## II-UNIT OPERATIONS MANAGEMENT

Operations management is an area of management concerned with overseeing, designing, and controlling the process of production and redesigning business operations in the production of goods and/or services. It involves the responsibility of ensuring that business operations are efficient in terms of using as few resources as needed, and effective in terms of meeting customer requirements. It is concerned with managing the process that converts inputs (in the forms of materials, labor, and energy) into outputs (in the form of goods and/or services).

According to the U.S. Department of Education, operations management is the field concerned with managing and directing the physical and/or technical functions of a firm or organization, particularly those relating to development, production, and manufacturing.

**Examples of Types of operations:**

| Types of operations: | Examples: |
|---|---|
| Goods producing | Farming, mining, construction, manufacturing, power generating. |
| Storage/transportation | Ware housing, trucking, mail service, moving taxies, buses, |
| Exchange | Retailing, wholesaling, financial advice, renting / leasing, stock exchange. |
| Entertainment | Films, radio and television, recording, |
| Communication | News papers, internet, satellite, radio and TV newscasts. |

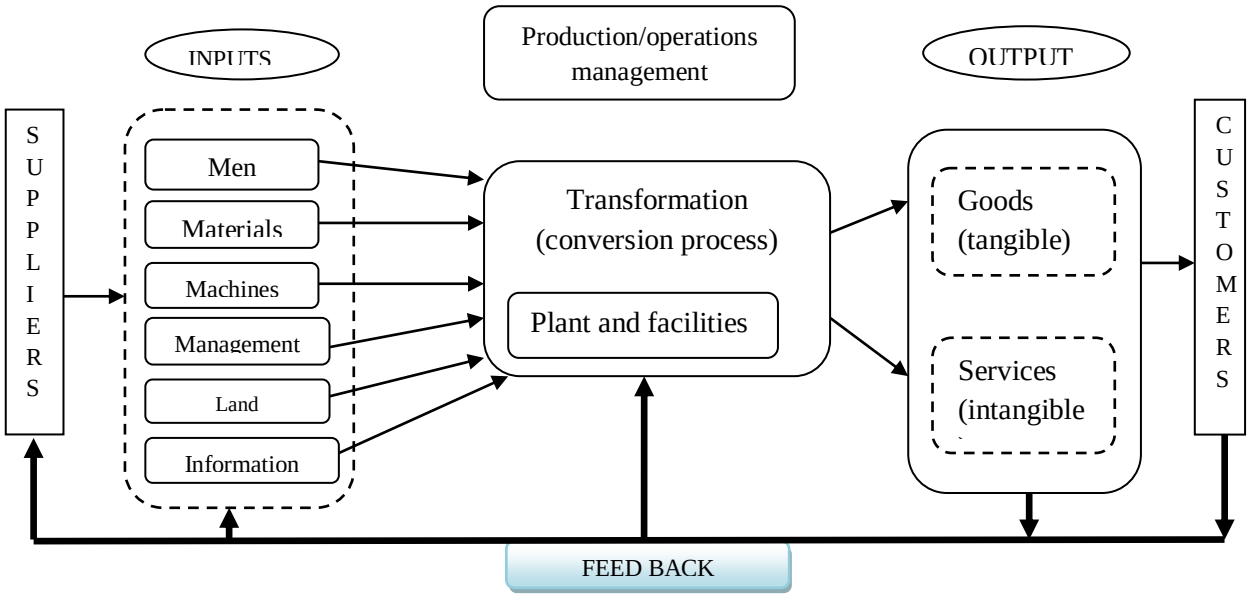
**Principles of Operations Management:**

- **Team up with customers**. Know what they buy and use, and organize product families accordingly.
- **Continual, rapid improvement**. Aim for non-stop improvement to always deliver the best quality, aim for a quicker response to customer demand, and always offer maximum flexibility. Thus, it gives more value, in a more flexible way.
- **Unified purpose**. Involve frontline employees in strategic discussions to make sure they understand the purpose of their work and have their say in what to change.
- **Know the competition**. Know their customers, their best practices, and their competitive edges.
- **Focus**. Allow no variations that the customers don't buy or demand.
- **Organize resources**. Set priorities in organizing resources in a way the operations are close to the customer rate of use or demand.
- **Invest in HR**. Offer cross-training options, job rotation, and improvements in work safety and health. Also offer more rewards and recognitions.
- **Maintain equipment**. Always think of improvement of current assets first, instead of a new purchase.
- **Total quality control**. Use only the best materials, processes, and partners.
- **Visibility management.** Promote corporate achievements; let the market know about organization improvements in competence or productivity.

**PRODUCTION:** Production refers to the sequence of operations that transform materials from a given state to a desired state. Production function is that part of organization, which is concerned with the transformation of a range of inputs (men, materials, machines, money, land, information, management, energy etc.,) in to desired output (goods / services) having the requisite quality level, the output produced has utility value and economic value.
Production is defined as 'a process by which goods and services are created'. Ex: manufacturing standardized products like: car, bus, motor vehicles.

**Definition of production management:** Production Management is a function of management, related to planning, coordinating and controlling the resources required for production to produce specified product by specified methods, by optimal utilization of resources.

**Definition of production and operations management:** Production and operations management is the conversion of inputs in to outputs in to using physical resources, so as it provide the desired utility / facilities of form, place, possession or state or a combination there of to the customer while meeting the other organizational objectives of effectiveness, efficiency and adaptability. The set of inter related management activities, which are involved in manufacturing certain products, is called as production management.




**PRODUCTIVITY**: Productivity describes various measures of the efficiency of production. A productivity measure is expressed as the ratio of output to inputs used in a production process, i.e. output per unit of input. Productivity is a crucial factor in production performance of firms and nations.

**PLANT LOCATION: "**Plant location is the function of determining where the plant should be located for maximum operating economy and effectiveness**"** - Prof. R.C. Davis

**Factors effecting or influencing plant location:**

- Nearness to raw material source (proximity to suppliers).
- Nearness to potential market (proximity to markets).
- Transportation facility (availability of all modes of transportation).
- Availability of power, fuel, labour, and water.
- Availability of land for present and future needs (cost, size, leveling etc).
- Supply of capital (availability of banks and financial institutions).
- Government policy, legal requirements and taxation.
- Integration with other group of companies (industrial atmosphere).
- Community infrastructure and amenity (availability of good housing facilities, hospitals, market centers, schools, and other recreational facilities).

**PLANT LAYOUT:** Plant layout refers to the arrangement of physical facilities such as machines, equipment, tools, furniture, etc. in such a manner so as to have quickest flow of material at the lowest cost and with the least amount of handling in processing the product from the receipt of raw material to the delivery of final product.

**Definition**: "Plant layout means planning for the location of all machines, employee work stations, customer service areas, and flow patterns of materials and people around, into, and within buildings". **–Norman Galther.**

**Objectives of Plant Layout-**

1. Economies in handling of materials, work-in-progress and finished stock.
2. Ensuring optimum utilization of men, materials, equipment and space available.
3. Minimizing changes of delays and bottlenecks in production system. It ensures a good work flow avoiding accumulation of work at vital points.
4. Ensuring efficient supervision and production control.
5. Ensuring satisfaction for the workmen by eliminating or at least minimizing the chances of accidents.

