from the angle of manufacture; sales people with what customer is willing to pay.

In the field of value investigation, value refers to economic value, which itself can be subdivided into four types as cost value, exchange value, use value and esteem value.

“Cost Value” is the measure of sum of all costs incurred in producing the product. The ‘cost value’, therefore is the sum of raw material cost, labour cost, tool cost and overheads expended to produce the product.

“Exchange Value” is the measure of all the properties, qualities and features of the product which make the product possible of being traded for another product or for money. In a conventional sense, ‘exchange value’ refers to the price that a purchaser will offer for the product, the price being dependent upon the satisfaction value which derives from the product.

Value derived from the product consists of two components namely (a) value due to reliability of performance of the product and the value which the possession bestows upon the buyer. These are often referred to as “value in value” and “esteem in value”.

“Use Value” is the measure of properties, qualities and features which make the product accomplish a use, work or service. Use value, therefore, is the price paid by the buyer or the cost incurred by the manufacturer in order to ensure that the product performs its intended function efficiently.

Use value in the fundamental form of economic value. An item without use value can have neither exchange value nor esteem value. “Esteem Value” is the measure of properties, features, attractiveness graphic packaging and the like which increases sales appeal or which attracts customers and create in them a strong desire to own the product.
"Esteem value", therefore, is the price paid by the buyer or the cost incurred by the manufacturer beyond the use value. It is the perception value.

**Value Analysis Proper:** Value analysis is an organised approach to identify unnecessary costs associated with any product, material, part, component, system or service by analysis of function and efficiently eliminating them without impairing the quality functional reliability or its capacity to give service.

According to Society of American Value Engineers (SAVE) “Value analysis is the systematic application of recognised techniques which identify the function of a product or services establish a monetary value for the function and provide the necessary function reliability at that lowest overall cost.”

Mr. Lorry D. Miles production engineer working at General Electicals of USA defined it as “Value analysis is the study of the relationship of design, function and cost of any material or service with an object of reducing its cost through modification of design or material specifications, manufacture by more efficient process, changes in sources of supply, elimination or incorporation into another item.”

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

**It is a rational and structured process consisting of:**

(a) Functional analysis to define the reason for the existence of a product or its components,
(b) Creatively analysis for generating new and better alternatives and
(c) Measurement for evaluating the value of present and future concepts.

The phrase value analysis can be defined as a technique which examines the facts of a function and cost of a product in order to determine whether the cost can be reduced or altogether eliminated, while retaining all the features of performance and quality of a product or both.

Therefore, logically, VA is an organised approach of exposing and eliminating unnecessary costs. The method has logical foundation in its fundamental approach to cost reduction and profit improvement and in this objective approach, the VA techniques has to analyse the functional cost of an item and recommend a change.

Put alternatively, VA is a team approach to think functionally about a component as to “what it does” rather than “what it is”.

This approach is the real test of understanding problems under study.

**Value Analysis and Value Engineering:** ‘VA’ and ‘VE’ are closely related terms so much so that many people use them interchangeably. Though the philosophy understanding the two is the same the identification of unnecessary costs yet they are different. The difference lies in the time and stage at which the technique is applied.

“Value Analysis” is the application of a set of techniques to an existing product with a view to improve its value. Thus, it is remedial process. “Value Engineering” is the application of exactly the same set of techniques to a new product at the design stage project concept or preliminary design when no hardware exists to ensure that bad features not added. Thus, it is a ‘preventive’ measure. In that sense, ‘VE’ is fundamental and VA is collateral because ‘prevention is better than cure.”

**Value Analysis versus Other Conventional Approaches:** Speaking in terms of “cost reduction” value analysis is an effective tool of cost reduction which differs from established conventional approaches such as industrial engineering, production engineering, methods engineering and the like.

The “traditional” or “conventional” approaches differ from this non-conventional or modern technique of VA as under:

**First:** Traditional approaches concern “post-production” stage but V.A. can be the ‘pre-production’ as well as “post production stage” technique.

**Second:** Traditional approaches are “methods concerned”. They accept the drawing of the part “as is” and, therefore, set to improve the part through analysis of manufacturing methods, machines, materials, tools, jigs and fixtures and the like.

On the other hand, ‘VA’ does not accept the designed product and its components “as is” but advocates cost reduction through identification of the function and subsequent redesign of the product so as to make it perform its functions at the lowest possible cost.

‘VA’, therefore, challenges the very design specifications, design requirements and the design itself.

**Third:** Traditional methods are mere “cost centered” while VA, in addition to cost improvement, usually seeks to improve quality, reliability, maintainability, safety, performance and alluring features.

**Fourth:** VA is more potent than traditional cost reduction techniques. Instances can be brought to surface to demonstrate that VA can remove ten to twenty percent of cost after the traditional methods of cost reduction have applied.

Award of warning is essential at this stage, Inspite of VA’s better potential and greater effectiveness, it is not a substitute nor is it intended to replace effective cost reduction techniques which have been in use for many years and have proved effective and
Valuable in their areas of application. What can be said is that VA can augment or strengthen the process of cost reduction and quality improvement.

**Phases of Value Analysis:** As an exercise, the phases of value analysis are:

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 familiarisation, 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 analysed 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. Now 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. Thus, 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:** - In case of tooth brushes, those in 1930's were flat and hard, over 60 to 70 years brushes have come making brushing teeth easy, cosy and dosy 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 organisational 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) Inertia
(d) Lack of knowledge and patience
(e) Attitude of ‘It will not work in India
(f) We are very small or very big
(g) This has been tried earlier and failed
(h) The change is too big
(i) ‘Let competitors try before we try’
(j) Difficulty of teams meeting or team meeting for getting consensus.

These limitations are man-made and can be over-come once the company decides 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.

Work Sampling: Definition, Theory and Confidence Level of Work Sampling

Definition: “Work sampling is a method in which a large number of instantaneous observations are made at random time intervals over a period of time or a group of machines, workers or processes/operations. Each observation records what is happening at that instant and the percentage of observations recorded for a particular activity or delay/idleness is a measure of the percentage of time during which that activity or delay/idleness occurs”.

Work sampling has a long and impressive list of applications but all of them fall into one of the following three categories:

(i) Work sampling can be used as ratio study of working and idle times.
(ii) It can be utilized as performance sampling study in which working and idleness on working times are measured and a performance index is prepared.
(iii) It can be used as a work measurement technique.

Theory of Work Sampling: - It states that the percentage of observations recorded on an operation/process in any state is a reliable estimate of the percentage time the operation/process is in that state, provided, “sufficient number of observations are taken at random”.

It may be noted that here, particular stress should be paid on the words “random” and “sufficient number of observations”. In this technique, some error may occur but the magnitude of error tends to decrease as the number of samples increases.

Work sampling is a sampling method and depends upon the laws of probability. A sample taken at random from a large population provides a good estimate of the distribution of the population. To make it clearer, let us consider the following example.

A worker while working during his shift either does the job assigned to him or remains idle for one or the other reason. The following table shows that out of total 50 observations, there were 45 working observations and five idle observations.

<table>
<thead>
<tr>
<th>State of worker</th>
<th>No of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working</td>
<td>45</td>
</tr>
<tr>
<td>Idle</td>
<td>5</td>
</tr>
</tbody>
</table>

This table indicates the working time and idle time.

In this Example, the idle time percentage would be 5/50 x 100 = 10%
Working time would be 45/50 x 100 = 90%

This investigation is for one worker for a shift of 8 hours a day and indicates that the operator was idle for 10% or 48 minutes in a shift of 8 hours (480 minutes) while working for 90% or 432 minutes in one shift.

Confidence Levels:

The results obtained by work sampling technique differ considerably from the results actually achieved by continuous recording of time. The accuracy of result depends upon the number or observations and the limits of confidence level because the sampling procedure used involves certain degree of error. So it is important to decide, what level of confidence is desired the final “Work Sampling” results.

During a investigation, if we increase the number of observations considerably and in each observation then number of activities are large we can obtain a smoother curve called normal distribution curve as shown in Fig. 7.1.

The most common confidence level is 95%. The area under the curve at 2 sigma or two standard deviations is 95.45% which is rounded off
Safety and Security Management: Meaning, Causes and Other Details!

**Meaning and Importance:** Safety refers to the accidents, stated differently. It also refers to the protection of workers from the danger of accidents. Employee safety and security refers to the protection of workers from the dangers of industrial accidents. An accident is an unplanned and uncontrolled event, which can be major or minor, partial or total. In any case a worker gets disabled, it can affect the productivity. So, an accident-free plant is expected from the employers.

**Causes of Accidents:** There are three factors that contribute to accidents. These causes can be work-related causes, unsafe acts by the employees, or chance occurrences. The work-related factors can be defective equipment, inadequate safety devices, poor housekeeping and absence of maintenance of machines, which can result in accidents. Unsafe acts can be due to carelessness of the workers and use of unsafe procedures. The other causes can be due to bad working conditions, very long hours of work, carelessness in handling materials and lack of training. All these accidents can increase the cost of production directly or indirectly. Therefore, the management should take enough care to reduce the accidents to the minimum.

**Techniques for Improving Safety and Security of Employees:**

1. **Safety programmes:** This deals with prevention of accidents, minimization of losses, and damages to the property and life of the employees. There are five principles for a safety programme.
   a. Industrial accidents can take place due various reasons such as lack of good leadership, lack of motivation from the management and insufficient safety mechanisms. The root cause has to be traced out.
   b. Identify the potential hazards and provide effective safety facilities.
   c. The top management should have safety policies, which should be continuously monitored.
   d. The accountability of the personnel should be determined for the safety performances.
   e. Thorough training and education regarding the safety measures and devices.

2. **Safety organization:** An organization can set up a safety committee and a safety director for deciding various safety programmes to be conducted in an organization. A safety programme must be developed to educate and train the employees to avoid mechanical as well as personal hazards.

3. **Safety engineering:** The important function of safety engineering is to eliminate all the possible risks due to processes, handling of machines or equipment’s. Safety equipment such as glasses, gas masks, and gloves should be provided free for protection.

4. **Safety education and training:** Safety education for all levels of management and for every employee is a must. The main objective of safety education is two-fold: first, to develop safety consciousness among the personnel and second, to ensure safe performance by developing the skills of the employees. Training gives immediate knowledge that can help the employees understand the hidden hazards, the knowledge to prevent accidents, safe handling of materials, and good housekeeping.

