# *OPERATIONS MANAGEMENT*

## *V SEMESTER*

## *CORE COURSE*

# *BBA*

*(2011 Admission)*


## UNIVERSITY OF CALICUT

**SCHOOL OF DISTANCE EDUCATION**

**Calicut university P.O, Malappuram Kerala, India 673 635.**


**314**

# UNIVERSITY OF CALICUT

SCHOOL OF DISTANCE EDUCATION

## STUDY MATERIAL

## Core Course

## BBA

## V Semester

# *OPERATIONS MANAGEMENT*

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# UNIT -1

# OPERATIONS MANAGEMENT

## Introduction

Innovations in technology have resulted in the development of manufacturing capabilities of organisation. Moreover, the study and application of management techniques in managing the affairs of the organisation have also changed its nature over the period of time. Therefore, managing a service system has become a major issue in the global competitive environment. Operations Management has been a driving force in the improvement of business practice around the world. Operations Management leads the way for the organisations to achieve its goals with minimum effort. Operations management is recognised as an important factor in a country's economic growth. Operation management is the crucial area in the functioning of organisations and therefore, an in-depth study of the subject matter becomes essential.

Operation is concerned with the transformation of inputs into the required output orservices. Management is the continuous process, which combines and transforms various resources used in the operations system of the organization into value added services. Operation Management is the set of interrelated management activities, which are involved in manufacturing of certain products or services.

## Concept of Production

Production is the step-by-step conversion of one form of material into another form through continuous process to create the utility of the product to the user. Production is a value addition process. Edwood Buffa defines production as 'a process by which goods and services are created'. Production function is concerned with the transformation of a range of inputs into the required outputs .For example, manufacturing of standardized products like, car, motor cycle, radio, television, soaps, etc.

## Production system

The production system is that part of an organisation, which produces goods of an organisation. It is a planned and integrated activity whereby resources are transformed in a controlled manner to add value for the product.

The production system has the following features:

1. Production is a well organised activity with pre-established objectives.

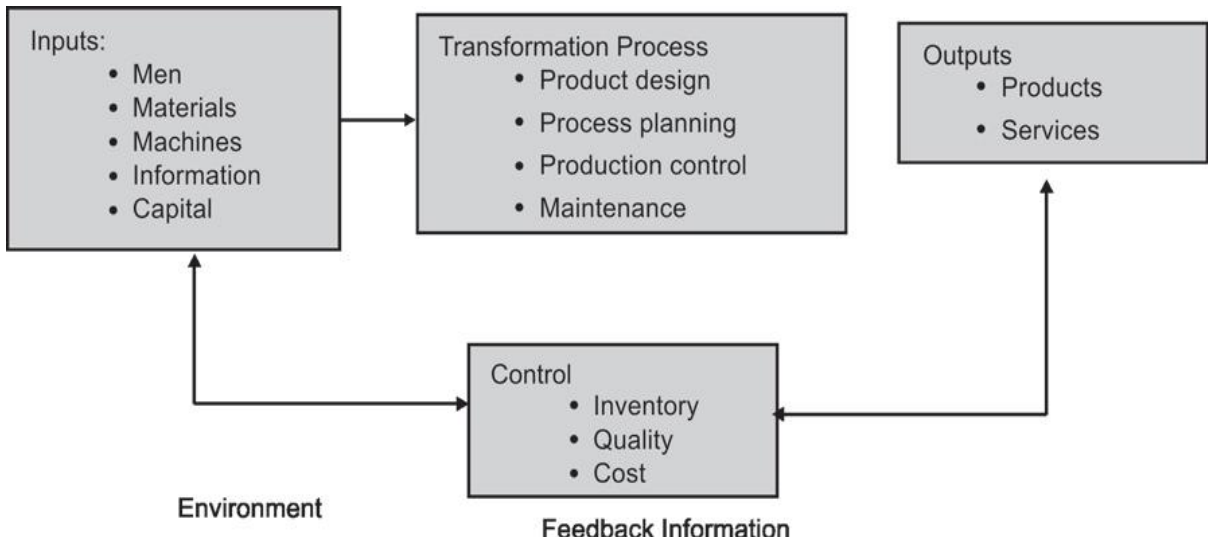
2. The production system converts the various inputs into outputs.

3. Production function is integrated with other activities of the organisation.

4. Feedback system is necessary to control and improve the system performance.

5.It is a continuous process.

Fig,1.1 production system




**Production Management**

Production management is a process of planning, organising, directing and controlling the activities of the production function. It combines and transforms various resources used in the production subsystem of the organization into value added products. Production management deals with decision-making related to production processes so that the resulting goods or services are produced according to specifications, in the amount and by the schedule demanded and out of minimum cost.

**Objectives of production management**

The objectives of the production management are given below:

1. Right Quality: Quality is the important factor, which should be considered at the time of manufacturing process. All efforts should be taken to ensure the quality of the manufactured goods.

2. Right Quantity: The manufacturing organisation should produce the goods in right number. If they are produced in excess of demand the capital will block up in the form of inventory. If the quantity is produced in short of demand, it leads to shortage of products.

3. Timeliness: Timeliness of delivery is one of the important factors to judge the effectiveness of production department. The production department has to make the optimal utilization of resources to achieve its objectives.

4. Low Manufacturing Cost: Manufacturing costs are determined before the product is actually produced. Hence, all attempts should be taken to produce the products at pre-established cost so as to reduce the variation between actual and standard cost.

**Operation management**

Operation Management is a part of management sciences. Operation Management is concerned with the production of quality goods and services and ensures that the business operations are performed smoothly, efficiently, effectively. It is a field of management that deals with effective planning, scheduling, use and control of a manufacturing or service organisation. Operations management is the business function that plans organises, co-ordinates, and controls, the resource needed to produce a company's goods and services. Operations Management is the process whereby resources, flowing within a defined system, are combined and transformed by a controlled manner to add value in accordance with policies communicated by management.