**Criteria or Principles of a Perfect Layout:** A good layout results in comforts, convenience, appearance, safety and profits. A poor layout results in congestion, waste frustration and inefficiency.

- **Maximum Flexibility:** A good layout will be one which can be modified to meet changing circumstances. It must be capable of incorporating, without major changes, new equipment to meet technological requirements or to eliminate waste.
- **Maximum Coordination:** It should clearly define the interrelationships between various machines, departments and personnel and should provide for coordinated efforts.
- **Maximum use of Volume:** Maximum use of volume available should be made. This principle is particularly true in stores where goods can be stocked at considerable heights without inconvenience.
- **Maximum Visibility:** The workers should be so arranged that there is no difficulty in supervision, coordination and control.

- **Maximum Accessibility:** All servicing and maintenance points should be readily accessible without making any hindrance to the production process. It will ensure a regular flow in production.
- **Maximum Movements:** The layout should be so planned that there must be least movements of goods and workers. All movements should be as far as possible direct.
- **Minimum Discomfort:** The layout must be designed in such a manner that may cause minimum discomfort to the working force. Poor lighting, excessive sunlight, heat, noise, vibrations and smells should be avoided or minimized.
- **Inherent Safety, Maximum Security, Visible Routes:** All layouts should be free from any danger to any person working on the machine. Care must also be taken for the safety of passerby. Similarly, safeguards against fire, moisture, theft, and general deterioration should be provided, as far as possible, in the original layout.

**Advantages of a good layout:**

**To the Worker:**

→ Reduction in the effort of the worker.

→ Reduction in number of handlings.

→ Extension of the process of specialization.

→ Better working conditions because of this number of accidents are reduced.

**In labour Cost :**

→ Reduction in the number of workers.

→ Increase in production per man-hour.

→ Reduction in the length of haul.

**In other Manufacturing costs:**

→ Maintenance and tool replacement costs are reduced.

→ Greater saving in the waste of raw material consumption.

→ Improved quality of product due to reduction in the number of handling.

**In Production Control:**

→ Provision of adequate and convenient storage facilities.

→ Better conditions for receipts, shipment and delivery.

→ Enabling the prediction of production time.

**In Supervision :**

→ Helps in easing the burden of supervision.

→ Reduces the amount of inspection.

→ Reduces the cost of supervision.

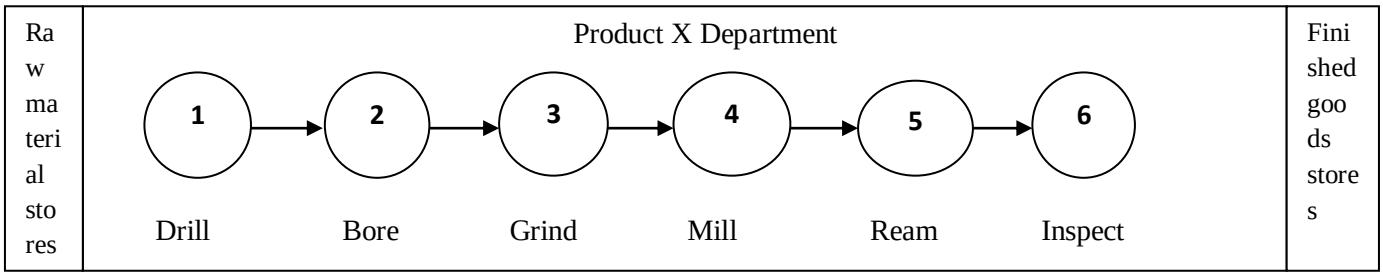
**In Capital Investment:**

→ Permanent investment is kept at the minimum

→ Floor space and shop areas required for manufacturing are reduced.

**DIFFERENT TYPES OF PLANT LAYOUT:** There are three basic types of plant layout: **(i) Product or line layout, (ii) Functional or process layout, and (iii) Stationary layout.**

**i) Product/Line Layout**: Product or line layout is the arrangement of machines and equipment in a line (not always straight) or a sequence in which they would be used in the process of manufacture of the product or group of related products. In this layout, materials are worked out into finished stock through a series of integrated operations (operated one after the other in a sequence) that is arranged in a line.



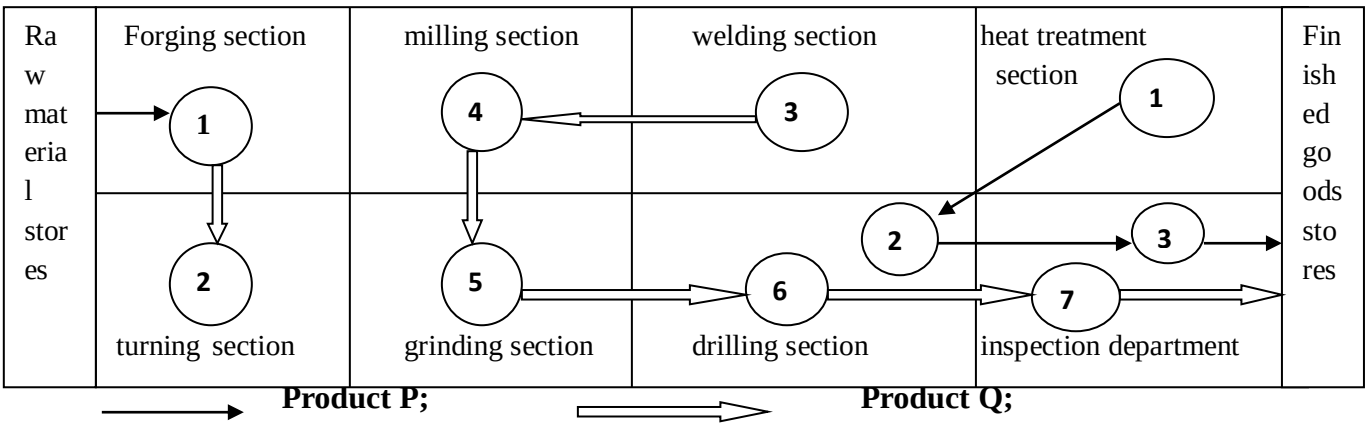

**Advantages of Product or Line Layout:**

- ✓ Ensures Smooth Flow of Production and finished products.
- ✓ Mechanization of Material Handling due to straight flow of materials.
- ✓ Easy and effective inspection of work.
- ✓ Economy in manufacturing due to large scale and continuous production.
- ✓ Effective utilization of available resources.

**Disadvantages of product or line layout:**

- **Expensive:** This type of layout is costly because machines under this system are arranged in sequence of operations and not according to functions.
- **Inflexible:** The system is quite inflexible, as the operations are performed in sequence, adjustment in the course of production cannot be made without much difficulty.
- **Difficulty in supervision:** Since there are no separate departments for various types of work, specialization in supervision is also difficult.
- **Difficult in Expansion:** Under this type of layout, it is usually not possible to expand the production beyond the capacity of each line of production.
- **Stoppage of Work through Breakdown:** Any breakdown in any of the machines along the line can disrupt the whole work of production.

**ii) Functional or Process Layout:** This system is based on the functions performed by a department. Under this system of layout, machines or equipment of the same functional type are grouped together in a separate department. For example, welding equipment may be placed in one department, i.e., welding department that will perform wilding function for the benefit of all the lines of production.