5. **Safety contests:** Some organizations encourage safety competitions among their departments to emphasize the importance of safety.

6. **Disciplinary action:** An organization can take action against any employee in case they are found guilty of any violations. The safety programme and safety policy is based on the well-being of employees, and it stresses the fact that human resources are the most valuable assets, and their safety is the greatest responsibility.

**Need for Safety:** There are certain benefits enjoyed by the organization as well as the employees when the plants become accident free. International Labour Organization (ILO) observes 28 April as the World Safety and Health Day just to give significance for safety at work.

**Benefits to the Organization:**

1. There is substantial savings in costs.
2. This can reduce the wastages to the minimum.

Sample Size Determination. To obtain a desired accuracy level an analyst is required to take sufficient number of observations. Following formula may be used for finding the requisite number of observation in order to achieve the desired accuracy:

\[
\text{Limit of error} = Sp \sqrt{\frac{p(1-p)}{N}}
\]

Where \( x = 1, 2 \) or 3 for confidence level of 68%, 95% and 99% or one sigma, two sigma three sigma confidence levels respectively. **S** = Desired relative accuracy. **P** = Percentage occurrence of an activity or delay expressed in decimal e.g. 10% = 0.10. **N** = Sample size or total number of random observations.

The formula gives 95% This indicates that the probability is 95% of the time the random, observations will be true or represents the fact and 5% of the time false or will not. For majority of cases, an accuracy of 5% is considered satisfactory. This is usually referred to as the percentage standard error.

**Meaning and Importance:** Safety is a system of measures and planning for making an organization accident-free. It also refers to the protection of workers from the dangers of industrial accidents. Employee safety and security refers to the protection of workers from the dangers of industrial accidents. An accident is an unplanned and uncontrolled event, which can be major or minor, partial or total. In any case a worker gets disabled, it can affect the productivity. So, an accident-free plant is expected from the employers.

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**Benefits to the Organization:**

1. There is substantial savings in costs.
2. This can reduce the wastages to the minimum.
3. Safety can also ensure optimum utilization of resources.
4. All the above reasons can contribute to improvements in productivity.
5. Financial losses that accompany accidents can be avoided.
6. The employees are less worried about their safety, which can improve their efficiency.
7. The penalty for non-compliance of safety measures can be avoided.

**Benefits to the Employee:**
1. Increased earnings of a company improve the earnings of a worker.
2. This can boost up the morale of the employees.
3. The workers are less worried about their safety.
4. They are motivated to work better.
5. This can again improve their efficiency.
6. Employees in a safe plant can devote more time for improving the quality and quantity of their output.
7. They can spend less time in worrying about their well-being and safety.

**Accident prevention in radiotherapy**

**INTRODUCTION**

Preparation and execution of radiotherapeutic treatment is a complex task with many inherent hazards. When considering the potential risks in radiotherapy, it should, however, always be recognised that the treatment has a potential substantial benefit to the patient.

In attempting to avoid accidents in radiotherapy, it is very important to remember the lessons that can be learned from previous radiotherapy accidents and to ensure that preventive actions are applied in a clinical setting. A number of accidents have been thoroughly investigated and the lessons learned have been disseminated by the International Atomic Energy Agency (IAEA). The International Commission on Radiological Protection (ICRP) has summarised causes and contributory factors for radiotherapy accidents in 2000.

Prevention of accidents in radiotherapy involves applying several layers of preventive actions, addressing this issue at several levels. It is suggested that these layers encompass:

1. Actions where potential deviations from intended dose and geometry can be found before the first irradiation-fraction of the patient;
2. Actions where deviations can be found during or after the treatment course;
3. Application of safety-technology;
4. Application of safety procedures; and
5. Actions where contributing factors such as staffing-levels and structure, training and communication are addressed.

The first objective of this review is to assess common aspects of lessons learned from major radiotherapy accidents in order to highlight patterns seen during accidents. This follows a review performed by the author of the creation of an IAEA regional training course on prevention of accidental exposure in radiotherapy. The second objective is to identify actions within the preventive layers as suggested above.

**PREVENTIVE MEASURES**

Human errors should always be expected, leading to the conclusion that there should be defences in place. When a hazard is realised, it is due to weaknesses in this defence. These weaknesses can be seen as a combination of two factors, with the first factor being active failures (mistakes, lapses and procedural violations) and the second factor being latent conditions (i.e., conditions built into the system such as understaffing, high workload, and inadequate procedures or equipment). This approach follows Reason’s model. Several layers of preventive actions should be put in place.

**Actions where potential deviations from intended dose and geometry can be found before the first irradiation-fraction of the patient**

Independent verification of calculations has been seen to be lacking in several of the accidents presented above. There are indications that a recently reported accident in Glasgow might have been prevented if a truly independent calculation check had been used. The independency of the check is vital to be able to find parameters that are not the same as intended. Many mistakes in the calculation process are due to mistakes in the act of transferring information. Another example of action in this safety-layer is clinical peer review of treatment preparation (e.g., dose and volume to be irradiated).

**Actions where deviations can be found during or after the treatment course**

In vivo dose measurement is a way of finding deviations after one or a few treatment fractions. This is regularly performed with diodes. Systematic dose deviations as low as about 1-2% that affected large groups of patients, have been found by diode systems. Another action belonging to this safety-layer is clinical monitoring of adverse effects in patients.

**Application of safety-technology**
An example of safety-technology to serve as a safety layer for the prevention of radiotherapy accidents is integrated radiotherapy networking. This implies the automatic transfer of parameters and images as well as the RV-system on linear accelerators. The most comprehensive level is the full integration of images and parameters throughout the treatment chain, without breaking the chain for manual transfer of information. However, a department often has a mix of electronic and manual parameter transfer. It should also be recognised that even if the full integration of equipment decreases the likelihood of mistakes in transfer of information, it does not necessarily remove the mistakes done in the creation of information. Video and audio monitoring of patients are more examples from this safety-layer.

Application of safety procedures

There are many types of safety procedures to be put in place in order to increase safety in radiotherapy. One example is the utilisation of an incident reporting system. This has been successfully employed in a non-medical setting for many years, enhancing safe practice. The objective is for the organisation to learn from events within and outside the organisation. Potential incidents (near misses) are important in this context. Another example here is the use of documentation systems for procedures.

The Difference Between Quality Assurance and Quality Control

It is important for an organisation to agree on what the meanings of Quality Assurance (QA) and Quality Control (QC). Both form an integral part of the organisation's quality management plan, and the effectiveness of delivery teams relies on the differences being well understood by all stakeholders, including management.

Effective quality systems can contribute enormously to the success of projects, but the counterpoint is that, when poorly understood, the quality systems are likely to be weak and ineffective in ensuring that the delivered system is delivered on time, built by the team within their allocated budget, and satisfies the customer’s requirements.

Introduction

How many times has it struck you that many practitioners involved in the ICT field lack an understanding of the difference between Quality Assurance and Quality Control? Often you will hear someone talk about ‘QA’, when what they actually mean is ‘QC’.

This ambiguity consistently throws up problems and is a sure way of undermining a project. Projects are negatively affected as it tends to lead to strained conversations and makes reaching consensus difficult.

Although QA and QC are closely related concepts, and are both aspects of quality management, they are fundamentally different in their focus:

-QC is used to verify the quality of the output;

- QA is the process of managing for quality.

Achieving success in a project requires both QA and QC. If we only apply QA, then we have a set of processes that can be applied to ensure great quality in our delivered solution, but the delivered solution itself is never actually quality-checked. Likewise, if we only focus on QC then we are simply conducting tests without any clear vision for making our tests repeatable, for understanding and eliminating problems in testing, and for generally driving improvement into the means we use to deliver our ICT solutions.

In either case, the delivered solution is unlikely to meet the customer expectation or satisfy the business needs that gave rise to the project in the first place.

Understanding the Difference between QA and QC

So, what exactly is the difference between Quality Assurance (QA) and Quality Control (QC)?

A good point of reference for understanding the difference is the ISO 9000 family of standards. These standards relate to quality management systems and are designed to help organisations meet the needs of customers and other stakeholders.

In terms of this standard, a quality management system is comprised of quality planning and quality improvement activities, the establishment of a set of quality policies and objectives that will act as guidelines within an organisation, and QA and QC.

In the ISO 9000 standard, clause 3.2.10 defines Quality Control as:

“A part of quality management focused on fulfilling quality requirements”

“A part of quality management focused on providing confidence that quality requirements will be fulfilled”

These definitions lay a good foundation, but they are too broad and vague to be useful. NASA, one of the most rigorous software engineering firms in the world, provides the following definitions

Software Quality Control: - "The function of software quality that checks that the project follows its standards, processes, and procedures, and that the project produces the required internal and external (deliverable) products"

Software Quality Assurance: - "The function of software quality that assures that the standards, processes, and procedures are appropriate for the project and are correctly implemented"
Simply put, Quality Assurance focuses on the process of quality, while Quality Control focuses on the quality of output.

### Quality Assurance: a Strategy of Prevention

QA is focused on planning, documenting and agreeing on a set of guidelines that are necessary to assure quality. QA planning is undertaken at the beginning of a project, and draws on both software specifications and industry or company standards. The typical outcomes of the QA planning activities are quality plans, inspection and test plans, the selection of defect tracking tools and the training of people in the selected methods and processes.

**The purpose of QA is to prevent defects from entering into the solution in the first place.** In other words, QA is a pro-active management practice that is used to assure a stated level of quality for an IT initiative.

Undertaking QA at the beginning of a project is a key tool to mitigate the risks that have been identified during the specification phases. Communication plays a pivotal role in managing project risk, and is crucial for realising effective QA. Part of any risk mitigation strategy is the clear communication of both the risks, and their associated remedies to the team or teams involved in the project.

### Quality Control: a Strategy of Detection

Quality Control, on the other hand, includes all activities that are designed to determine the level of quality of the delivered ICT solutions. **QC is a reactive means by which quality is gauged and monitored**, and QC includes all operational techniques and activities used to fulfil requirements for quality. These techniques and activities are agreed with customers and/or stakeholders before project work is commenced.