**Definition of Operation Management**

According to S.Buffa 'production or operation management deals with decision making related to production process so that the resulting goods and services are produced according to specifications ,in the amount and by the schedule demanded and at a minimum cost'.

The Association of Operation Management defines operation management as 'the field of study that focuses on the effective planning ,scheduling, use and control of manufacturing or service organisations through the study of concepts from design engineering, industrial engineering, MIS, quality management, production management, industrial management and other functions as they affect the organisation'.

Operation management is the business function that manages that part of a business that transforms raw materials and human inputs in to goods and services of higher value. Operation management is a business activity that deals with the production of goods and services. The term operation includes management of materials, machines, and inventory control and storage functions. Operations management includes a set of activities performed to manage the available resources in an efficient manner in order to convert inputs in to desired outputs.

The value addition to an input can be done in the following ways. They are mentioned below:

1. Alteration

   It refers to the transformation of the state of input. This transformation can be a physical change in the input to produce goods.

2. Transportation

   It refers to physical movement of goods from one location to another.

3. Storage

   It refers to preserving goods in a protected environment.

4. Inspection

   It refers to the verification of and confirmation towards the requirements of an entity.

All the above activities in one way or another are making a product more useful. The operations managers have the prime responsibility for processing inputs into outputs. They must bring together the materials, capacity and knowledge available for the purpose achieving its production objectives. The definition of the operations Management contains the concepts such as Resources, Systems, transformation and Value addition Activities etc. A brief explanation about such words is given below:

Resources

Resources are in the forms of the human, material and capital inputs. Human resources are the key resources of an organisation. By using the intellectual capabilities of people, managers can multiply the value of their employees. Material resources are the physical inputs, which are needed for production.

Systems

Systems are the arrangement of components designed to achieve objectives. The business systems are subsystem of large social systems. Business system contains subsystem such as personnel, engineering, finance and operations. The ability of any system to achieve its objective depends on its design and control mechanism. System design is a predetermined arrangement of components. It establishes the relationships between inputs, transformation activities and outputs in order to achieve the system objectives. System control consists of all actions necessary to ensure that activities conform to pre-conceived plans.

Productivity

The objective of combining resources is to transform the inputs into goods and services having a higher value than the original inputs. The effectiveness of the production factors in the transformation process is known as productivity.

The productivity refers to the ratio between values of output per work hour to the cost of inputs.

**Scope of operations management**

As stated earlier, Operations Management is concerned with the conversion of inputs into outputs using physical resources so as to provide the desired utilities to the customers. It involves a number of well planned activities. Following are the activities that come under Production and Operations Management functions:

1. Location of facilities.

2. Plant layouts and Material Handling.

3. Product Design.

4. Process Design.

5. Production and Planning Control.

6. Quality Control.

7. Materials Management.

8. Maintenance Management

**1. Location facilities**

Location of the proposed factory building is an important consideration in operation management. It is an important strategic level decision-making for an organisation. It deals with the questions such as 'where our main operations should be based?' The selection of location is a key-decision because large amount of investment is required in building plant and machinery. An improper location of plant may lead to waste of all the investments made in plant and machinery. Hence, location of plant should be based on the company's future plan about expansion, diversification, nature of sources of raw materials and many other factors. The very purpose of the location study is to identify the optimal location facility that will results in the greatest advantage to the organization.

**2. Plant layout and material handling**

Plant layout refers to the physical arrangement of facilities. It is the configuration of departments, work centres and equipment's in the inputs conversion process. The objective of the plant layout is to design a physical arrangement that meets the required output quality and quantity most economically. According to James More 'Plant layout is a plan of an optimum arrangement of facilities including personnel, operating equipment, storage space, material handling equipment and all other supporting services along with the design of best structure to contain all these facilities'.

**Material Handling** refers to the moving of materials from the store room to the machine and from one machine to the next machine during the production process. It is the art and science of moving, packing and storing of products in any form. Material cost can be reduced by judicious selection of materials and its proper storage. Material handling devices increases the output, improves quality, speeds up the deliveries and decreases the cost of production. Hence, material handling should be a prime task in the designing of new projects.

### 3. Product design

Product design deals with conversion of ideas into reality. Every business organisation has to design, develop and introduce new products as a commercial strategy. Developing the new products and launching them in the market are the biggest problems faced by the organizations. The entire process of need identification to physical manufactures of product involves three functions—Design, Product Development, and manufacturing. Operation management has the responsibility of selecting the processes by which the product can be produced.

### 4. Process design

Designing of manufacturing process is another functional area of operation management. It deals with how the process required to produce a product is selected. These decisions encompass the selection of a process, choice of technology, process flow analysis and layout of the facilities. The major consideration in process design is to analyse the workflow for converting raw materials into final products.

### 5. Production Planning and Control

Production planning and control can be defined as the process of planning the production in advance, setting the exact route of each item, fixing the starting and finishing dates for each item, to give production orders to shops and to follow-up the progress of products according to orders. The principle of production planning and control lies in the statement 'First Plan Your Work and then Work on Your Plan'. Main functions of production planning and control include Planning, Routing, Scheduling, Dispatching and Follow-up.

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

**Routing** is the process of selection of path, which each part of the product will follow. Routing determines the most advantageous path to be followed for department to department and machine to machine till raw material gets its final shape.

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

**Dispatching** is concerned with the starting the processes. It gives authority so as to start a particular work, which has been already been planned under Routing and Scheduling. Therefore, dispatching is the release of orders and instruction for the starting of production.

**Follow-up** is the process of reporting daily progress of work in each shop in a prescribed proforma and to investigate the causes of deviations from the planned performance and to take necessary actions.