**Advantages of process layout:**

- ➢ More flexibility in production, a high degree of flexibility with regards to work distribution to machines and workers.
- ➢ This layout provides Scope for Expansion.
- ➢ Maximum Utilization of Equipment

- Lower Financial Investment is required this type of layout.
- Here Better Working Conditions provided to the workers.
- Better Supervision: Under process layout, better and efficient supervision is possible because of specialization in operation.

**Disadvantages of process or functional layout:**

**Inefficient Material Handling:** Efficient material handling is difficult to practice in process layout because fixed path material handling equipment like conveyor belts, chutes etc. cannot be possible to use.

**Diseconomy to Floor Space:** Under this type of layout requires more floor spaces than the product layout because a distinct department is established for each operation.

**High Inventory Investment:** The materials have to be carried forward and backward very frequently. This means both delay and waste. It increases the need of working capital in the form of inventory.

**High Cost of Supervision**

**iii)Stationary / Fixed Position Layout:** Under this type of layout, materials remain at a fixed place and the complete job is done at a fixed station with materials.


**Advantages of Stationary Layout:**

- ✓ Flexibility for change in design, operation sequence, labour availability, etc. exists in this layout.
- ✓ Lower labour Cost and effective utilization of labour.
- ✓ Saving in time and lesser floor space.
- ✓ Movement of material is minimum.
- ✓ Easy for products which are difficult to move.

**Disadvantages of stationary layout:**

- ✓ Higher Capital Investment due to long production period and long duration to complete a product.
- ✓ Highly skilled workers are required.
- ✓ Large space is required for storage of material and equipment ear the product.

**Methods of production:** There are three main methods of production:

- Job or Unit Production
- Mass or Continuous Production
- Batch or Quantity Production.

**Job Production:** In this system, goods are produced according to the orders placed by the customers. With this method, individual requirements of the consumers can be met. Each job order stands alone and is not likely to be repeated. This type of production has a lot of flexibility of operation and hence general purpose machines are required. Factories adopting this type of production are generally small in size.

**Advantages:**

→ It is the only method, which can meet the individual requirements.
→ There is no managerial problem, because of very less number of workers, and small size of concern.
→ Such type of production requires less money and is easy to start.

**Disadvantages:**

→ There is no scope for continuous production and demand.
→ For handling different types of jobs, only skilled and intelligent workers are needed, thus labour cost increases.

**Batch production:** Batch production process, identical goods are manufactured to meet the specification. In this method two or more types of products are manufactured in lots (i.e., batched) at regular interval, on this basis of customer's order or with a hope of continuous demand of the product. Most of the engineering concerns, pharmaceutical items are adopting Batch production. In this type of production, different products are manufactured and stocked and then sold on receipt of orders.

**Advantages:**

→ While comparing with mass production, it requires less capital.
→ If demand for one product decreases then production for another product may be increased, thus the risk of loss is very less.
→ Comparing with job production, it is more advantageous commercially.

**Disadvantages:**

→ Comparing with mass production cost of scales and advertisement per unit is more.
→ Raw material to be purchased is in less quantity than that in mass production.

**Mass Production:** This method of production is used by concerns where manufacturing is carried on continuously in anticipation of demand though demand of the product may not be uniform throughout the year. Such type of production is useful for cement industry, fertilizer industry, and etc.

**Advantages:**

→ Mass production gives better quality and increased production.
→ Wastage is minimum.
→ As raw materials are purchased on a large scale and hence higher margin of profits can be made while purchasing them.
→ Only few skilled and rest semi- skilled workers are required hence labour cost is reduced.

**Disadvantages:**

→ During the period of less demand, losses on the invested capital may take place.
→ All the machines used in this method are one purpose machines.
→ Most of the workers handle only particular operations.
→ As this type of production is on a large scale, therefore it cannot fulfill individual taste.

## WORK STUDY

**Introduction:** Work study is undertaken to find better ways of doing the job and have better control over the output. It seeks to increase the productivity by improving ways and means of doing work through the process of continuous innovation the benefits of which in turn are available to employees, consumers and to society at large.

**Meaning:** Work study is the systematic examination of the methods of carrying out activities such as to improve the effective use of resources and to setup standards of performance for the activities carried out. It is an analysis of specific job in order to find most efficient method in terms of cost and effort. Time study, method study and motion study are the components of work study.

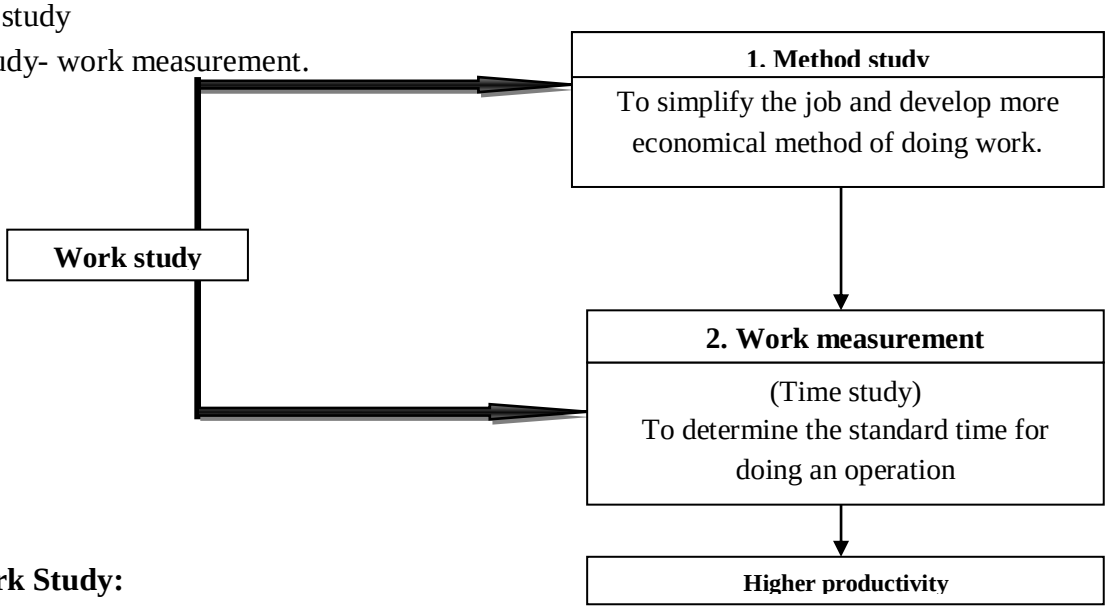
**Definition:** Work study may be defined as one of management techniques which can be applied to achieve the optimum use of the resources available to an organization for the accomplishment of the work, it is engaged in.

**Objectives of Work Study:**

- Eliminate unnecessary and wasteful steps in work process.
- Establishing best and economical way of doing at job.
- Reduce the delays in work.
- Increase the Productivity.
- To save the time and cost
- To improve the efficiency of work, so the resources plant and equipment can also be effectively used.

**Components of Work Study:** A work study will consist of the following two main components:

- Method study
- Time study- work measurement.




**Benefits of Work Study:**

- Reduce the cost and time for manufacturing of the product.
- Leads to the production of more qualitative product in turn more profits
- Improved layout
- Better working conditions to employees
- Basis of rewards
- Provide better control and performance.