**QC involves verification of output conformance to desired quality levels.** This means that the ICT solution is checked against customer requirements, with various checks being conducted at planned points in the development lifecycle. Teams will use, amongst other techniques, structured walkthroughs, testing and code inspections to ensure that the solution meets the agreed set of requirements.

### Benefits of Quality Management

The benefits of a structured approach to quality management cannot be ignored. Quality Control is used, in conjunction with the quality improvement activity, to **isolate and provide feedback on the causes of quality problems**. By using this approach consistently, across projects, the feedback mechanism works towards identifying root-cause problems, and then developing strategies to eliminating these problems. Using this holistic approach ensures that teams achieve ever higher levels of quality.

As a consequence of formulating and executing a quality management plan the company can expect:

- Greater levels of customer satisfaction, which will very likely result in both repeat business, as well as referral business
- A motivated team that not only understand the policy objectives of the quality management plan, but who also actively participate in executing the plan
- Elimination of waste by eliminating rework arising from either the need to address bugs, or to address gaps in the solution’s ability to meet customer requirements
- Higher levels of confidence in planning, since the tasks arising from unplanned rework will fall away
- Financial rewards for the company, which are a consequence of new projects from existing and referral clients, as well as through the reduction of monies spent on rework tasks.

As the company’s quality management plan matures, the confidence of all stakeholders will grow. The company will be seen to be more effective and efficient in delivering an agreed ICT solution to clients.

### Dialog Information Technology

Dialog is a Premier Google for Work Partner and Microsoft Gold Partner in Australia and New Zealand, with over 1,200 full-time consultants and offices in all capital cities.

Dialog Information Technology provides expertise in Quality Control and Quality Assurance and services range from strategic IT consulting through full lifecycle application development and managed application services to long-term operational support.

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### Techniques of Applying Statistical Quality Control | Production Management

Important techniques of applying statistical quality control are: (A) Quality Control Charts and (B) Acceptance Sampling.

**A** Quality Control Charts: A quality control chart is a graphic presentation of the expected variations in quality. Certain presumptions are taken into consideration before drawing these charts e.g., inherent nature of certain variables in a product, tolerance limits and probability of chance in variations etc.

Tolerance limits are clearly shown by these charts with regard to a particular product. Variations in quality beyond these limits clearly disclose that the production process is out of control and the quality of the product has not been achieved in accordance with the predetermined standards. On the other hand, a process is said to be in control if the finished product remains within the tolerance limits.
Quality control charts are very helpful in spotting the causes responsible for variations from the set standards on the basis of information disclosed by these charts. Different types of quality control charts may be used for recording different types of analysis. Some of the important quality control charts are chart of averages and that of range etc. Information disclosed by these charts is very accurate and an authentic one.

(B) Acceptance Sampling: - This is another technique of statistical quality control. This is also referred as ‘Sampling Inspection plan.’ This method is usually followed after goods have been produced or are in the final stage of production. Thus, it can be said that it is a post mortem of the quality of the product that has already been produced. Under this method, a sample of the product produced is selected at random to study in detail whether the product conforms to the pre-determined standards or not. A limited percentage of defective products are allowed.

But it has been observed that sometimes the sample selected turns out to be good, but the lot represented by the sample may be defective or sub-standard. In order to have more accurate and exact results, more than one sample of the product should be selected for carrying out the Sampling Inspection Plan.

The technique Acceptance Sampling undertakes two limiting levels of quality viz., (i) The Acceptable Quality Level (AQL) i.e. the least number or percentage of defective products that the buyer expects to purchase and the seller expects to sell and (ii) The Lot Percentage Tolerance Defective (LPTD) refers to that limit where the buyer wants to be certain about the rejection of the lot.

This technique can be greatly helpful for improving relations between vendor and the customer which may be adverse on account of disputes relating to quality. Both the parties may sit together and mutually decide the limits within which quality should be accepted.

Advantages of Statistical Quality Control: Following are the important benefits derived from the technique of statistical quality control:

(1) Lesser cost of inspection: - Statistical quality control is based on sampling technique which involves lesser cost of inspection thereby cost of production is considerably reduced.

(2) Increase in profits: - By minimising rejections, statistical quality control ensures the production of standard products which bring higher profits for the producer.

(3) Setting tolerance limits: - Quality control charts clearly lay down the tolerances limits beyond which the product is to be rejected. The results shown by these charts are more authentic and correct.

(4) Develops quality consciousness: - Statistical quality control is greatly helpful in developing the feeling of quality consciousness among the workers working in an organisation. This improves their functioning and reduces the number of defective operations undertaken by them.

(5) Enhances reputation of the concern: - By adopting the techniques of statistical quality control, pre-determined quality of the product is achieved and consumers get desired quality products. This brings good name to the firm and increases its goodwill among the people.

(6) Improved relations between vendor and customers: - It is greatly helpful in improving relations between supplier and the purchaser of material, by clearly fixing the tolerance limits with regard to quality of the goods supplied. This minimises the possibility of any dispute between both the parties.

Besides the above mentioned benefits, statistical quality control ensures smooth and unrestricted production by removing breakdown of machinery and work stoppages as it greatly helps in detection of the troubles soon, which are immediately corrected without delay.

Quality Control: Concept, Significance and Techniques | Business

(I) What is Quality?

Quality may be defined as follows: - Quality is the degree of excellence a product possesses with respect to design of product and conformity with certain prescribed standards and specifications; so as to meet customers’ expectations most satisfactorily.

John D. Mclellan defines quality as follows: - “Quality is the degree to which a product conforms to specifications and workmanship standards.”

Points of Comment: - Certain pertinent observations on the concept of quality may be made as follows:

(i) Quality is a Subjective Concept: - A product which one thinks ‘as superior’, may be rated as ‘inferior’ by some other, one.

(ii) Quality is a Relative Concept: - It is relative to the cost of the product i.e. quality is something which is consistent with the price of the product.

(iii) Quality is a conditional concept; i.e. the characteristic of quality has a meaning and relevance; only when it meets the purpose for which it is bought by a buyer.
(iv) **Quality is a dynamic concept**: i.e. the notion of quality changes with times. Products regarded in the past as possessing excellent quality may be looked down upon as substandard, by people of modern times.

(II) **What is Quality Control?**

**Quality control may be defined as follows**: Quality control involves establishment of quality standards and installation of systems to ensure that these standards are maintained and practiced.

Following are cited certain outstanding definitions of quality control:

1. “Quality control is systematic control of management of the variables in the manufacturing process that affects goodness of the end product.” — H.N. Broom.
2. “Quality control means the recognition and removal of identifiable causes of defects and variations from the set standards.” — J. A. Shubin
3. “Quality control is that industrial management technique or group of techniques by means of which products of uniform acceptable quality are manufactured.” — Alford and Beaty.

**Steps in the process of quality control:**

1. Establishing quality standards; in terms of size, design, durability, appearance etc., on the basis of customers’ preferences and cost of production.
2. Selecting the manufacturing process; this permits output of the required specifications.
3. Developing measurement techniques; to ensure whether production conforms to set specifications or not.
4. Monitoring product quality; which requires designing a system of periodical checks of the end product to find out deviations from set standards of a quality; and locating causes of such deviations.
5. Taking corrective action; to remove the causes of deviations

**Significance of Quality Control**:

1. **Cost Reduction and Profit Maximization**: Quality control helps in better utilisation of productive resources; and in elimination of all sort of wastes. Thus it leads to cost reduction and profit maximisation for the enterprise.
2. **Increase in Operational Efficiency**: Quality control implies control over quality of raw materials, performance of men and machines etc. Thus it brings about more operational efficiency of the organisation.
3. **Maximum Customer Satisfaction**: Quality control minimizes complaints from customers and results in maximum customer satisfaction. It is quality that brings customers back for a second time, third time and so on. Thus quality control leads to sales maximisation; and consequently profit maximisation.
4. **Good-Will and Image of the Enterprise**: Quality control builds goodwill of the enterprise in society. It makes for an image of the enterprise in the eyes of the public, due to the quality products offered by the enterprise.
5. **Insurance Against Heavy Losses**: Quality control protects the manufacturer against heavy losses which may be caused due to rejection of large quantity of sub-standard products.
6. **Promotes Employees’ Productivity**: Quality control inculcates a feeling of quality consciousness among employees; and promotes their productivity.
7. **Morale of Employees**: Quality control heightens morale of employees; as they feel that they are working for an enterprise producing goods of superior quality.

**Significance of quality control — at a glance**

| 1. Cost reduction and profit maximisation |
| 2. Increase in operational efficiency |
| 3. Maximum customer satisfaction |
| 4. Goodwill and image of the enterprise |
| 5. Insurance against heavy losses |
| 6. Promotes employees’ productivity |
| 7. Morale of employees |

**Techniques of Quality Control:**

(I) **Inspection**

Let us describe both these techniques.

(I) **Inspection**:

Inspection is that component of quality control programme which is concerned with checking on the performance of items to the specifications set for it. It involves periodic checking and measuring - before, during and after the production process. Because of the numerous variables that enter into manufacturing, inspection is a never ending process.

Inspection may be ‘Centralised’ or ‘Floor Inspection’:
Under centralized inspection, all the work from a department is sent to the Inspection Department, before passing on to the next operation. Floor inspection, on the other hand, follows the practice of sending inspectors to the floor and inspects work at the machines of operatives. It is also called patrolling or travelling inspection.

**Advantages of centralized inspection:**
(i) Centralised inspection ensures impartial supervision; because the inspector is not under the strain of not rejecting the work of a person with him he has good personal relations.
(ii) Under centralized inspection, it is easier to keep records of items/part which are approved or rejected.
(iii) Production work is liable to less interruption, under centralized inspection.

**Advantages of floor inspection:**
(i) Since work is inspected on the floor; delay in sending work to next station is avoided.
(ii) Inspector can immediately locate the fault and suggest rectification.
(iii) It involves minimum material handling.

**(II) Statistical Quality Control (SQC):**

- SQC is based upon the laws of probability. It is a system for controlling the quality of production within specified limits (tolerance limits) by means of a sample procedure and continuing analysis of inspection results.

*Grant defines SQC as follows:* “SQC is a simple statistic method for determining the extent to which quality goods are being met without necessarily checking every item produced and for indicating whether or not the variations which occur are exceeding normal expectations. It enables us to decide whether to reject or accept a particular product.”