## 6. QUALITY CONTROL

Quality Control may be defined as a system that is used to maintain a desired level of quality in a product or service. It is a systematic control of various factors that affect the quality of the product. Quality Control aims at prevention of defects at the source, relies on effective feedback system and corrective action procedure. Quality Control ensures that the product of uniform acceptable quality is manufactured. It is the entire collection of activities, which ensures that the operation will produce the optimum quality products at minimum cost. The main objectives of Quality Control are:

1. To produce qualitative items

2. To reduce companies cost through reduction of losses due to defects.

3. To produce optimal quality at reduced price.

4. To ensure satisfaction of customers with productions or services or high quality level, to build customer good will, confidence and reputation of manufacturer.

6. To make inspection prompt to ensure quality control.

7. To check the variation during manufacturing.

7. MATERIALS MANAGEMENT

Materials Management is that aspect of operation management function, which is concerned with the acquisition, control, and use of materials needed and flow of goods and services connected with the production process. The main objectives of Material Management are given below:

1. To minimise material cost.

2. To purchase, receive, transport and store materials efficiently.

3. To reduce costs through simplification, standardisation, value analysis etc.

4. To identify new sources of supply and to develop better relations with the suppliers.

5. To reduce investment made in the inventories and to develop high inventory turnover ratios.

8. MAINTENANCE MANAGEMENT

Equipment and machinery are very important parts of the total production system. Therefore, their efficient usage is very mandatory. It is very important to see that the organisation maintains plant and machinery properly. The main objectives of Maintenance Management are given below:

1. To reduce breakdown of machineries

2. To keep the machines and other facilities in a good condition.

3. To ensure the availability of the machines, buildings and services required by other sections of the factory also.

4. To keep the plant in good working condition.

**History of operations management**

The traditional view of manufacturing management began in eighteenth century when Adamsmith recognised the economic benefits of specialization of labour. He recommended breaking of jobs down into subtasks and recognises workers to specialized tasks in which they would become highly skilled and efficient. In the early twentieth century, F.W. Taylor implemented Smith's theories and developed scientific management. From then till 1930, many techniques were developed prevailing the traditional view. Production Management became the acceptable term from 1930s to 1950s. As F.W. Taylor's works become more widely known, managers developed techniques that focused on economic efficiency in manufacturing. Workers were studied in great detail to eliminate wasteful efforts and achieve greater efficiency. At the same time, psychologists, socialists and other social scientists began to study people and human behaviour in the working environment. In addition, economists, mathematicians, and computer socialists contributed newer approaches.

With the 1970s emerged other two distinct changes. The most obvious of these, reflected in the new name Operations Management was a shift in the service and manufacturing sectors of the economy. As service sector became more prominent, the change from 'production' to 'operations' emphasized the broadening of field to service organizations. The second, more suitable change was the beginning of an emphasis on synthesis, rather than just analysis, in management practices.

A brief account of development of operations and production management is given below:

| Year | Contribution | Contributors |
|---|---|---|
| 1776 | Specialization of labour in manufacturing | Adam Smith |
| 1799 | Interchangeable parts, cost accounting | Eli Whitney & others |
| 1832 | Division of labour by skill; assignment of jobs by Skill; basics of time study | Charles Babbage |
| 1900 | Scientific management time study and work study Developed; dividing planning and doing of work | Frederick W.Taylor |
| 1900 | Motion of study of jobs | Frank B. Gilbreth |
| 1901 | Scheduling techniques for employees, machines Jobs in manufacturing | Henry L. Gantt |
| 1915 | Economic lot sizes for inventory control | F.W. Harris |
| 1927 | Human relations; the Hawthorne studies | Elton Mayo |
| 1931 | Statistical inference applied to product quality: quality control charts | W.A. Shewart |
| 1935 | Statistical Sampling applied to quality control: inspection sampling plans | H.F. Dodge & H.G. Roming |
| 1940 | Operations research applications in world war II | P.M. Blacker & others |
| 1946 | Digital Computer | John Mauchlly and J.P. Eckert |
| 1950 | Mathematical programming, on-linear and stochastic processes | A. Charnes, W.W. Cooper& others |
| 1960 | Organisational behaviour: continued study of people at work | L. Cummings, L. Porter |
| 1970 | Integrating operations into overall strategy and policy Computer applications to manufacturing, scheduling, and control, Material Requirement Planning (MRP | W. SkinnerJ.Orlicky & G. Wright |
| 1980 | Quality and productivity applications from Japan: robotics, CAD-CAM | W.E. Deming & J. Juran |

**Objectives of Operation Management**

Operation Management involves management of the entire process responsible for converting inputs into outputs**.** The following are the objectives of Operations Management.

**1.** To provide customer service

The main objective of any operating management systems is to utilize resources judiciously for the satisfaction of customer needs and wants. Therefore, customer satisfaction is a key objective of operations management. Operation management focuses on providing the right products at a right price at the right time. Hence, this objective will influence the operations manager's decisions to achieve the required customer service.

**2.** Effective utilisation of resources

Resourcesthat are used in the business organisation must be carefully utilised. Inefficient use of resources or inadequate customer service leads to commercial failure of an organisation. Operations management is concerned essentially with the utilisation of resources. It aims at obtaining maximum output from the available resources with minimum cost.

**3.** To reduce cost of production

Operation management aims at reduction in the cost of production of goods and services. The cost per unit of the product has to be set properly and all efforts should be taken to control the actual cost to pre-determined cost of production. Cost can be classified in to fixed cost and variable cost. The variable cost changes with every level of production. This variable cost can be checked by means of inventory and labour control techniques.

**4.** To improve product quality

Quality control and maintenance are the two important objectives of operations management. Quality control consists of all those activities, which are designed to define, maintain and control specific quality of products within reasonable limits. It is the systematic regulation of all variables affecting the goodness of the final product. In other words, quality control involves determination of quality standards and its actual measurement .It is necessary to ensure that the established standards are practiced and maintained. It does not attempt to achieve the perfect quality but to secure satisfactory or reasonable quality at a reasonable level of cost.