**METHOD STUDY:** Method study is a technique which analyses each operation of a given piece of work very closely in order to eliminate unnecessary operation. It includes the standardization of equipment, methods and working conditions, and training of the operator to follow the standard method.

**Definition:** Method study can be defined as "systematic recording and critical examination of existing and proposed ways of doing work as a means of developing and applying easier and more effective method and thereby reducing cost".

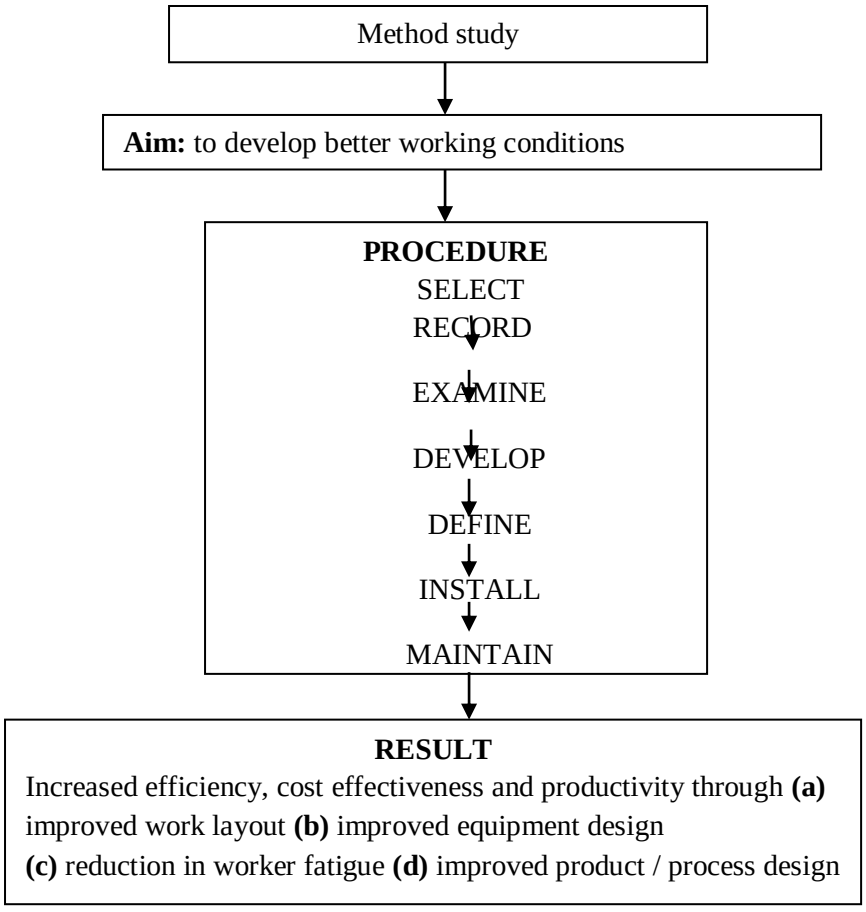
**Objectives of method study:**

- To eliminate wastage of time and labour.
- To reduce fatigue and boredom of work by avoiding unnecessary movements.
- To find the best way of doing a job.
- To have more effective utilization of materials, machines and workers.
- To improve the design of work place layout.
- To train the individual worker in its practice as per standardized method.
- Disable possible hazards and dangers to safety.

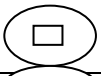
**Need for Method Study:** The need for methods analysis can come from a number of different sources:

→ Changes in tools and equipment
→ Changes in product design or new products
→ Changes in materials or procedures and other factors (e.g. quality problems, accidents)

**Procedure for Method Study:** The process is often seen as a linear, described by its main stages.



- **SELECT (the work to be studied):** Work is selected for method study on the basis of it being an identified problem area or an identified opportunity. Identify the job for method study and specify the objectives, related to cost, productivity and labour, to be achieved.
- **RECORD (all relevant information about that work):** Make a detailed list of all operations in the present method of detailed list of all operations in the present method of manufacturing a job. All the material handling, machine work, and hand work are also include in this detail and recorded by using process chart symbols, simple charts and diagrams used to record and represent the situation.

| S.No | Event | Symbol | Description |
|---|---|---|---|
| 1. | Operation |  | Operation represents an action. It involves change in the condition of a product |
| 2. | Transport |  | Transport indicates the movement of an item from one location to another. |
| 3. | Storage |  | Storage represents a stage when a finished good or raw material waits for an action or an item retained for some time for reference purpose. |
| 4. | Delay |  | Delay occurs when something stops the process and a product waits for the next event. |
| 5. | Inspection |  | Inspection is the act of checking the quality and quantity of product. |
| 6. | Operation cum inspection |  | Inspection during the production process. |
| 7. | Operation cum transportation |  | Operation during the transportation. |

- **EXAMINE (the recorded information):** Following questions should be asked on himself by the motion study engineer about the way in which these operations are to be performed, and about the tools and equipments needed. The procedure of this questioning is known as 'Cortical Examination', questions are asked on the following five points:

**Purpose:** What is the purpose of this operation? Does this fulfill the requirements? And whether this can be eliminated?
**Place:** Where is the best place to do this operation?
**Sequence:** What is the best time to do this operation and whether it can be done at the same time as before or at any other better time? When will it be more suitable and economical?
**Person:** Who will do this operation? Who can do it in a better way?
**Means:** How this operation can be performed, i.e., which machines and tools are to be used? Can we make the work easier and safer for both worker and equipment?

- **DEVELOP (an improved way of doing things):** After considering the above questions, a new better method is developed.

**Elimination:** Every operation or detail of the job should be thought that whether it can be eliminated without harm.
**Combining:** In this aspect, it is to be observed that whether two or more operations can be combined any adverse effect to save operation time.

**Rearrangement:** If rearrangement in the sequence of operations help in simplification or in any other aspect then it should be done.

**Simplification:** In simplification, it is found that if the operation is possible with any other easy, safe and economical method that should be adopted. The work can also be simplified by:

(i) Placing the materials, tools and equipment at proper working area.
(ii) Using gravity feed hoppers and other material handling equipment.
(iii) Taking useful work by both hands.
(iv) Using special jigs and fixtures.

- **INSTALL/IMPLEMENT (the new method as standard practice):** After having developed the method, this is required to install. The new method must first be got approved form the supervisors, workers and management. Then the workers must be trained to work according to this new method and their habits must be developed to follow the correct way. For sometime, close contacts must be maintained with the progress of the job until it runs satisfactorily.
- **MAINTAIN (the new standard proactive):** Once a method is installed, it should be maintained in its specified form, and is not allowed to slip back to old form or introduction of any other unauthorized changes.

**Advantages of method study:**

- Better understanding of work performed
- Improved operator performance
- More safety less risks from hazards for health and assets
- Save the cost and time

**Outcome of method study:**

- Work instructions
- Systematic method description involving, operators, equipment, materials and procedures. These can be of graphical or narrative nature.
- Flow charts
- Recommendations for improvement

**WORK MEASUREMENT / TIME STUDY:** Time study also called work measurement. Time study or 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.