**Point of Comment:** SQC does not produce a quality product. It merely informs management that things are not going as they should. Management must take necessary action to remove the causes of variations and ensure production of quality products.

**Inspections vs. SQC:** It is an interesting academic exercise to compare inspection and SQC.

**The two techniques of quality control may be compared as follows:**
(i) The result of inspection is acceptance or rejection of production; while SQC enables management to take action so that products will meet specifications. As such inspection enables one “to be wiser after the event” whereas SQC enables one “to get wiser before the event.”
(ii) Inspection can be cent per cent; while SQC always involves sampling.

**Techniques of SQC:**

- Techniques of SQC can be divided into two parts:
  (1) Process control
  (2) Acceptance sampling

**Following is a brief account of these techniques of SQC:**

**1. Process Control:**

   - The checking up of quality characteristics under process control is done with the help of charts. There may be many types of charts like ‘X-Chart’, ‘R-Chart’, ‘C-Chart’ and ‘P-Chart’. All types of charts are similar in composition and structure. All of them represent how quality characteristic is changing from one sample to another.

   **A control chart when prepared would appear as follows:**

   ![Control Chart](chart.png)

   **Note:** UCL = Upper Control Limit  
   LCL = lower control Limit

   A process is considered out of control and an action to check and correct the process is taken; when a plotted point falls outside the control limits.

   **Advantages of control charts:**

   1. They provide visual aids
   2. They are easy to prepare.
   3. They give early warning of trouble

**2. Acceptance Sampling:**

   - Control charts are useful for process control. In case of receipt of materials and dispatch of finished goods; a different method is used, that of acceptance sampling. Acceptance sampling plans are of utmost value when the nature of the process used to manufacture products remains unchanged.

   In acceptance sampling, decisions [e.g. whether acceptable/not acceptable (rejection)] about the quality of batches or lots are made after inspection of only a portion i.e. a sample. If the sample of items conforms to requisite quality levels; then the whole batch from which the sample is taken is accepted. If the sample does not conform to the requisite quality level; then the whole batch is rejected.

**An acceptance sampling is defined as:**

- **Lot size (N)**
  - **Sample size (n)**
  - **Acceptance number (C)**

   Suppose N = 9000; n = 300 and C = 7; then this sampling plan means that a lot of 9000 items has 300 units (sample size) inspected. If seven or less defectives are found in 300 units sample; the lot is accepted. If eight or more defectives are found in the sample; the lot is rejected.
A close study of acceptance sampling technique would reveal that there is likelihood that a lot of satisfactory quality is rejected on the basis of sample result. This is technically called producer’s risk. Similarly, the consumer (or buyer) has the risk of accepting a lot of unsatisfactory quality, on the basis of sample results. This risk is called consumer’s risk.

**Advantages of acceptance sampling:**

(i) Less expensive than 100% inspection  
(ii) Used where 100% inspection is not possible.  
(iii) Useful when inspection may cause damage or complete destruction.

**Advantages of SQC:**

(i) Reduced Cost: - Since only a fraction of output is inspected; costs of inspection are greatly reduced.  
(ii) Early Warning of Defects: - SQC gives an early warning of defects in the production process; so that these defects can be detected and corrected at inception.  
(iii) Simple Technique: - SQC techniques are simple and can be operated by semi-skilled operators.  
(iv) Continuous Inspection: - SQC is a technique which provides a continuous inspection of the product at various stages of the manufacturing process.  
(v) Adherence to Specifications: - SQC enables a process to be held in a state of statistical control i.e. a state in which variability is the result of chance causes alone.

**What is acceptance sampling?**

Acceptance sampling is a major component of quality control and is useful when the cost of testing is high compared to the cost of passing a defective item or when testing is destructive. It is a compromise between doing 100% inspection and no inspection at all. Acceptance sampling can be done on attributes or measurements of the product. You can use acceptance sampling to develop inspection plans that enable you to accept or reject a particular lot of incoming material based on the data from a representative sample.

**Example of an attribute acceptance sampling plan**

For example, you receive a shipment of 10,000 microchips. You either cannot or do not want to inspect the entire shipment. An attribute sampling plan can help you determine how many microchips you need to examine (sample size) and how many defects are allowed in that sample (acceptance number).

In this case, suppose your acceptable quality level (AQL) is 1.5% and the rejectable quality level (RQL) is 5.0%, and you assume alpha = 0.05 and beta = 0.1. Minitab generates a sampling plan that indicates that you need to inspect 206 chips. If 6 or less of the 206 inspected microchips are defective, you can accept the entire shipment. If 7 or more chips are defective, you must reject the entire shipment.

**Example of a variables acceptance sampling plan**

For example, you receive shipments of 2500 plastic pipe segments each week and you need to verify that the wall thickness measurements meet specifications. You either cannot or do not want to inspect the entire shipment. A variables sampling plan can help you determine how many pipes you need to measure (sample size) and the criteria for accepting or rejecting an entire lot (critical distance).

In this case, the lower specification for the wall thickness of the piping is 0.09". You and the supplier agree that the acceptable quality level (AQL) is 100 defectives per million and the rejectable quality level (RQL) is 300 defectives per million, and you assume alpha = 0.05 and beta = 0.1. Minitab generates a sampling plan that indicates that you need to measure 104 pipes and indicates that the critical distance is 3.5570. You can use the accept/reject tool in Minitab to indicate whether a shipment should be accepted or rejected.

**STATISTICAL PROCESS CONTROL**

Statistical Process Control (SPC), and its companion Statistical Quality Control (SQC), are tools utilized by a six sigma process. They are not the invented creations of the Japanese or of Edward Deming. However, Ed Deming taught SPC techniques to Japanese manufacturing, and, as a result, has become the default father of the SPC process. The original objective of SPC is to provide productivity and quality information about a production process real-time. The focus was on process control and continuous improvement. The operators become their own inspectors and control their own processes.

The SPC process should collect data and report results as the process is occurring, so that immediate action can be taken. This should help a process, and its quality measures, avoid straying beyond acceptable limits and would avoid the production of bad parts. When appropriately applied, SPC can virtually eliminate the production of defective parts. Additionally, SPC creates visibility of the cause of the failure. Since an operator is able to immediately recognize that a failure is occurring, he would be able to react to that failure and observe the cause of the failure, and then take corrective action. As Peter Drucker emphasizes, the "operators become the 'owners' of not just the process, but also the parts they produce."

**Example of variables acceptance sampling plan**

Suppose you have a steel pipe manufacturer that want to inspect 106 pipes of wall thickness and needs to determine the criteria for accepting or rejecting an entire lot (critical distance). In this case, you need to measure 104 pipes and indicate the criteria for accepting or rejecting the entire lot (critical distance).
Because of its success, SPC has found application in other industries, including service industries, transportation industries, deliver services, and can even be found in fast food and baggage handling. For example, on-time delivery performance can be monitored on an SPC chart.

Within the SPC process there are several tools. These tools include a change management process, the collection of data, and the display of the data. In the change management process we find the use of PDCA (Plan-Do-Check-Act). The objective is to solve problems by trial and error. The process includes (P) planning a work change, (D) executing the change, (C) monitoring the effects of the change to assure that the desired results are occurring, and taking corrective (A) action in the event that the desired results are not occurring—in effect repeating the PDCA cycle. The PDCA cycle is repeated until the error is reduced to zero.

In the SPC data collection process, the objective is to collect the necessary data that will be needed to validate that a specific process is occurring correctly. The methodology for measurement is established at the point where the appropriate data is collected. Only the data that is required for the monitoring of the process is collected. An analysis of the specific reasons for collection the data is important because any additional, unnecessary data collection is considered to be a waste. The accuracy of the measurement process is also confirmed.

There are several tools available for the display of SPC data. These include:

1. Graphs and Charts are used to display trends or to summarize the data. These tend to be bar or line graphs that report on a specific parameter of performance.
2. Check Sheets or Tally Sheets are used to take the raw data and reorganize it into specific categories that are being observed.
3. Histograms or Frequency distribution charts are used to translate raw data into a pictorial display showing the performance of specific quality characteristics.
4. Pareto Principles are used to prioritize the contribution effect of specific quality problems. This tool assists in identifying which problems have the largest impact on a specific quality problem under study.
5. Brainstorming is used to generate ideas by taking advantage of the synergistic power of a team of people.
6. Ishikawa Diagrams (Fishbone Charts) are used to create problem and solution visibility by grouping problem causes into branches. Often this is referred to as a cause and effect diagram. Using this tool in conjunction with the PDCA process helps to narrow down the root cause.
7. Control Charts are used to validate that the variation of measurement of a specific parameter is kept within a set of control limits.

In SPC, the most critical part of the process is the validation that you are measuring the right thing and thereby motivating the correct response. Additionally, if one measure can take the place of several measures, then that one measure should be identified, thereby simplifying the measurement process. Once a measurement has been selected, then we are ready to set up the data collection process and to establish control charts that will monitor the performance of this data.

The control charts are built around a specific product parameter that requires monitoring because of its impact on the over-all quality of the product. The following discussion is an extremely basic overview of the SPC process, and should not be considered to be sufficient for implementing an SPC process. Rather, this discussion is simply intended to give the reader and basic overview of the process.

The next step in the SPC process is to establish a set of control variables that includes an average (X) and a range (R). These can be established by going to the drawings and reviewing the initial part specifications using the expected value as X and the tolerance range as R. Or, these variables can be established using historical values and calculating the historical average (X) and range (R) for the data.

Having established an X and R value, we can calculate an Upper Control Limit (UCL) and a Lower Control Limit (LCL).

\[ UCL = X + R \]
\[ LCL = X - R \]

From these values, a pair of control charts is created. These charts are used to plot the SPC data as it occurs. They are used as a visual tool to monitor the process. Chart 1 is an example of two basic SPC charts which are monitoring a process. For these charts we will use X=1.23 and R=.45.

From Chart 1 we can see how the measurement data is recorded on the chart at the time each measurement occurs. The objectives behind this data collection process are several. One is to catch outliers in the data (anything above the UCL or below the LCL). These outliers are quality failures and must immediately stop the process. Another purpose for the
measures is to identify trends. For example data points 1 through 5 indicate a strong trend to failure approaching the LCL. Corrective action should be taken immediately to avoid the possibility of producing bad parts. Another objective can be seen in data points 7 through 13 which indicates that perhaps our LCL and UCL are too far and need to be brought in tighter, thereby giving us a higher level of performance and a higher level of quality.