**5.** To fix time schedule

Another important objective of operation management is to establish time schedule for various operation activities. The schedule fixation includes the operating cycle time, inventory turnover rate, machine utilisation rate, capacity utilisation etc.

**6.** Proper utilisation of Machinery

Operation management has to take number of decisions with regard to machinery and equipment. New machines should be installed and the old machines are to be replaced. It has to ensure judicious utilisation of machinery and equipment.

**7.** Material control

Based on the sales forecast and production plans, the materials planning and control is done. This involves estimating the individual requirements of parts, preparing materials budget, forecasting the levels of inventories, scheduling the orders and monitoring the performance in relation to production and sales.

**MANUFACTURING AND NON –MANUFACTURING OPERATIONS**

On the basis nature of operations the organisations can be divided in to:

1. Manufacturing organisations

2. Non-manufacturing organisations

The following are the differences between manufacturing organisations and non-manufacturing organisations:

1. Manufacturing organisation produces the goods that are tangible in nature. On the other hand service organisations render service to the customers instead of tangible products.

2. The products of manufacturing units can be stored in physical form. But the products of non-manufacturing organisation cannot be stored.

3. In manufacturing organisation, mostof the customers have no direct contact with the operations.On the other hand, in the caseservice organisations the customers are present during the creation of the service.

Differences between the goods and the service

| **goods** | **service** |
|---|---|
| Goods are tangible | Services are intangible |
| Goods can be stored and transported | Services cannot be produced beforehand |
| They are produced in a factory environment | Services are produced in a market environment |
| Goods are mainly standardised | Services are often customised |
| Quality is inherent in the product | Quality is inherent in the process |

**Interaction of operation management with other areas**

An organisations function can be broadly divided in to

1. Finance

2. Operation

3. Marketing

Operation as a function of management has relationships with marketing, finance, engineering and other functional areas. Finance department is concerned with securing adequate financial resources for the organisation and its proper utilisation. Allocation of the financial resources throughout the organisation is the major function of finance department including **operations department**. Marketing department is responsible for identification of needs and wants of the prospective customers and developing a suitable marketing plan. Inshort, operation is a key activity in an organisation, which is linked with marketing and financial activities. For the successful functioning of the organisation, co-operative actions of all section of the organisation are needed. All functional departments have to work together. Here, operational management is central to the functioning of all other parts of organisation. There should be functional collaboration among different departments. For this purpose information sharing between these departments is essential. In short operation management is the business function that plans, organises, coordinates, and controls the resources needed to produce a company's products and services. For ensuring this, the co-operation and support from all other department of the organisation are essential.

**Material handling equipment**

The material handling is an important activity in the operations system. The speed of the material flow across the supply chain depends on the type of the material handling equipment is used. In the logistics operation the material handling system is designed in and around the warehouse. The various operation activities like the unloading of incoming material from transport equipment, moving the unloaded material to the assigned storage place, lift the material from its storage place during order picking, move the material for inspection and packing, and load the packages on to the transport vehicle. These operations are performed using manual, mechanized controlled material handling equipment's. The following are some of the material handling equipments commonly used

**1.**Lifting Equipment

Lifting and transport equipment is used to move product around the production facility, from loading bay to storage, from storage to production, around production, from production to storage, and from storage to loading bay. Equipment that falls into this category is fork lift trucks, order picking trucks etc.

**2**. Storage Equipment

Storage equipment is used to store materials, components and assemblies. The level of complexity of this type of equipment is wide ranging, from a welded cantilever steel rack to hold lengths of stock materials to a powered vertical carousel system.

**3.** Automated Handling Equipment

Manufacturers of automated handling equipment produce automated guide vehicles, storage and retrieval equipment and product sortation equipment. The level of automation varies depending on the handling requirements. Fully automated handling systems ensure that the materials are delivered to the production line when required without significant manual intervention.

**4.** Robotics

The usage of Robotics applications and versatility hasincreased dramatically. In manufacturing applications, robots can be used for assembly work, process such as painting, welding, etc. and for material handling. Morerecently robots are equipped with sensory feedback through vision and tactile sense.

Container crane

Mobile harbour crane

# UNIT -2

# FACILITIES PLANNING

## PRODUCT DESIGN

Designing of good product is the major challenge of any organisation. Design gives the blueprint idea about the product. Design starts with concept ualisation of ideas. Providing value to the customer, the return on investment and the competitiveness of the organisation should form the basis of the product design effort. A product design has an impact on what materials and components would be used, which suppliers will be selected, what machines or what type of processes will be utilised, where it will be stored, how it will be transported etc. A product design reflects a company's overall strategy. Therefore, it should be undertaken carefully.

Product development and design is primarily governed by management decisions. A marketing research can provide information as to market potentialities as well as functional, operational, dependability, and durability requirements of the customers. There are number of factors which affect the design of the product. They are given below:

1. Requirements of customers

2. Production facilities of the manufacturers

3. Availability of materials

4. Method of works

The following are the different stages involved in the product development process:

1. Generation of ideas from multiple sources

2. Screening of ideas for further analysis

3. Business analysis of data

4. Development of product

5. Market testing

6. Commercialisation of the products

## PROCESS SELECTION

A process is a way to convert raw materials in to finished products. Process selection is a strategic decision as it involves allocation of men, material and

financial resources. Production engineering provides expert advices for process selection. Process selection involves the decisions with regard to work station and the choice of work flow. Work station selection involves the choice of machines to be included in the manufacturing process. Work flow analysis concerns with the flow of work between these stations. The following are the factors affecting the choice of process of manufacture:

1. Product features

2. Requirements of customers

3. Availability of capital

4. Availability of technologies

5. Legal factors

6. Availability of employees

**Types of Production Process**

There are mainly three types of production systems or production process. They are discussed briefly below:

1. Continuous System

2. Intermittent System

3. Project systems

1. Continuous System

Continuous production refers to the manufacturing of large volume of a single or a very few varieties of products with a standard set of processes. The mass production is carried on continuously for stock in anticipation of demand.