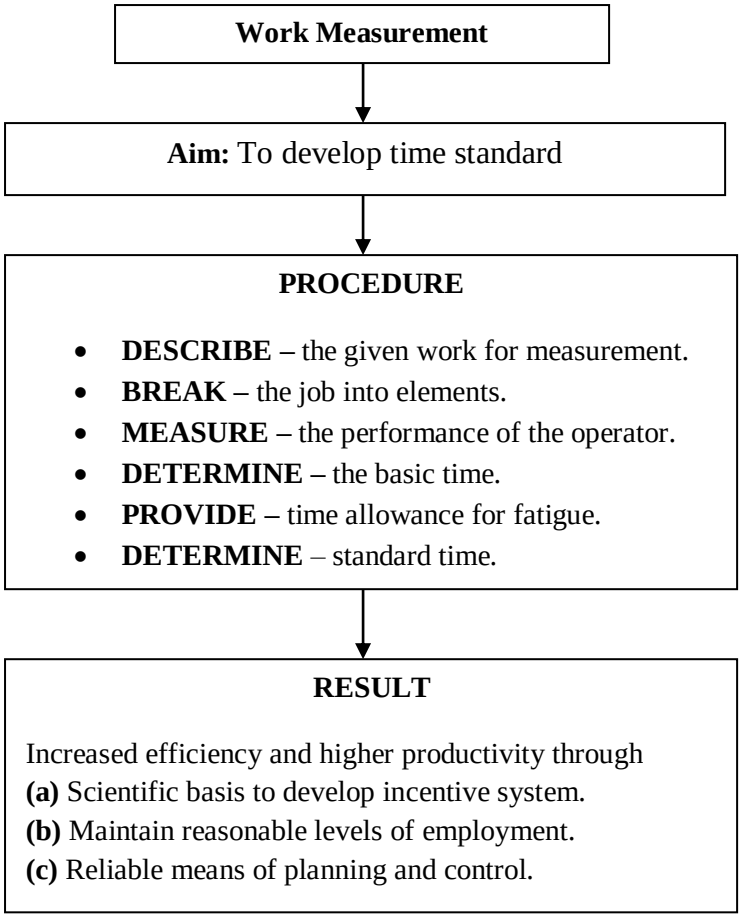
**Objectives of Time Study:**

- Establish standard times
- Rate operator performance
- Gain information to calculate overall production capabilities and data for capacity planning.
- Establish the total work content of finished goods.
- To develop incentive schemes.
- To compare the time taken by alternative methods of a given job.

**Methods /Techniques of Time study:**

- Stopwatch time study
- Using synthetic time standards
- Work sampling.

**Procedure of work measurement:**




The essential prerequisite to carry out work measurement is to describe the method underlying the job. In other words it is a logical sequence of method study where the focus is on proposing a new method, which results in elimination of unnecessary motions. Having decided the new method, the next step is find out how much time is taken for carrying out the new method. In determine this, the following process involved.

- Break the job in to elements which can be identified as distinct parts of an operation, capable of being observed, measured analyzed.
- Measure time taken to perform each element (ideally each element should not take time more than 30 seconds) using a stop watch.
- Add the time taken to do all the elements and arrive at the basic time (also called as normal time) required to do entire job.

**Advantages of Time Study:**

- Knowledge about standard times to be expected.
- Ability to estimate total work content
- Operators can be appraised on factual grounds
- Some labour regulation might require standard times on the basis of solving labor disputes.

# STATISTICAL QUALITY CONTROL

Quality of product is always a matter of concern for all manufacturing firms because in the changing scenario need for quality control has taken a front seat. Traditional quality control was designed to prevent the production of products that do not meet certain acceptance criteria. This could be accomplished by performing inspection on products that, in many cases, have already been produced. Action could then be taken by rejecting those products. Some products would go on to be reworked, it is expensive, and time consuming. Then quality concept was introduced.

**Definition:** quality refers to the sum of the attributes or properties that describe a product. These are generally expressed in terms of specific product characteristics such as length, width, colour, and so on.,

Quality as a concept can be subdivided into **i)** quality of design and **ii)** quality of conformance.

**Quality of design** is determined by the extent to which products and services are designed with the needs and desires of the customers in mind.

**Quality of conformance** is determined by the extent to which the intent of the designer is actually built into the product or service.

**STATISTICAL QUALITY CONTROL (SQC)** is concerned with quality of conformance. This term is often used interchangeably with statistical process control (SPC), which involves using statistical techniques to measures and analyze the variation in processes.

**Meaning & Definition of SQC:** Statistical Quality Control (SQC) is a method for achieving quality control in processes. It is a set of methods using statistical tools such as mean, variance and others, to detect whether the process observed is under control.

**History of SQC:** Dr.Walter shewart working laid the foundation for statistical quality control in the Bell Telephone Laboratories in the 1920's conducting research on methods to improve quality and lower costs. He developed and introduced the concept of control in 1931 with regard to variation, and came up with statistical process control charts which provides a simple way to determine if the process is in control or not. Dr.W.Edwards Deming built upon shewart's work and took the concept to Japan following WWII. There, Japanese industry adapted the concepts whole – heartedly. The resulting high quality of Japanese product is world – renowned. Dr.Deming is famous throughout Japan as a "God of Quality". Today, SPC is used in manufacturing facilities around the world.

**Objectives of statistical quality control:** The main objective of any SQC study is to reduce variations. Any process can be considered a transformation mechanism of different input factors into a product or service. Since inputs exhibit variations, the result is a combined effect of all variations. This, in turn, is translated into the product.

- **Common causes of variation:** chance causes of variation are inherent in the process. Chance causes are reasons for minor variations in the quality characteristics that are inspected. The causes do not cause the item to be rejected as the variations are with in the limits (i.e. tolerance limit).
- **Special cause variation**, which stems from external sources and indicates that the process is out of statistical control.

**Techniques of SQC:** Process Control through Control Charts, Acceptance sampling.
**Quality Control Tools which include:** Check sheet**,** Bar chart and other graphs**,** Histogram**,** Control chart.
**Procedure of SQC:** Proper statistical process control starts with planning and data collection.

The steps followed in the statistical process control are explained with the help of PDSA cycle as described by Walter Shewart.

**PLAN:** Identify the problem and the possible causes. The QC tools described in this manual can help organizations identify problems and possible causes, and to prioritize corrective actions.
**DO:** Make changes designed to correct or improve the situation.
**STUDY:** Study the effect of these changes on the situation. This is where control charts are used-they show the effects of changes on a process over time. Evaluate the results and then replicate the change or abandon it and try something different.
**ACT:** if the result is successful, standardize the changes and then work on further improvements or the next prioritized problem. If the outcome is not yet successful, look for other ways to change the process or identify different causes for the problem.

**Benefits of SQC:**

- Provides surveillance and feedback for keeping processes in control.
- Signals when a problem with the process has occurred.
- Detects assignable causes of variation
- Accomplishes process characterization
- Reduces need for inspection
- Monitors process quality
- Provides mechanism to make process changes and track effects of those changes.

## STATISTICAL PROCESS CONTROL (SPC):

The purpose of SPC is to isolate the natural variation in the process from other sources of variation that can be traced or whose causes may be identified. There are two different kinds of variation that affect the quality characteristics of products.