Another methodology for applying SPC processes is by collecting data, not on every event, but on a random sampling of the event. This occurs when there is a large volume of activity and the time required to measure each event is too burdensome. A statistical sample is taken, and from that sample the average of the sample data (X) and the range of that sample (R = highest minus lowest measure) is calculated. For example, if our random sample size was 5 data points and our sample included the measures of 1.4, 1.45, 1.2, 1.3, and 1.65, then X = 1.4 and R = 1.65−1.2 = .45. This X value would then be the first data point plotted on Chart 1.

Using the statistical random sample, a Range chart would also need to be created. Chart 2 is an example of a range chart and the first data point of Chart would be the plot of the data corresponding to the example given. For this example, the lower limit is zero, which states that there is no deviation between each of the data points of that sample. The center point is R (.45) and the UCL is equal to 2 time R (.90).

In the example of the Range Chart (R Chart), the lower the value is better. A lot of vibration all over the chart suggests that the process may be going out of control. Also, a trend moving upwards as we see from data points 5 through 10 would indicate that a process is starting to go out of control and corrective action should be taken immediately.

With the X-Bar and R Charts, we can now create summarized reports, like the Histograms and Frequency Distributions that were discussed earlier. This allows a long term, summarized perspective of the process, rather than the chronological time-line that the X-Bar and R Charts offer.

There are systems and philosophies that go beyond SPC, which includes "Design of Experiments (DOE)" and "Concept Management." In DOE the

![Chart 2](image)

**Chart 2**

**R Chart**

focus is on front-end design work, rather than on SPC problem solving as you go. And Concept Management utilizes Total Quality Management (TQM) methodologies to implement continuous improvement change processes, once again in an attempt to identify and resolve potential problems before they occur. Additionally, Concept Management uses Breakthrough Thinking techniques rather than Root Cause Analysis to question the cause of problems.

Six Sigma, and one of it's primary tools SPC, have their roots in Japanese manufacturing process. But they have since become a key quality standard for the United States and Europe through their use of management principles and effective measurement tools.
Walter Shewhart, then working at Bell Telephone Laboratories first devised a statistical control chart in 1923; it is still named after him. He published his method in 1931 as *Control of Quality of Manufactured Product*. The method was first introduced at Western Electric Company's Hawthorn plant in 1926. Joseph Juran was one of the people trained in the technique. In 1928 he wrote a pamphlet entitled _Methods Applied to Manufacturing Problems_. This pamphlet was later incorporated into the _AT&T Statistical Quality Control Handbook_, still in print. In 1951 Juran published his very influential _Quality Control Handbook_.

W. Edwards Deming, trained as a mathematician and statistician, went to Japan at the behest of the U.S. State Department to help Japan in the preparation of the 1951 Japanese Census. The Japanese were already aware of Shewhart’s methods of statistical quality control. They invited Deming to lecture on the subject. A series of lectures took place in 1950 under the auspices of the Japanese Union of Scientists and Engineers (JUSE). Deming had developed a critical view of production methods in the U.S. during the war, particularly methods of quality control. Management and engineers controlled the process; line workers played a small role. In his lectures on SQC Deming promoted his own ideas along with the technique, namely a much greater involvement of the ordinary worker in the quality process and the application of the new statistical tools. He found Japanese executive receptive to his ideas. Japan began a process of implementing what came to be known as TQM. They also invited Joseph Juran to lecture in 1954: Juran was also enthusiastically received.

Japanese application of the method had significant and undeniable results manifesting as dramatic increases in Japanese product quality—and Japanese success in exports. This led to the spread of the quality movement across the world. In the late 1970s and 1980s, U.S. producers scrambled to adopt quality and productivity techniques that might restore their competitiveness. Deming’s approach to quality control came to be recognized in the United States, and Deming himself became a sought-after lecturer and author. Total Quality Management, the phrase applied to quality initiatives proffered by Deming and other management gurus, became a staple of American enterprise by the late 1980s. But while the quality movement has continued to evolve beyond its beginnings, many of Deming’s particular emphases, particularly those associated with management principles and employee relations, were not adopted in Deming’s sense but continued as changing fads, including, for example, the movement to "empower" employees and to make "teams" central to all activities.

**TQM PRINCIPLES**

Different consultants and schools of thought emphasize different aspects of TQM as it has developed over time. These aspects may be technical, operational, or social/managerial.

The basic elements of TQM, as expounded by the American Society for Quality Control, are 1) policy, planning, and administration; 2) product design and design change control; 3) control of purchased material; 4) production quality control; 5) user contact and field performance; 6) corrective action; and 7) employee selection, training, and motivation.

The real root of the quality movement, the "invention" on which it really rests, is statistical quality control. SQC is retained in TQM in the fourth element, above, "production quality control." It may also be reflected in the third element, "control of purchased material," because SQC may be imposed on vendors by contract.

In a nutshell, this core method requires that quality standards are first set by establishing measurements for a particular item and thus defining what constitutes quality. The measurements may be dimensions, chemical composition, reflectivity, etc.—in effect any measurable feature of the object. Test runs are made to establish divergences from a base measurement (up or down) which are still acceptable. This "band" of acceptable outcomes is then recorded on one or several Shewhart charts. Quality control then begins during the production process itself. Samples are continuously taken and immediately measured, the measurements recorded on the chart(s). If measurements begin to fall outside the band or show an undesirable trend (up or down), the process is stopped and production discontinued until the causes of divergence are found and corrected. Thus SQC, as distinct from TQM, is based on continuous sampling and measurement against a standard and immediate corrective action if measurements deviate from an acceptable range.

TQM is SQC—plus all the other elements. Deming saw all of the elements as vital in achieving TQM. In his 1982 book, _Out of the Crisis_, he contended that companies needed to create an overarching business environment that emphasized improvement of products and services over short-term financial goals—a common strategy of Japanese business. He argued that if management adhered to such a philosophy, various aspects of business—ranging from training to system improvement to manager-worker relationships—would become far healthier and, ultimately, more profitable. But while Deming was contemptuous of companies that based their business decisions on numbers that emphasized quantity over quality, he firmly believed that a well-conceived system of statistical process control could be an invaluable TQM tool. Only through the use of statistics, Deming argued, can managers know exactly what their problems are, learn how to fix them, and gauge the company’s progress in achieving quality and other organizational objectives.

**MAKING TQM WORK**

In the modern context, TQM is thought to require participative management: continuous process improvement; and the utilization of teams. Participative management refers to the intimate involvement of all members of a company in the management process, thus de-emphasizing traditional top-down management methods. In other words, managers set policies and make key decisions only with the input and guidance of the subordinates who will have to implement and adhere to the directives. This technique improves upper management’s grasp of operations and, more importantly, is an important motivator for workers who begin to feel like they have control and ownership of the process in which they participate.

Continuous process improvement, the second characteristic, entails the recognition of small, incremental gains toward the goal of total quality. Large gains are accomplished by small, sustainable improvements over a long term. This concept necessitates a long-term approach by managers and the willingness to invest in the present for benefits that manifest themselves in the future. A corol-
Teamwork, the third necessary ingredient for TQM, involves the organization of cross-functional teams within the company. This multidisciplinary team approach helps workers to share knowledge, identify problems and opportunities, derive a comprehensive understanding of their role in the overall process, and align their work goals with those of the organization. The modern “team” was once the “quality circle,” a type of unit promoted by Deming. Quality circles are discussed elsewhere in this volume.

For best results TQM requires a long-term, cooperative, planned, holistic approach to business, what some have dubbed a “market share” rather than a “profitability” approach. Thus a company strives to control its market by gaining and holding market share through continuous cost and quality improvements—and will shave profits to achieve control. The profitability approach, on the other hand, emphasizes short-term stockholder returns—and the higher the better. TQM thus suits Japanese corporate culture better than American corporate culture. In the corporate environment of the U.S., the short-term is very important; quarterly results are closely watched and impact the value of stocks: for this reason financial incentives are used to achieve short term results and to reward managers at all levels. Managers are therefore much more empowered than employees—despite efforts to change the corporate culture. For these reasons, possibly, TQM has undergone various changes in emphasis so that different implementations of it are sometimes unrecognizable as the same thing. In fact, the quality movement in the U.S. has moved on to other things: the lean corporation (based on just-in-time sourcing), Six Sigma (a quality measure and related programs of achieving it), and other techniques.

**PRACTICING TQM**

As evident from all of the foregoing, TQM, while emphasizing “quality” in its name, is really a philosophy of management. Quality and price are central in this philosophy because they are seen as effective methods of gaining the customer's attention and holding consumer loyalty. A somewhat discriminating public is thus part of the equation. In an environment where only price matters and consumers meekly put up with the successive removal of services or features in order to get products as cheaply as possible, the strategy will be less successful. Not surprisingly, in the auto sector, where the investment is large and failure can be very costly, the Japanese have made great gains in market share: but trends in other sectors—in retailing, for instance, where labor is imposed on customers through self-service stratagems—a quality orientation seems less obviously rewarding. For these reasons, the small business looking at an approach to business ideal for its own environment may well adapt TQM if it can see that its clientele will reward this approach. The technique can be applied in service and retail settings as readily as in manufacturing, although measurement of quality will be achieved differently. TQM may, indeed, be a good way for a small business, surrounded by “Big Box” outlets, to reach precisely that small segment of the consuming public that, like the business itself, appreciates a high level of service and high quality products delivered at the most reasonable prices possible.

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### Basic requirements of ISO-9000

This is a summary of principle requirements of ISO 9000. Use it to explain to managers and others what ISO requires and why. Most of these requirements are just common sense, and yet, many organizations fail to use that common sense.