Features of the continuous production are given below:

1. The volume of output is generally large.

2. The product design and the operations stages are standardised

3. Special purpose automatic machines are used to perform standardised operations.

4. Product layout is designed according to a separate line for each product.

## Merits of continuous production process

The following are the advantage of continuous production system:

1. The main advantage of continuous production system is that work-in-progress inventory is minimal.

2. The quality of output is kept uniform because each stage develops skills of employees through repetition of work.

3. Any delay at any stage is automatically detected.

4. Handling of materials is reduced due to the set pattern of production line

5. Control over materials, cost and output is simplified.

6. The work can be done by semi-skilled workers because of their specialization.

## Demerits of continuous production system:

1. Strict maintenance is necessary to avoid production hold ups.

2. Huge capital investment is required.

3. Cannot make sudden changes in the production system.

## Types of continuous production system:

### 1.1. Mass Production

In this method, a few types of products are manufactured in large quantities. The volumes are high and products are standardised which allows resources to be organised around particular products. Mass Production is characterised by the following features:

1. Standard products are manufactured.

2. Standardised inputs and standardised operations are used for manufacturing.

3. Large volume of products.

4. Shorter cycle time of production.

5. Less supervision is required.

6. Perfectly balanced production lines.

7. Flow of materials, components and parts are continuous

8. Production planning and control are easy.

### Advantages of mass production

Following are the advantages of Mass Production:

1. Higher rate of production with reduced cycle time.

2. Higher capacity utilisation.

3. Less skilled operators can also be employed.

4. Low process inventory.

5. Manufacturing cost per unit is low.

**Limitation of mass production**

Following are the limitations of Mass Production:

1. Breakdown of one machine will stop entire production line.

2. Line layout needs major change with the changes in the product design.

3. High investment in production facilities is required.

## 1.2. Process Productions

Production facilities are arranged as per the sequence of production operations from the first operations to the finished product. It involves continuous physical flow of material from one stage to another stage. The process usually operates round the clock to maximise utilisation and to avoid expensive shutdowns and start-ups.

Characteristics of process production

Process Production is characterised by:

1. Material handling is fully automated.

2. Process follows a predetermined sequence of operations.

3. It is used for bulk manufacturing.

4. Planning and scheduling is a routine action.

**Advantages**

Following are the advantages of process Production:

1. Standardisation of product and process sequence.

2. Higher rate of production with reduced cycle time.

3. Higher capacity utilisation due to line balancing.

4. Manpower is not required for material handling as it is completely automatic.

5. Person with limited skills can be used on the production line.

6. Unit cost is lower due to high volume of production.

**Limitations**

Following are the limitations of process Production:

1. Flexibility to accommodate and process number of products does not exist.

2. Very high investment for setting flow lines.

**2. Intermittent Production System**

In this system, the goods are generally produced to fulfill customers' orders rather than producing against stock. Intermittent situations are those where the facilities must be flexible enough to handle a variety of products and sizes. The flow of material is intermittent. The production facilities are flexible enough to handle a wide variety of products and sizes. In the industries following the intermittent production system, some components may be made for inventory but they are combined differently for different customers. The finished product is heterogeneous but within a range of standardized options assembled by the producers. Since production is partly for stock and partly for consumer demand, there are problems to be faced in scheduling, forecasting, control and coordination.

**Characteristics intermittent production**

The Characteristics intermittent production is given below:

1. The flow of production is intermittent, not continuous.

2. The volume of production is generally small.

3. A wide variety of products are manufactured.

4. General purpose machines and equipment are used.

5. No single sequence of operations is used for a long period.

6. Process layout is most suited in a highly competitive environment.

7. Periodical adjustments are made to suit different jobs or batches.

Intermittent system is much more complex than continuous production system because every product has to be treated differently. Intermittent system can be effective in situations which satisfy the following conditions:

1. The production centres should be located in such a manner so that they can handle a wide range of inputs.

2. Transportation facilities between production centres should be flexible.

3. It should be provided with necessary storage facility.

Types of Intermittent Production

Basically there are two types of intermittent production system. They are as follows:

## 2.1. Job Production

In the case of Job production, the products are manufactured as per the specifications of the customers within pre-determined time and cost. The main feature of this method is low volume and high variety of products compared to mass production. Under this method, each job demands unique production activities.

### Features of job production

The following are the features of job production system:

1. More variety of products is manufactured as per customer'srequirements.

2. Volume of production is low.

3. Highly skilled employees are required to do the work.

4. Detailed planning is essential for sequencing the requirements of each product.

5.Employees should be able to take each job as a challenge.

### Advantages

Advantages of job production are as follows:

1. It tries to satisfy the unique requirements of customers.

2. Employees will become more skilled, as each job gives them learning opportunities to develop.

3. Full potential of employees can be utilised.

4. Opportunity exists for employees to do creative works.

### Limitations

Following are the limitations of Job Production system:

1. Higher cost due to frequent set up changes.

2.It results in higher level of inventory at all levels and also higher inventory cost.

3. Production planning is complicated.

4. Larger space requirement is needed.

## 2.2. Batch Production

Under batch production method, items are processed in lots or batches and a new batch is undertaken for production only when the production on all

items of a bath is complete. In fact, batch type of production system can be considered as an extension of job type system.

**Characteristics of batch production**

Batch Production is characterised by

1. Shorter production runs.

2. Products are manufactured in small batches.

3. Plant and machinery set up is used for the production of item in a batch and change of set up is required for processing the next batch.