**Definition:**
Statistical process control (SPC) is defined as "The application of statistical techniques to control a process." Statistical process control is defined as use of tools to observe or monitor the performance of the production or service process's tendency to vary in order to predict an outcome that if not corrected may later result in rejected product BEFORE IT HAPPENS. Thus SPC is known as prevention and prediction tool for quality.

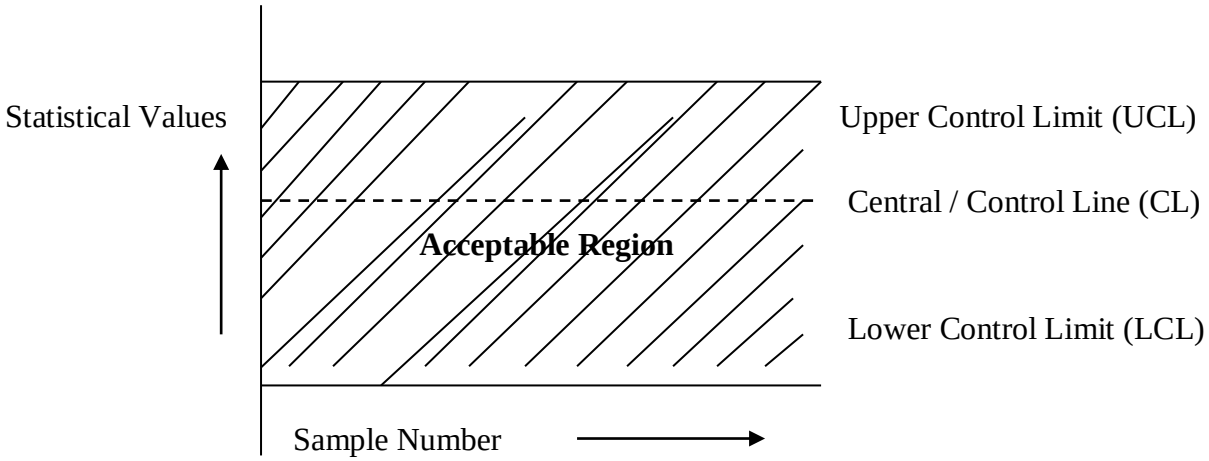
**Tools of statistical process control:**
Some of the common statistical process control tools are:

- Control charts.
- Flow charts.

**Control charts:** Control chart (also called as process control chart or quality control chart) is an important statistical tool used for the study and control of the repetitive processes. Control charts are the tools to determine whether the process is under control or out of control. The charts were developed by "W.A. Shewart". The main objective of the control chart is to identify process variation and help to reduce the same.

Control chart is a graphical representation of quality characteristics which indicates whether the process is in under control or not. It shows whether a sample of data fall within a common or normal range of variation.

A control chart has upper, lower, and central control limits they are represented as follows:




**Types of control charts:** The control charts are mainly two types:

**1. Control charts for variables (measurement charts):** Variable control charts are used to control measurable quality characteristics like hardness, thickness, length, and so on. Variable control charts are of following types:

- **X chart (Mean chart):** An X chart is used if the quality of output is measured in terms of a variable such as length, weight, temperature, and so on. X represents the mean value found in a sample of the output. a mean control chart is often referred to as an **X- bar chart**.

**Advantages:**

→ This chart shows graphically how a process varies with time. This has a good motivational effect even if such a graph is not very useful as a control chart.

→ This type of chart enables the state of a process evaluated rapidly and quick action to be taken.

**Disadvantages:**

→ The chart's power of test is poor. This is because the ability of the X bar chart to detect abnormalities generally deteriorates as the size of the subgroups (n) decreases.

→ The most important feature of the control chart, rational sub grouping is unclear, and within subgroup variation is obscured.

- **R chart (Range chart):** In addition to the central tendency in a sample, it is also required to monitor the amount of variation from sample to sample. A range chart shows the variation in the sample ranges. It is used to monitor the range of the measurements in the sample. If the points representing the ranges fall between the upper and the lower limits it is concluded that the operation is in control.

**2. Control charts for attributes:** Charts for attributes which are based on the distinction between defectives and defects. Control charts for attributes are based on countable rather than measurable characteristics. These are countable ones. The quality of attributes can be determined on the basis of 'yes or no'. Control charts in this category include P chart, C chart.

- **P – Chart (fraction defectives):**

The P- Charts are used to measure the proportion that is defective in a sample and it is also used where there is data about the no. of defectives per sample. It is also called fraction defective chat or percentage defective chart. Here, each item is classified on 'go or no go' basis, that is good or bad (defective). If the sample size is large it could be better.

**Use of P- Charts:**

- When observations can be placed into two categories.
  - Good or bad.
  - Pass or fail.
  - Operate or don't operate.
- When the data consists of multiple samples of several observations each.

- **C- Charts (No. of defectives per piece):**

The C- chart for no. of non conformities. c – Charts are used to monitor the number of defectives per unit. Here the sample size should be constant. The c- bar chart plots the number of defectives or failures per unit. It is useful when several independent defects may occur in every unit produced, as in complex assemblies.

**Ex:** Number of printing errors in a book page, number of defective welds per mile of pipe line.

**Use of c – charts:**

- Used only when the number of occurrences per unit of measure can be counted; non-occurrences cannot be counted.
- Calls, complaints, failure per unit of time.
- Cracks or faults per unit of distance.

**Application of control charts:**

- Final assemblies (Attribute Charts).
- Manufactured components such as balls, pin holes, slots etc (variable charts).
- Bullets and shells (Attribute Charts).
- Incoming materials (Attribute and Variable charts depending upon the type of material.

**Advantages of Control Charts:**

- Control carts indicate whether the process is in control or out of control.
- It defects unusual variations taking place in the process.
- The inspection work also reduces.
- It ensures the product quality level.
- Brings substantial improvement in product quality.
- Control charts can be applied to many businesses including manufacturing.

# MATERIALS MANAGEMENT

**Introduction:** Materials management plays a very significant role in controlling the costs and reducing the wastage, particularly, in a manufacturing industry.

**Materials** refer to inputs into the production process, most of which are embodied in the finished goods being manufactured. It may be raw materials, work-in-progress, finished goods, spare parts and components, operating supplies such as lubricating oil, cleaning materials, and others required for maintenance and repairs.

**Definition:** Materials management is the process of planning, organizing and controlling the materials in a given organization. Among some government organizations, it is better known as supply management.

**Objectives of material management:** The objectives of material management are as follows.

**1: Material selection:** material selection includes correct specification of material. Material requirements are decided with the help of sales programme. The standardization of raw material ensures lower cost and ease in procurement, replacement etc.

**2: Low cost:** purchase of material required quality at reasonable cost is of greater importance. Slight saving per unit cost of material can improve total profitability.

**3: Receiving and controlling of material:** Receiving and controlling of material in good condition is very important. When material is received it is checked in terms of quality and quantity. Then it is stored at proper location so that it can be issued immediately whenever necessary.

**4: Issue of material:** whenever there is requisition of material, it is immediately issued to the concerned department.

**5: Continuous supply:** uninterrupted flow of material is necessary for smooth production. In uncertainties in market can create shortage of material in the market if materials department has good relations with the suppliers, in shortages suppliers can make materi8al available on priority to the company.