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<tr>
<td>▪ The quality policy shall be defined, documented, understood, implemented and maintained.</td>
<td>▪ Incoming contracts (and purchase orders) shall be reviewed to verify whether the requirements are adequately defined, agreed to in bid and can be supplied.</td>
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<td>▪ Responsibilities and authorities for all personnel specifying, achieving and monitoring quality shall be defined.</td>
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<tr>
<td>▪ In-house verification resources shall be defined, trained and funded.</td>
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<td>▪ A designated management person sees that the Q91 program is implemented and maintained.</td>
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<tr>
<th>2. Quality System</th>
<th>4. Design Control</th>
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<td>▪ Procedures shall be prepared.</td>
<td>▪ The design project shall be planned.</td>
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<td>▪ Procedures shall be implemented.</td>
<td>▪ Design input parameters shall be defined.</td>
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<td>▪ Design output, including crucial product characteristics, shall be documented.</td>
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<td>▪ Design output shall be verified to meet input requirements.</td>
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<td>▪ Design changes shall be controlled.</td>
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<td>▪ Generation of documents shall be controlled.</td>
<td>▪ The products shall be identified and traceable by item, batch or lot during all stages of production, delivery and installation.</td>
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<tr>
<td>▪ Distribution of documents shall be controlled.</td>
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<tr>
<td>▪ Changes to documents shall be controlled.</td>
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The requirements for written documentation under ISO 9000 are often exaggerated. The standard unconditionally requires documentation for only a few items. However, common sense, experience, and the Auditors may demand documentation beyond the minimum requirements.
### 6. Purchasing
- Potential subcontractors and sub-suppliers shall be evaluated for their ability to provide stated requirements.
- Requirements shall be clearly defined in contracting data.
- Effectiveness of the subcontractor's quality assurance system shall be assessed.

### 7. Customer-Supplied Material
- Any customer-supplied material shall be protected against loss or damage.

### 9. Process Control
- Production (and installation) processes shall be defined and planned.
- Production shall be carried out under controlled conditions: documented instructions, in-process controls, approval of processes and equipment, and criteria for workmanship.
- Special processes that cannot be verified after the fact shall be monitored and controlled throughout the processes.

### 10. Inspection and Testing
- Incoming materials shall be inspected or verified before use.
- In-process inspection and testing shall be performed.
- Final inspection and testing shall be performed prior to release of finished product.
- Records of inspection and test shall be kept.

### 11. Inspection/Measuring/Test Equipment
- Equipment used to demonstrate conformance shall be controlled, calibrated and maintained.
- Identify measurements to be made.
- Identify affected instruments.
- Calibrate instruments (procedures and status indicators).
- Periodically check calibration.
- Assess measurement validity if found out of calibration.
- Control environmental conditions in metrology lab.
- Measurement uncertainty and equipment capability shall be known.
- Where test hardware or software is used, it shall be checked before use and rechecked during use.

### 12. Inspection and Test Status
- Status of inspections and tests shall be maintained for items as they progress through various processing steps.
- Records shall show who released conforming product.

### 13. Control of Nonconforming Product
- Nonconforming product shall be controlled to prevent inadvertent use or installation.
- Review and disposition of nonconforming product shall be formalized.

### 14. Corrective Action
- Problem causes shall be identified.
- Specific problems and their causes shall be corrected.
- Effectiveness of corrective actions shall be assessed.

### 15. Handling, Storage, Packaging & Delivery
- Procedures for handling, storage, packaging and delivery shall be developed & maintained.
- Handling controls shall prevent damage and deterioration.
- Secure storage shall be provided. Product in stock shall be checked for deterioration.
- Packing, preservation and marking processes shall be controlled.
- Quality of the product after final inspection shall be maintained. This might include delivery controls.

### 16. Quality Records
- Quality records shall be identified, collected, indexed, filed, stored, maintained and dispositioned.

### 17. Internal Quality Audits
- Audits shall be planned and performed.
- Results of audits shall be communicated to management.
- Any deficiencies found shall be corrected.

### 18. Training
- Training needs shall be identified.
- Training shall be provided.
- Some tasks may require qualified individuals.
- Records of training shall be maintained.

### 19. Servicing
- Servicing activities shall be performed to written procedures.
- Servicing activities shall meet requirements.

### 20. Statistical Techniques
- Statistical techniques shall be identified.
- Statistical techniques shall be used to verify acceptability of process capability and product characteristics.

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ISO 9000

ISO 9000 is a set of international standards of quality management that have become increasingly popular for large and small companies alike. "ISO is grounded on the 'conformance to specification' definition of quality," wrote Francis Buttle in the *International Journal of Quality and Reliability Management*. "The standards specify how management operations shall be conducted. ISO 9000's purpose is to ensure that suppliers design, create, and deliver products and services which
meet predetermined standards; in other words, its goal is to prevent non-conformity." Used by both manufacturing and service firms, ISO 9000 had been adopted by more than 100 nations as their national quality management/quality assurance standard by the end of 1997.

This quality standard was first introduced in 1987 by the International Organization for Standards (ISO) in hopes of establishing an international definition of the essential characteristics and language of a quality system for all businesses, irrespective of industry or geographic location. Initially, it was used almost exclusively by large companies, but by the mid-1990s, increasing numbers of small-and mid-sized companies had embraced ISO 9000 as well. In fact, small and moderate-sized companies account for much of the growth in ISO 9000 registration over the past several years. The total number of ISO 9000 registrations in the United States increased from a little more than 2, 200 in 1993 to more than 17, 000 in 1998; of those 17, 000 registrations, nearly 60 percent were held by companies with annual sales of $100 million or less.

The increased involvement of small and midsized firms in seeking ISO 9000 registration is generally attributed to several factors. Many small businesses have decided to seek ISO 9000 certification because of their corporate customers, who began to insist on it as a method of ensuring that their suppliers were paying adequate attention to quality. Other small business owners, meanwhile, have pursued ISO 9000 certification in order to increase their chances of securing new business or simply as a means of improving the quality of their processes. "The pressure for companies to become ISO 9000-certified is absolutely increasing and will continue to increase," predicted one management consultant in an interview with Nation's Business. "The question many smaller companies have to ask is when, not if, they [will] get ISO 9000-registered."

ELEMENTS OF ISO 9000 QUALITY MANAGEMENT SYSTEMS
The standards of ISO 9000 detail 20 requirements for an organization’s quality management system in the following areas:

- Management Responsibility
- Quality System
- Order Entry
- Design Control
- Document and Data Control
- Purchasing
- Control of Customer Supplied Products
- Product Identification and Tractability
- Process Control
- Inspection and Testing Control of Inspection, Measuring, and Test Equipment
- Inspection and Test Status
- Control of Nonconforming Products
- Corrective and Preventive Action
- Handling, Storage, Packaging, and Delivery
- Control of Quality Records
- Internal Quality Audits
- Training
- Servicing
- Statistical Techniques

MODELS OF ISO 9000
The ISO 9000 quality standards are broken down into three model sets—ISO 9001, ISO 9002, and ISO 9003. Each of these models, noted Industrial Management contributors Stanislav Karapetrovic, Divakar Rajamani, and Walter Willborn, "stipulate a number of requirements on which an organization’s quality system can be assessed by an external party (registrar)" in accordance with the ISO’s quality system audits standard. "A quality system," they added, "involves organizational structure, processes, and documented procedures constituted towards achieving quality objectives."

Each of the three sets concentrates on a different quality area. ISO 9001 is the most wide-ranging, for it specifies the various operating requirements in such areas as product design and development, production, installation, and servicing. ISO 9002 is concerned with quality assurance at the production and installation stages. ISO 9003 covers testing and inspections. As Karapetrovic, Rajamani, and Willborn noted, "If the minimum requirements are met [for the above operating areas], a registrar accredited by a national accreditation institution issues a certificate of compliance and the organization’s quality system becomes ISO 9001, 9002, or 9003 registered."

It is worth noting that certification is handed out for individual quality systems, not companies; this means that one company may hold more than one ISO 9000 registration. Moreover, Harvey R. Meyer pointed out in Nation's Business that "the standards do not certify the quality of a product or service. Rather, they attest that a company has fully documented its quality-control processes and consistently adheres to them. If that's done, quality products and services generally follow."

In addition to ISO 9000, two related quality standards emerged in American industries in the late 1990s. ISO 14000, also known as the Environmental Management Systems Standards, is intended to combine environmental management systems with the ISO 9000 quality system. The second system, QS9000 is an adaptation of ISO 9000 to meet the specific needs of the "big three" American automobile manufacturers—Ford, General Motors, and Daimler Chrysler. Both systems were expected to have a substantial impact on U.S. companies.

ADVANTAGES OF ISO 9000
The advantages associated with ISO 9000 certification are numerous, as both business analysts and business owners will attest. These benefits, which can impact nearly all corners of a company, range from increased stature to bottom-line operational savings. They include:

- ...
Increased marketability—Nearly all observers agree that ISO 9000 registration provides businesses with markedly heightened credibility with current and prospective clients alike. Basically, it proves that the company is dedicated to providing quality to its customers, which is no small advantage whether the company is negotiating with a long-time customer or endeavoring to pry a potentially lucrative customer away from a competitor. This benefit manifests itself not only in increased customer retention, but also in increased customer acquisition and heightened ability to enter into new markets; indeed, ISO 9000 registration has been cited as being of particular value for small and mid-sized businesses hoping to establish a presence in international markets.

Reduced operational expenses—Sometimes lost in the many discussions of ISO 9000’s public relations cache is the fact that the rigorous registration process often exposes significant shortcomings in various operational areas. When these problems are brought to light, the company can take the appropriate steps to improve its processes. These improved efficiencies can help companies garner savings in both time and money. "The cost of scrap, rework, returns, and the employee time spent analyzing and troubleshooting various products are all considerably reduced by initiating the discipline of ISO 9000," confirmed Richard B. Wright in Industrial Distribution.

Better management control—The ISO 9000 registration process requires so much documentation and self-assessment that many businesses that undergo its rigors cite increased understanding of the company's overall direction and processes as a significant benefit.

Increased customer satisfaction—Since the ISO 9000 certification process almost inevitably uncovers areas in which final product quality can be improved, such efforts often bring about higher levels of customer satisfaction. In addition, by seeking and securing ISO 9000 certification, companies can provide their clients with the opportunity to tout their suppliers’ dedication to quality in their own business dealings.

Improved internal communication—The ISO 9000 certification process's emphasis on self-analysis and operations management issues encourages various internal areas or departments of companies to interact with one another in hopes of gaining a more complete understanding of the needs and desires of their internal customers.

Improved customer service—The process of securing ISO 9000 registration often serves to refocus company priorities on pleasing their customers in all respects, including customer service areas. It also helps heighten awareness of quality issues among employees.