4. Manufacturing lead-time and cost are lower as compared to job order production.

**Advantages**

Following are the advantages of Batch Production:

1. Better utilisation of plant and machinery facilities.

2. It promotes functional specialisation.

3. Cost per unit is lower as compared to job order production.

4. Lower investment in plant and machinery is required.

**Limitations**

Following are the limitations of Batch Production:

1. Material handling is complex because of irregular and longer flows.

2. Production planning and control are complex.

3. Higher set up costs due to frequent changes in set up.

**3. Project process**

A project process is one in which there is a very high degree of customization and the job is undertaken to meet specific requirements. Each project is unique. Project process is valued more on the basis of their capabilities to do certain kinds of jobs, rather than to produce specific products at low cost. They tend to take a long time to complete the work. It involves several inter related tasks that must be completed. Resources needed for a project are brought together at the beginning of the project and are disbanded once the project is over.

## FACILITY OR PLANT LOCATION

Facility location decision is the systematic process of determining a geographic site for a firm's operations. Managers of both service and manufacturing organizations should consider the desirability of a particular site, including proximity to customers and suppliers, labour costs, and transportation costs. Location conditions are difficult to measure. Tangible cost based factors such as wages and products costs can be quantified easily. On the other hand non-tangible features, which refer to such characteristics as reliability, availability and security, cannot be measured exactly in quantitative forms.

### Steps in site Selection

The following are the different stages involved in the site selection process:

1. Selection of the region in which the plant is to be established
2. After selecting the region, the next step is to select a locality with in the region.
3. Selection of site for plant construction
4. Final investment decision

There are mainly two sets of factors affecting the location decision:

1. General locational factors, which include controllable and uncontrollable factors for all type of organisations.

2. Specific locational factors specifically required for manufacturing and service organisations.

Following are the general factors required for location of plant in case of all types of organisations.

1. Proximity to markets
2. Supply of materials
3. Transportation facilities
4. Infrastructure availability
5. Labour and wages
6. External economies
7. Capital.
8. Government policy
9. Climate conditions
10. Supporting industries and services
11. Community and labour attitudes
12. Community Infrastructure.

**Controllable factors**

1. Proximity to markets

Every company is expected to serve its customers by providing goods and services at the reasonable price and time.Organizations may choose to locate facilities near to the market. When the buyers are concentrated, it is advisable to locate the facilities close to the market. Nearness to the market ensures a consistent supply of goods to customers and it reduces the cost of transportation.

Locating nearer to the market is preferred if:

• The products are subject to spoilage.

• After sales services are promptly required very often.

2. Supply of raw material

It is essential for the organization to get right type of raw materialsat the right time in order to have a continuous production. This factor becomes very important if the materials are perishable and cost of transportation is very high. Nearness to raw material is important in case of industries such as sugar, cement, jute and cotton textiles.The following things are to be considered in this case:

• When a single raw material is used without loss of weight, locate the plant at the rawmaterial source or at the market place.

• When weight loosing raw material is required, locate the plant at the raw material source itself.

• When raw material is universally available, locate close to the market area.

3. Transportation facilities

Speedy transport facilities ensure timely supply of raw materials to the production centres. The transport facility is a prerequisite forthe location of the plant. There are different modes of transportation such as, air, road, rail, water and pipeline. Goods that are mainly intended for exports demand, a location near to the port is useful and economical. The factors influencing the choice locational facility includecosts, convenience, and suitability.

4. Availability of infrastructure facilities

The infrastructure facilities like power, water and waste disposal etc., are the important factors in deciding the location facility. Certain types of industries use more amount of power and such company's should be located close to the power station. The non-availability of power may become a survival problem for such industries. Process industries like paper, chemical, cement etc. require continuous supply of water in large amount. Availability of waste disposal facility for process industries is an important factor in modern times.

5. Labour and wages

The problem of securing adequate number of skilled and unskilledwork force is a major factor to be considered at the time site selection. Importing labour is usually costly and involves administrative problems. Productivity of labour is also an important factor to be considered. Prevailing wage pattern, quality of human resources in terms of education, cost of living, industrial relation and bargaining power of the unions' form important considerations.

6. External economies of scale

Availability of various external economies of scale is major factor in deciding the project location. Tax incentives, facility of industrial estates, special economic zone are some of the factors to be considered at the time of taking location decision. Location economies of scale in the manufacturing sector have evolved over time and have mainly increased competition due to production facilities and lower production costs as a result of lower transportation and logistical costs.

7. Availability of Capital

Another important factor deciding the choice of location is the availability of capital. Fixed capital is required for the construction of building and acquisition of land. But on the other hand buildings can also be rented and existing plants can be expanded. The availability of such factors is also affecting the decision on site selection.A careful study on financial strength and weaknesses of the proposed project should be undertaken.

8. Policies of the Government

The policies of the Central, state governments and local bodies concerninglabour laws, building codes, safety, taxetc. are the major factors which affect the choice location for the industries. Government provides various kinds of incentives to entrepreneurs for industrial development in special economic zone. The incentive package may be in the form of exemption from a sales tax and excise duties for a specific period, soft loan from financial institutions and investment subsidy. Some of these incentives may tempt to locate the plant to avail these facilities offered.

9. Climatic conditions

The natural condition of the geographical area needs to be considered together with climatic conditions. Climates greatly influence human efficiency and behaviour and reflect the same in the labour productivity. Some industries require specific climatic conditions e.g., textile mill requireshumidity. Therefore such special climatic factors have to be carefully examined in the choice of project site.

10. Supporting industries and services

Availability of supporting industries is another consideration which affects the choice of location. Manufacturing organisation will not make all the components and parts by itself .Sometimes it subcontracts the work to vendors to manufacture. So,the source of supply of component parts will be the one of the factors that influences the location. The presence of healthy relationship among different firms is also a pre-requisite for industries to develop. The various services like communications, banking services, professional consultancy services will play a vital role in selection of a location.