**6. Cordial and good relations with suppliers :** there are various benefits of having good and cordial relations with suppliers they inform about probable shortage of materials, new materials and new substitutes etc. suppliers can offer greater credit period in situations of financial crisis.

**7. New materials in product:** material department should always in search of new materials good relation with suppliers helps to get information about new materials.

**8. Maintaining safety stock:** safety stock of raw materials, parts and finished goods is maintained to absorb uncertainties and supply of material and demand for finished products .if demand for products excess this safety stock can be used.

**9. Purchasing at competitive prices:** materials department try to purchase best quality items at competitive prices this needs constant contacts with suppliers and market. material manager should always be in search of new source of supply new materials.

**10. Inventory control:** inventory control is absolutely necessary proper steps are taken to reduce inventory level are over stocking. Inventory is properly maintained to reduce damages brekage, deterioration of material.

# INVENTORY MANAGEMENT

**Meaning of inventory:** Inventory refers to all the physical stocks, which have economic value. It covers the items i.e. own stores, in addition to the materials in transit and materials in process.

**Need for inventory:**

- Un interrupted supply of materials.
- Optimal stock (not too much, not too little).
- Adequate control over materials used, un-used.

**Definition of Inventory control:** Inventory control is defined as "the scientific method of providing the right type of material at the right time in the right quantities and at right place to sustain the given production schedules". Inventory control is essentially concerned with two aspects:

- Minimizing investments for the organization in the materials, and
- Maximizing the service levels to the customers and its own operating departments.

**Objectives of inventory control:**

1. To support the production departments with materials of right quality in the right quantity, at the right time and the right place, and from the right supplier.
2. To minimize investments in the materials by ensuring economies of storage and ordering costs.
3. To avoid delays in production or manufacturing process.
4. To ensure economy of costs by processing economic order quantities.
5. To maintain adequate inventories at the required sales outlets to meet the market needs promptly, thus, avoiding both excessive stocks and shortages at any given time.
6. To contribute directly to the overall profitability.
7. To maintain balance between demand and supply of materials.

**Need for inventory control:** It is an established fact that through the practice of scientific inventory control, the stocks can be reduced anywhere between 10 to 40 %. The need for inventory control in the organizations is mainly due to the benefits derived such as:

- ✓ Reduction in investment on inventory.
- ✓ Proper and efficient use of raw materials.
- ✓ Ensures against scarcity of materials in the market.
- ✓ No interruption in production.
- ✓ Avoids over stocking.
- ✓ Eliminates the possibility of duplicate stocking.
- ✓ Economy in purchasing.
- ✓ Helps in minimizing loss due to deterioration, obsolescence and damage.

**Functions of inventory control:**

- ❖ Ensures availability of raw material continuously with out causing any disturbance to the production process.
- ❖ Manages stores of the organization effectively.
- ❖ **Effective Stock control system:** it includes physical verification, proper record maintenance of stored raw materials, ordering policies & procedures for the purchase of the goods.
- ❖ Inventory is required to meet the anticipated demand of the company.

**Inventory control tools and techniques:**

- EOQ – Economic order quantity.
- ABC – Analysis (Always better control).
- Selective inventory controls such as ABC, HML, VED, FSN, SDE.
- Material requirement planning.

## ECONOMIC ORDER QUANTITY (EOQ)

Economic order quantity is defined as that quantity of material, which can be ordered at one time to minimize the cost of ordering and carrying the stocks. In other words, it refers to the size of each order that keeps the total cost low.

Given the annual demand, the cost of acquisition, and carrying costs, what should be the size of each order? This is EOQ. This concept is explained below:

**Inventory costs**: The inventory costs can be classified into two categories: inventory ordering costs and inventory carrying costs.

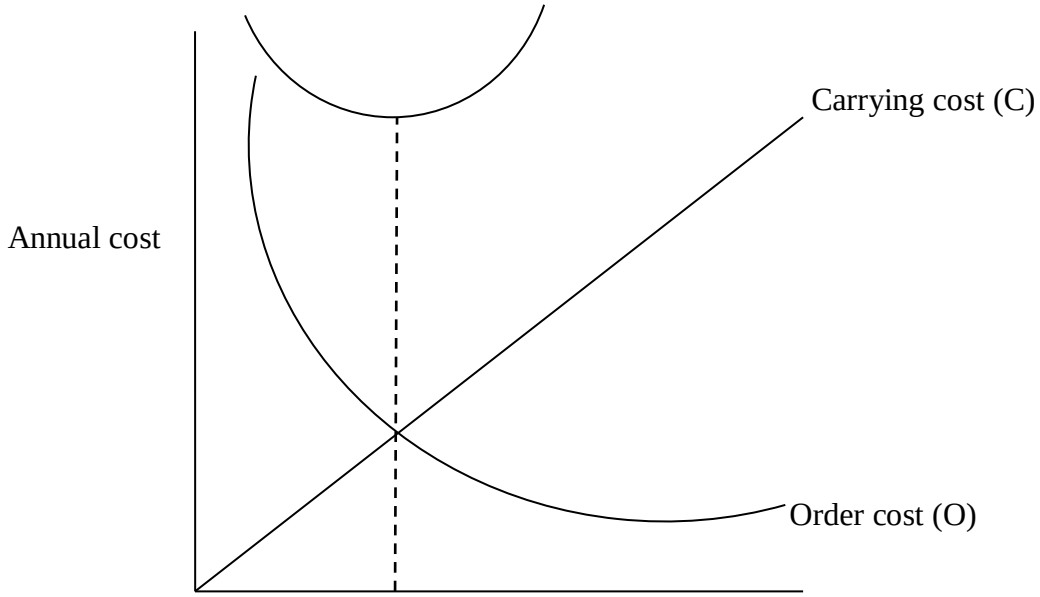
**Inventory ordering costs** refer to the costs incurred to procure the materials. Particularly in large organizations, these costs are significant. Several departments such as purchasing and stores department, engineering department, computing department, and others, are associated with the procurement of inventory. It costs a lot to maintain these departments in terms of wages and salaries, other operating expenses such as stationery and supplies, and the cost of services such as computer time, telephone, fax, and so on.

**Inventory carrying costs** include insurance costs, property taxes (such as corporate tax for a storage premises etc.), storage costs, cost of obsolescence and deterioration, and the opportunity costs of invested funds. Normally, all these work out to 20 to 30 percent of the total value of inventory. Carrying costs per year are computed as a percentage of average inventory value. The more the inventory is, the more the inventory carrying costs.

The special feature of inventory costs is that they do not depend upon the volume of inventory. They are the function of the number of orders placed during a given time period. The more the number of orders, the more are the procurement costs.

**Determining the Economic Order Quantity:** Given the annual requirement of inventory, the question-what should be the size of each order?-is best addressed by the economic order quantity. The economic order quantity is that quantity of the order, which minimizes the related material costs, the ordering costs, and the carrying costs. Consider that the sum of ordering costs and carrying costs is the total cost. EOQ is that order quantity at which the total cost is minimum. This is graphically represented in figure as shown below

**1. Graphical representation of EOQ:**




**EOQ Order quantity.**

**2. Algebraic method of determining method of EOQ:** Let us determined by the EOQ variables as below

A=Annual demand
S=size of each order (units per orders)
O=ordering cost per unit
C=carrying cost per unit

**Step-I:** find out the total ordering cost per year
Total ordering cost per year= number of orders placed year X Ordering cost per order.
= A/S XO

**Step- II:** Find out the total carrying cost per year.
Total carrying cost per year= average inventory level X Carrying cost per year.
= S/2 X O

**Step- III**: Determining economic order quantity (EOQ).

A/S X O = S/2 X C
2AO = S square C
S square = 2AO / C
S = square root of 2AO / C.