Reduction of product-liability risks—Many business experts contend that companies that achieve ISO 9000 certification are less likely to be hit with product liability lawsuits, etc., because of the quality of their processes.

Attractiveness to investors—Business consultants and small business owners alike agree that ISO-9000 certification can be a potent tool in securing funding from venture capital firms.

**DISADVANTAGES OF ISO 9000**

Despite the many advantages associated with ISO 9000, however, business owners and consultants caution companies to research the rigorous certification process before committing resources to it. Following is a list of potential hurdles for entrepreneurs to study before committing to an initiative to gain ISO 9000 certification:

- Owners and managers do not have an adequate understanding of the ISO 9000 certification process or of the quality standards themselves—Some business owners have been known to direct their company’s resources toward ISO 9000 registration, only to find that their incomplete understanding of the process and its requirements results in wasted time and effort.
- Funding for establishing the quality system is inadequate—Critics of ISO 9000 contend that achieving certification can be a very costly process, especially for smaller firms. Indeed, according to a 1996 Quality Systems Update survey, the average cost of ISO certification for small firms (those registering less than $11 million in annual sales) was $71,000.
- Heavy emphasis on documentation—The ISO 9000 certification process relies heavily on documentation of internal operating procedures in many areas, and as Meyer stated, "many say ISO’s exacting documentation requirements gobble up time. Indeed, there are horror stories about companies losing substantial business because a documentation obsession redirected their priorities." According to Nation’s Business, small business owners need to find an appropriate balance between ISO documentation requirements, which are admittedly "one is ISO 9000’s hallmarks," and attending to the fundamental business of running a company: "Strike a balance among obsessively writing down every employee's task, offering training for the work, and letting common sense dictate how a task is to be performed."
- Length of the process—Business executives and owners familiar with the ISO 9000 registration process warn that it is a process that takes many months to complete. The 1996 Quality Systems Update survey indicated that it took businesses an average of 15 months to move from the early stages of the process to passage of the final audit, and that processes of 18-20 months or even longer were not that uncommon.

Human Resource Development: Concept, Instruments and Integrating Strategies

Concept:
Human resource development is a part and parcel of human resource management. It is the main function of HRM. Every organisation and its management have the responsibility to develop its human resources if at all it wanted to remain in business, face the competition and March towards prosperity and growth. In the modern times of growing awareness the human resource development is the task number one for any organisation.

The very survival and growth of the organisation depend on human resource development. HRD programmes have become routine now in the organisations. Gone are the days when employees were treated as part of the machine. Now new awakening has emerged. Organisations have now realized that employees are human being and if they are treated well and their talent is developed they can be of immense help to them in fostering organisational growth. This has given rise to the emergence of new relationship between employees and management.

Autocratic ways of supervising are gone. Employees are looked as having tremendous potential. This potential needs to be developed and exploited for the organisation's growth and prosperity by rewarding the employees suitably. Now all round efforts are mooted to employee development.

The organisations are making efforts to increase worker’s influence. Committees are set up to study their problems and are finding new approaches to solve their problems. An open door policy is being adopted to redress their grievances. Efforts are made for their career development. Human resource development is the centre point of human resource management.

**Instruments of Human Resource Development:**

**Human Resource Development: Features, Scope, Objectives and Functions!**

**Definitions of HRD:**

1. According to South Pacific Commission ‘human resource development is equipping people with relevant skills to have a healthy and satisfying life’.
2. According to Watkins, ‘human resource development is fostering long-term work related learning capacity at individual, group and organizational level’.
3. The American Society for Training and Development defines HRD as follows: ‘human resource development is the process of increasing the capacity of the human resource through development. It is thus the process of adding value to individuals, teams or an organization as a human system’.

**Features of HRD:**

1. **Systematic approach:** - HRD is a systematic and planned approach through which the efficiency of employees is improved. The future goals and objectives are set by the entire organization, which are well planned at individual and organizational levels.
2. **Continuous process:** - HRD is a continuous process for the development of all types of skills of employees such as technical, managerial, behavioural, and conceptual. Till the retirement of an employee sharpening of all these skills is required.
3. **Multi-disciplinary subject:** - HRD is a Multi-disciplinary subject which draws inputs from behavioural science, engineering, commerce, management, economics, medicine, etc.
4. **All-pervasive:** - HRD is an essential subject everywhere, be it a manufacturing organization or service sector industry.
5. **Techniques:** - HRD embodies with techniques and processes such as performance appraisal, training, management development, career planning, counselling, workers’ participation and quality circles.

**Scope of HRD:** - Human resource management (HRM) deals with procurement, development, compensation, maintenance and utilization of human resources. HRD deals with efficient utilization of human resources and it is a part of HRM.

Human resource being a systematic process for bringing the desired changes in the behaviour of employees involves the following areas:

1. Recruitment and selection of employees for meeting the present and future requirements of an organization.
2. Performance appraisal of the employees in order to understand their capabilities and improving them through additional training.
3. Offering the employees’ performance counselling and performance interviews from the superiors.
4. Career planning and development programmes for the employees.
5. Development of employees through succession planning.
6. Workers’ participation and formation of quality circles.
7. Employee learning through group dynamics and empowerment.
8. Learning through job rotation and job enrichment.
9. Learning through social and religious interactions and programmes.
10. Development of employees through managerial and behavioural skills.

**Objectives of HRD:** - The prime objective of human resource development is to facilitate an organizational environment in which the people come first. The other objectives of HRD are as follows:

1. **Equity:** - Recognizing every employee at par irrespective of caste, creed, religion and language, can create a very good environment in an organization. HRD must ensure that the organization creates a culture and provides equal opportunities to all employees in matters of career planning, promotion, quality of work life, training and development.

2. **Employability:** - Employability means the ability, skills, and competencies of an individual to seek gainful employment anywhere. So, HRD should aim at improving the skills of employees in order to motivate them to work with effectiveness.

3. **Adaptability:** - Continuous training that develops the professional skills of employees plays an important role in HRD. This can help the employees to adapt themselves to organizational change that takes place on a continuous basis.

**HRD Functions:** **HRD includes the following:**
1. Employee training and development,
2. Career planning and development,
3. Succession planning,
4. Performance appraisal,
5. Employee’s participation in management,
6. Quality circles,
7. Organization change and organization development.

**Motivation & Productivity in the Workplace**
Most employees need motivation to feel good about their jobs and perform optimally. Some employees are money motivated while others find recognition and rewards personally motivating. Motivation levels within the workplace have a direct impact on employee productivity. Workers who are motivated and excited about their jobs carry out their responsibilities to the best of their ability and production numbers increase as a result.

**Incentives**
An incentive is a motivating influence that is designed to drive behavior and motivate employees to produce quality work. Employers use several types of incentives to increase production numbers. Employee incentives come in a variety of forms including paid time off, bonuses, cash and travel perks. Incentives drive employee motivation because they offer workers more to strive for than a regular paycheck.

**Recognition**
Many employees need recognition from their employers to produce quality work. Recognition and employee reward systems identify employees who perform their jobs well. Acknowledging a job well done makes employees feel good and encourages them to do good things. Employers recognize workers by tracking progress and providing feedback about how they have improved over time. Public recognition is also a motivating factor that drives worker productivity.

**Self-Motivation**
Some employees are motivated through feeling a sense of accomplishment and achievement for meeting personal and professional goals. Many workers are self-disciplined and self-motivated. Incentive and rewards have little effect on employees who feel motivated only when they are confident in their abilities and personally identify with their role within the organization. These individuals perform productively for the sake of the personal challenge their work provides.

**Implementation Strategies**
There are several ways employers can motivate employees and drive worker productivity. Because different factors influence workers in different ways, employers can utilize motivation strategies that encompass several techniques. For example, to influence workers who are money motivated, an employer may implement a daily "spiff" that pays cash instantly to employees who meet short-term production goals. To achieve long-term production goals, an employer could implement a program that encourages friendly competition between workers to meet production numbers. At the conclusion of the program, employers can publicly recognize top performers for a job well done.

**Training of Employees: Meaning, Objectives, Need and Importance**
Training is concerned with increasing the knowledge and skills of employees for doing specific jobs, and development involves the growth of employees in all aspects.

Whereas training increases job skills, development shapes attitudes of employees.

**Meaning of Training:** - “Training is the act of increasing the knowledge and skills of an employee for doing a particular job.” — Edwin B. Flippo
Training is an organized activity for increasing the technical skills of the employees to enable them to do particular jobs efficiently. In other words, training provides the workers with facility to gain technical knowledge and to learn new skills to do specific jobs. Training is equally important for the existing as well as the new employees. It enables the new employees to get acquainted with their jobs and also increase the job-related knowledge and skills.

**Objectives of Training: The objectives of training are as follows:**

(i) To provide job related knowledge to the workers.
(ii) To impart skills among the workers systematically so that they may learn quickly.
(iii) To bring about change in the attitudes of the workers towards fellow workers, supervisor and the organization.
(iv) To improve the productivity of the workers and the organization.
(v) To reduce the number of accidents by providing safety training to the workers,
(vi) To make the workers handle materials, machines and equipment efficiently and thus to check wastage of time and resources.
(vii) To prepare workers for promotion to higher jobs by imparting them advanced skills.

**Need and Importance of Training: Why is Employees’ Training Necessary?**

The need for training of employees arises due to the following factors:

(i) **Higher Productivity:** - It is essential to increase productivity and reduce cost of production for meeting competition in the market. Effective training can help increase productivity of workers by imparting the required skills.

(ii) **Quality Improvement:** - The customers have become quality conscious and their requirement keep on changing. To satisfy the customers, quality of products must be continuously improved through training of workers.

(iii) **Reduction of Learning Time:** - Systematic training through trained instructors is essential to reduce the training period. If the workers learn through trial and error, they will take a longer time and even may not be able to learn right methods of doing work.

(iv) **Industrial Safety:** - Trained workers can handle the machines safely. They also know the use of various safety devices in the factory. Thus, they are less prone to industrial accidents.

(v) **Reduction of Turnover and Absenteeism:** - Training creates a feeling of confidence in the minds of the workers. It gives them a security at the workplace. As a result, labour turnover and absenteeism rates are reduced.