11. Community and labour attitudes

The general attitude of the community towards proposed industry will have an important bearing in the choice location.Sometimes,a specific location is not desirable because of labours negative attitude towards management, which brings very often the strikes and lockouts. Such conditions have to be seriously analysed.

12. Availability of Community infrastructure

All manufacturing activities require access to a transport infrastructure such as roads, railways, port, power lines and other service facilities .The availability of social facilities like schools, universities and hospitals are also the major determinants in the choice project site. These factors are also required to be considered by managers.

**PLANT/FACTORY LAY OUT**

Plant layout refers to the physical arrangement of production facilities. It is the configuration of departments, work centres and equipment in the conversion process. It is a floor plan of the physical facilities. There are several factors which affect the choice of factory layout.

Definition of plant layout

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

OBJECTIVES OF LAY OUT

The basic objective of the plant layout is to arrange production facilities economically. The objectives of plant layout are given below:

1. Streamline the flow of materials through the plant.

2. Facilitate the manufacturing process.

3. Minimise materials handling cost.

4. Effective utilisation of men, equipment and space.

5. Flexibility of manufacturing operations and arrangements.

6. Provide for employee convenience, safety and comfort.

7. Minimize investment in equipment

PRINCIPLES OF LAY PUT

The following are the principles plant layout:

1. Principle of integration

A good layout is one that integrates men, materials, machines and supporting services and others in order to get the optimum utilisation of resources and maximum effectiveness at least cost.

2. Principle of minimum distance

This is concerned with the minimum movement of man and materials. The facilities should be arranged such a way that, the total distance travelled by the men and materials should be minimum. As far as possible straight line movement should be preferred.

3. Principle of cubic space utilisation

The good layout is one that utilise both horizontal and vertical space. It is not only enough if only the floor space is utilised optimally but the third dimension, i.e., the height is also to be utilised effectively.

4. Principle of flow

A good layout is one that makes the materials to move in forward direction towards the completion stage. This means there should not be any backtracking.

5. Principle of maximum flexibility

The good layout is one that can be altered without much cost and time .The future requirements should be taken into account while designing the present layout of the plant.

6. Principle of safety, security and satisfaction

A good layout is one that gives due consideration to workers safety and satisfaction and safeguards the plant and machinery against fire, theft, etc.

7. Principle of minimum handling

A good layout is one that reduces the material handling.

**Factors to be considered in plant lay out**

The following are the important factors to be considered at the time of plant lay out. They are given below;

1. Need for plant expansion

The future requirements of the organisation should be considered at the time of planning for plant location.

2. Protection of operation equipment

Every care should be taken to ensure the safety machinery and equipment. Shelter is required whenever there is need to protect equipment from adverse climatic conditions.

3. Maintenance requirements

Some equipment's require continuous maintenance .There should be adequate facilities in maintain the equipment's and machinery. This requirement has to be considered at the time of planning plant layout.

4. Location

The site selected for the plant also determines the plant lay out. The structure, geology, climatic conditions of the location influence the decision on plant layout.

**TYPES OF LAY OUT**

Layouts can be classified into the following five categories:

1. Process layout

2. Product layout

3. Combination layout

4. Fixed position layout

5. Group layout

**PROCESS LAY OUT**

In the case of process lay out all the machines performing similar type of operations are grouped at one location. In process layout the arrangement of facilities is grouped together according to their functions and operations. The flow of material through the facilities from one functional area to another functional area varies from product to product. Process layout is suggested for batch production. Usually the paths are long and there will be possibility of backtracking.Process layout is normally used when the production volume is not sufficient to justify a product layout.

**Advantages of process layout**

Advantages of process layout are as follows:

1. In process layout machines are better utilized.

2. Flexibility is possible in process layout.

3. Lower investment on account of comparatively less number of machines

4. Higher utilisation of production facilities.

5. A high degree of flexibility with regards to work distribution to machineries and workers.

6. The diversity of tasks and variety of job makes the job interesting.

7. Supervisors will become highly knowledgeable about the functions under their department.

**Limitations of process layout**

1. Backtracking of materials.

2. Material handling cannot be mechanised which adds to cost.

3. Lower productivity due to number of set-ups.

4. Space and capital are tied up by work-in-process

5.Long movements may occur in the handling of materials thus reducing material handling efficiency.

**Product lay out**

In product layout, machines and other supporting services are located according to the processing sequence of the product. It implies that various operations on a product are performed in a sequence and the machines are placed along the product flow line .In product layout machines are arranged in the sequence in which a given product will be operated upon. This type of layout is preferred for continuous production of goods.

**Advantages of product lay out**

1. The flow of product will be smooth.

2. Work -in-process inventory is less.

3. Processing time is less.

4. Minimum material handling cost.

5. Simplified production, planning and control systems are possible.

6. Less space is occupied by work transit and for temporary storage.

7. Reduced material handling cost due to mechanised handling systems.

8. Perfect line balancing which eliminates all bottlenecks.

9. Manufacturing cycle is short due to continuous flow of materials.

10. Small amount of work-in-process inventory.

11. Unskilled workers can manage the production.

**Limitations**

1. A breakdown of one machine in a product line may cause stoppages of machines in the downstream of the line.

2. A change in product design may require major alterations in the layout.

3. Comparatively high investment in equipment's is required.

4. Lack of flexibility.

5. A change in product may require the facility modification

**Combination lay out**

A combination layout combines the advantages of both types of product and process layouts. A combination layout is possible where an item is being made in different types and sizes. Here machinery is arranged in a process layout but the process grouping is then arranged in a sequence to produce various types and sizes of products. It is to be noted that the sequence of operations remains same with the variety of products and sizes.

**Advantages**

The major advantages of this type of layout are:

1. Helps in job enlargement

2.Upgrades the skills of the employees.