Here, we assume that the material prices and transportation costs are constant for a given range of order quantities. In other words, the quantity discounts, which are normally available for large size orders, are not considered here.

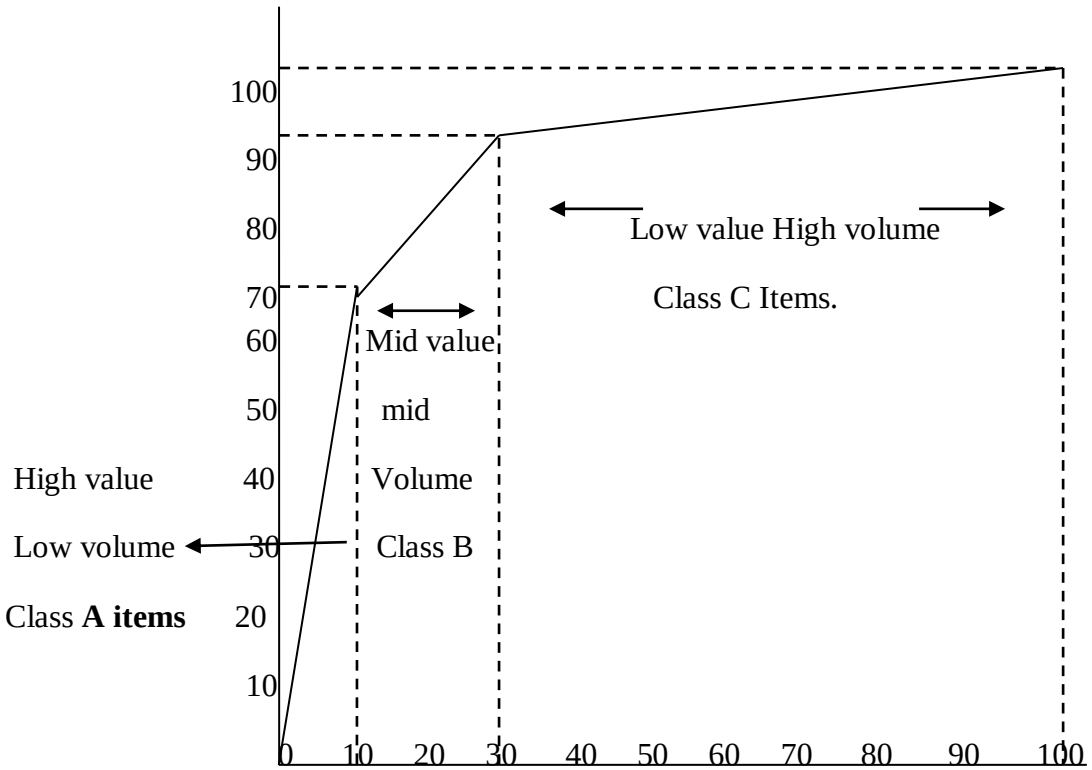
## A-B-C ANALYSIS

A-B-C analysis is an American terminology for selective control or selective or split inventory management or proportional value analysis. It is the basic technique of materials management and is the commencing event. annual consumption if itemized in rupee value consideration we find that ground 10% of the items are contributing for about 70% of total annual consumption cost. Around 20% will account for 25% of annual consumption cost while balance of 70% will embrace only 5-10% of that cost. The small number of high consumption value items is called as A items. The medium consumptions value items are B items while large number of items whose annual consumption value is very low is C items.

The following table summarizes the concept of ABC analysis.

| **Category** | **Value (%)** | **Volume (%)** | **Desired degree of control** |
|---|---|---|---|
| A | 70 | 10 | Strict |
| B | 20 | 20 | Moderate |
| C | 10 | 70 | Low |

The purpose of A-B-C analysis must by now be quite clear. It is to separate predominant few from the point of view annual consumption value. The methodological and systematic approach by A-B-C analysis will assist to have more or less equal attention to all items. In the absence of which; control will be too diffused and desultory to remain efficient .Selective inventory control is the other name of A-B-C analysis. The estimate of requirement of A items should be worked out more precisely. Critically on activities such as scheduling, safety stock receiving and inspection be examined for a type of items .This pace substantial dividends way of reduced costs.




Here ‘A’ refers to high value items. ‘C’ refers to low value items.

‘B’ refers to medium items.

**Difference between the items of ABC Analysis:**

| Item – A | Item – B | Item – C |
|---|---|---|
| very strict control | moderate control | low control |
| no safety stock or very low | low safety stock | high safety stock |
| frequent ordering or weekly deliveries | ordering once in three months | bulk ordering, once in 6 months |
| weekly control statements | monthly control statements | quarterly reports |
| maximum follow-up | periodic follow up | follow-up in exceptional cases |
| rigorous value analysis | moderate value analysis | minimum value analysis |
| as many sources as possible for each time | two / more reliable sources | two sources for each item |
| Minimization of wastage, obsolete, and surplus (review every 15 days). | quarterly review | annual review |
| to be handled senior officers | to be handled by middle management | can be fully delegated. |

**Types of ABC Analysis:** The ABC analysis is classified in to following types:

- **HML Analysis:** The items in this analysis are classifies in to three groups i.e. High, Medium, Low. The management decides the cutoff lines (or) prices for the three categories. This analysis helps to keep control over consumption as per the price and helps to assess storage and security requirements i.e. the high priced items are to be stored in the cupboards. This is always based on the cost of the item.

  H = High cost items.
  M = Medium cost items.
  L = Low cost items.

- **SDE Analysis:** In it the items are classifies in to three groups i.e. scarce, difficult, and easy.

**Scarce:** it includes items which are in short supplies, imported items. Such items are produce once in a year. Because of effort and expenditure involved in its import.
**Difficult:** it includes which are indigenously but are difficult to produce.
**Easy:** it includes which are readily available and easy to procure.
SDE analysis is applied by purchased departments. This classification runs like this:

S = Scarce items
D = Difficult items (difficult to procure items)
E = easy items (not difficult to get)

- **VED Analysis:** The items can be classified according to their use, consumption, value etc..,

V - Stands for vital items, without which production would come to halt.
E - Stands for essential items, without which dislocation of production work occurs.
D - Stands for desired items, remaining items, which do not cause immediate loss in production fall under this category.

(OR)

V - Vital items are those items the unavailability of which will stop the production.
E - Essential items are those items whose stock out cost as very high.
D - Desirable items will not cause any immediate production stoppage and their stock out cost is nominal.

- **FSN Analysis:** The items are classified in to 3 categories.
  - F - Fast moving
  - S - Slow moving
  - N - Non- moving

All the items in the inventory are not required at the same frequency. Some are required regularly, some occasionally and some very rarely. Hence based on the frequency of requirement, the items are classified in FSN Analysis as fast moving, slow moving, and non- moving.