(vi) **Technology Update:** - Technology is changing at a fast pace. The workers must learn new techniques to make use of advance technology. Thus, training should be treated as a continuous process to update the employees in the new methods and procedures.

(vii) **Effective Management:** - Training can be used as an effective tool of planning and control. It develops skills among workers and prepares them for handling present and future jobs. It helps in reducing the costs of supervision, wastages and industrial accidents. It also helps increase productivity and quality which are the cherished goals of any modern organization.

**Ways/Methods of Training**

Training is generally imparted in two ways:

1. **On the job training**- On the job training methods are those which are given to the employees within the everyday working of a concern. It is a simple and cost-effective training method. The inproficient as well as semi-proficient employees can be well trained by using such training method. The employees are trained in actual working scenario. The motto of such training is “learning by doing.” Instances of such on-job training methods are job-rotation, coaching, temporary promotions, etc.

2. **Off the job training**- Off the job training methods are those in which training is provided away from the actual working condition. It is generally used in case of new employees. Instances of off the job training methods are workshops, seminars, conferences, etc. Such method is costly and is effective if and only if large number of employees have to be trained within a short time period. Off the job training is also called as vestibule training, i.e., the employees are trained in a separate area (may be a hall, entrance, reception area, etc. known as a vestibule) where the actual working.

**Workers Participation in Management: Definition, Characteristics and Objectives**

**Definition:** - Like other behavioural terms, WPM means different things to different people depending upon their objectives and expectations. Thus, WPM is an elastic concept. For example, for management it is a joint consultation prior to decision making, for workers it means co-determination, for trade unions it is the harbinger of a new order of social relationship and a new set of power equation within organisations, while for government it is an association of labour with management without the final authority or responsibility in decision making.

Let us also go through some important definitions of WPM.

According to Keith Davis, “Workers’ participation refers to the mental and emotional involvement of a person in a group situation which encourages him to contribute to group goals and share in responsibility of achieving them”. 
In the words of Mehtras “Applied to industry, the concept of participation means sharing the decision-making power by the rank and file of an industrial organisation through their representatives, at all the appropriate levels of management in the entire range of managerial action”.

A clear and more comprehensive definition of WPM is given by the International Labour Organisation (ILO). According to the ILO: “Workers’ participation may, broadly be taken to cover all terms of association of workers and their representatives with the decision-making process, ranging from exchange of information, consultations, decisions and negotiations to more institutionalized forms such as the presence of workers’ members on management or supervisory boards or even management by workers themselves as practised in Yugoslavia”.


In fact, the basic reason for differences in perception of WPM is mainly due to the differential pattern of practices adopted by various countries while implementing workers’ participation in management. For example, in Great Britain and Sweden, WPM is in the form of Joint Consultation through Joint Consultative Committees, Works Committees in France, Co-determination Committees in West Germany, Joint Work Council in Belgium, Workers’ Council and Management Board in Yugoslavia and Union Management Co-operation in USA.

In India, WPM is in the form of, what we call Labour Management Cooperation and Workers’ Participation in Management. It is implemented through the agencies like Works Committees, Joint Management Councils (JMCs) Shop Councils, Unit Councils and Joint Councils. Notwithstanding, these different forms of WPM differ only in degree, not in nature.

Be the perceptual differences as these may, WPM is a system of communication and consultation, either formal or informal, by which the workers of an organisation are kept informed, as and when required, about the affairs of the undertaking and through which they express their opinion and contribute to decision-making process of management.

Characteristics: The following are the main characteristics of WPM:

1. Participation implies practices which increase the scope employees’ share of influence in decision-making process with the assumption of responsibility.
2. Participation presupposes willing acceptance of responsibility by workers.
3. Workers participate in management not as individuals but as a group through their representatives.
4. Worker’s participation in management differs from collective bargaining in the sense that while the former is based on mutual trust, information sharing and mutual problem solving; the latter is essentially based on power play, pressure tactics, and negotiations.
5. The basic rationale for worker’s participation in management is that workers invest their labour and their fates to their place of work. Thus, they contribute to the outcomes of organization. Hence, they have a legitimate right to share in decision-making activities of organisation.

Objectives: The objectives of WPM are closely netted to the ration-able for WPM. Accordingly, the objectives of WPM vary from country to country depending on their levels of socio-economic development political philosophies, industrial relations scenes, and attitude of the working class.

To quote, the objective of WPM is to co-determine at the various levels of enterprises in Germany, assign the final to workers over all matters relating to an undertaking in Yugoslavia, promote good communication and understanding between labour and management on the issues of business administration and production in Japan, and enable work-force to influence the working of industries in China, for example.

In India the objective of the government in advocating for workers’ participation in management, as stated in the Industrial Policy Resolution 1956, is a part of its overall endeavour to create a socialist society, wherein the sharing of a part of the managerial powers by workers is considered necessary.

The objective of WPM, as envisaged in the Second Five Year Plan of India is to ensure:

1. Increase in productivity for the benefit of all concerned to an enterprise, i.e., the employer, the employees and the community at large.
2. Satisfaction of worker’s urge for self-expression in the matters of enterprise management.
3. Making employees better understood of their roles in the organisation.

In ultimate sense, the objective of WPM in India is to achieve organizational effectiveness and the satisfaction of the employees.

Accordingly, the objectives of WPM in India are to:

1. Promote mutual understanding between management and workers, i.e., industrial harmony.
2. Establish and encourage good communication system at all levels.
3. Create and promote a sense of belongingness among workers.
4. Help handle resistance to change.
5. Induce a sense among workers to contribute their best for the cause of organisation.
6. Create a sense of commitment to decisions to which they were a party.

Levels of Participation: - Having known the objectives of WPM, the question then is to what extent workers can participate in decision-making process. In other words, it is important to know the extents/levels of co-determination in an organisation. Viewed from this angle, Mehtras has suggested five levels of workers’ participation ranging from the minimum to the maximum. Since these levels of workers’ influence the process and quality of decision making in an organisation. We are therefore highlighting here these levels briefly ranking them from the minimum to the maximum level of participation.

Informative Participation: - This refers to management’s information sharing with workers on such items those are concerned with workers. Balance Sheet, production, economic conditions of the plant etc., are the examples of such items. It is important to note that here workers have no right of close scrutiny of the information provided and management has its prerogative to make decisions on issues concerned with workers.

Consultative Participation: - In this type of participation, workers are consulted in those matters which relate to them. Here, the role of workers is restricted to give their views only. However the acceptance and non-acceptance of these views depends on management. Nonetheless, it provides an opportunity to the workers to express their views on matters involving their interest.

Associative Participation: - Here, the role of the workers’ council is not just advisory unlike consultative participation. In a way, this is an advanced and improved form of consultative participation. Now, the management is under a moral obligation to acknowledge, accept and implement the unanimous decision of the council.

Administrative Participation: - In the administrative participation, decisions already taken are implemented by the workers. Compared to the former three levels of participation, the degree of sharing authority and responsibility by the workers is definitely more in this participation.

Decisive Participation: - Here, the decisions are taken jointly by the management and the workers of an organisation. In fact, this is the ultimate level of workers’ participation in management.

Quality Circles (QCs): Definition, Objectives and Other Details

Definition: - Perhaps the most widely discussed and undertaken intervention of employee involvement is the quality circle (QC). The concept of QC originally began in the United States and was exported to Japan in the 1950s. It is mentioned that it is the concept of QC that enabled Japanese firms to make high quality products at low costs.

What is quality circle? It is a work group of employees who meet regularly to discuss their quality problems, investigate causes, recommend solutions, and take corrective actions. Generally, QC is a small group of employees belonging to the same similar work area. This is so because the employees doing the similar type of work are well familiar to problems faced by them. The size of the QC should not be too big so as to prevent some members from participating meaningfully in its meetings. Generally, six to eight members are considered the ideal size of the QC.

QC is formed to achieve the following objectives:
1. Improvement in quality of product manufactured by the organisation.
2. Improvement in methods of production.
3. Development of employees participating in QC.
4. Promoting morale of employees.
5. Respect humanity and create a happy working place worthwhile to work.

The main features of QC can be listed as follows:
1. Voluntary Groups: - QC is a voluntary group of employees generally coming from the same work area. There is no pressure from anywhere on employees to join QC.
2. Small Size: - The size of the QC is generally small consisting of six to eight members.
3. Regular Meeting: - QC meetings are held once a week for about an hour on regular basis. The members meet during working hours usually at the end of the working day in consultation with the manager. The time of the meetings is usually fixed in advance in consultation with the manager and members.
4. Independent Agenda: - Each QC has its own agenda with its own terms of reference. Accordingly, each QC discusses its own problems and takes corrective actions.
5. Quality Focused: - As per the very nature and intent of QC, it focuses exclusively on quality issues. This is because the ultimate purpose of QC is improvement in quality of product and working life.
Developing Quality Circles in Organisations: - Like any other organizational change, QC being a new concept may be opposed by the employees. Therefore, QC should be developed and introduced with great concern and precaution as discussed below:

1. Publicising the Idea: - Introduction of QC is just like an organisational change programme Hence, like an organisational change programme, the workers need to be convinced about the need for and significance of QC from the points of view of the workers and the organisation. Moreover, participation in QC being voluntary, its publicity among the workers is necessary. To begin with, management can also arrange for initial training to those workers who want to form a quality circle.

2. Constitution of QC: - Workers doing the same or similar type of work are drawn voluntarily to form quality circle. The membership of a QC is generally restricted to eight to ten. Once a QC is formed, they remain as permanent members of the circle unless they leave that work area.

3. Initial Problem Solving: - The members of QC should discuss the problem at threadbare and, then, prepare a list of alternative solutions. Thereafter, each alternative solution should be evaluated and the final solution should be arrived at on the basis of consensus.

4. Presentation and Approval of Suggestions: - The final solution arrived at should be presented to the management either in oral or in written form. The management may evaluate the solution by constituting a committee for this purpose. The committee may also meet the members of the quality circle for clarifications, if required. Presentation of solutions to the management helps improve the communication between management and workers and reflects management’s interest to the members of QC.

5. Implementation: - Once the suggestion or solution is approved by the management, the same is being put into practice in a particular workplace. Quality circles may be organized gradually for other workplaces or departments also. In this way, following above outlined process, the entire organisation can have quality circles.