2. Greater flexibility is possible.

3. Layout capital investment is lower

**Group lay out**

This type of layout brings an element of flexibility into manufacturing system as regards to variation in batch sizes and sequence of operations. Group Technology (GT) is the analysis and comparisons of items to group them into families with similar features. GT can be used to develop a hybrid between pure process layout and pure product layout. This technique is very useful for

companies that produce variety of parts in small batches to enable them to take advantage and economics of flow line layout.

The application of group technology involves two basic steps; first step is to determine component families or groups. The second step in applying group technology is to arrange the plants equipment used to process a particular family of components. This represents small plants within the plants. The group technology reduces production planning time for jobs. It reduces the set-up time. Thus group layout is a combination of the product layout and process layout. It combines the advantages of both layout systems.

**Advantages of Group Technology Layout**

Group Technology layout can increase—

1. Component standardization and rationalization.

2. Reliability of estimates.

3. Effective machine operation and productivity.

4. Customer service.

It can decrease the—

1. Paper work and overall production time.

2. Work-in-progress and work

**Fixed position layout**

This is also called the project type of layout. In this type of layout, the material, or major components remain in a fixed location and tools, machinery, men and other materials are brought to this location. This type of layout is suitable when one or a few pieces of identical heavy products are to be manufactured and when the assembly consists of large number of heavy parts, the cost of transportation of these parts is very high.

**Advantages**

The major advantages of this type of layout are:

1. Helps in job enlargement and upgrades the skills of the operators.

2. The workers identify themselves with a product in which they take interest and pride in doing the job.

3. Greater flexibility with this type of layout.

4. Layout capital investment is lower.

**Organisation of physical facility**

The following are the most important physical facilities to be organised:

1. Factory building

2. Lighting

3. Climatic conditions

4. Ventilation

5. Work-related welfare facilities.

**I. FACTORY BUILDING**

Factory building is a factor which is the most important consideration for every industrial enterprise. Factory building is required to provide protection for men, machines, materials. It should offer a comfortable working environment. It is for these reasons that the factory building acquires great importance.

Following factors are considered for an Industrial Building:

A. Design of the building.

B. Type of buildings.

A. Design of the Building

The building should be designed so as to provide a number of facilities—such as lunch rooms, cafeteria, locker rooms, crèches, libraries, first-aid and ambulance rooms, materials handling, facilities, heating, ventilation, air-conditioning, etc. Following factors are to be considered indesigning of a factory building:

1. Flexibility:

Flexibility is necessary because it is not always feasible to build a new plant, every time a new firm is organised or the layout is changed. With minor alternations, the building should be able to accommodate different types of operations.

3. Product and equipment

The type of product that is to be produced determines column-spacing, type of floor, ceiling, heating and air-conditioning. A product of a temporary nature may call for a less expensive building. Similarly, a heavy product demands a different building structure than a product which is light in weight.

3. Expansibility: Growth and expansion are natural to any manufacturing units. The following factors should be taken in to account if the future expansion of the concern is to be provided for:

(i) The area of the land which is to be acquired should be large enough to provide for the future expansion needs of the firm.

(ii) The design of the building may be in a rectangular shape. Rectangular shapes facilitate expansion on any side.

(iii) If vertical expansion is expected, strong foundations must be provided.

4. Employee facilities: The employee facility should be given enough consideration because it may affect the morale, satisfaction and attitude of the employees.

B. Types of Buildings

Industrial buildings may be grouped under two types:

1. Single-storey buildings,

2. Multi-storey buildings.

Choosing a suitable type of building for a particular firm depends on the manufacturing process and the area of land and the cost of construction.

1. SINGLE-STOREY BUILDINGS

If land is available, an organisation can construct single storey building. Single-storey buildings offer several operating advantages. A single-storey construction is preferable when materials handling is difficult because the product is big or heavy, natural lighting is desired and frequent changes in layout are anticipated.

**Advantages**

1. There is a greater flexibility in layout.

2. Expansion is easily ensured by the removal of walls.

3. low cost of transportation and material handling charges.

5. since all the equipment's are on the same level, effective layout supervision and control.

6. The danger of fire hazards is reduced because of the lateral spread of the building.

**Limitations**

Single-storey buildings have the following limitations. These are:

1. More land is required for building construction.

2. High cost of heating, ventilating and cleaning of windows.

3. High cost of transportation for moving men and materials to the factory

**2. MULTI-STOREY BUILDINGS**

Multi-storey buildings are useful in manufacture of light products, when the acquisition of land becomes difficult and expensive.

**Advantages**

1. Maximum operating floor space. This is best suited in areas where land is very costly.

2. Lower cost of heating and ventilation.

3. Reduced cost of materials handling because the advantage of the use of gravity for the flow of materials.

Limitations

Following are the disadvantages of multi-storey building:

1. Materials handling becomes very complicated. A lot of time is wasted in moving them between floors.

2. A lot of floor space is wasted on elevators, stairways and fire escapes.

3. Floor load-bearing capacity is limited.

4. Natural lighting is poor in the centres of the shop.

5. Layout changes cannot be effected easily and quickly.

Generally speaking, textile mills, food industries, detergent plants, chemical industries and software industry use these types of buildings.

II. LIGHTING

Good visibility of the equipment, the product and the data involved in the work process is an unavoidable factor in accelerating production, reducing the number of defective products and reducing waste. The use of natural light should be encouraged. Regular cleaning of lighting fixture is obviously essential. Excessive contrasts in lighting levels between the worker's task and the general surroundings should also be avoided. Artificial lighting will enable people to maintain proper vision.

III. CLIMATIC CONDITIONS

Control of the climatic conditions at the workplace is important to ensure the workers' health and comfort. With excess heat or cold, workers may feel very uncomfortable, and their efficiency drops. This can also lead to accidents. This human body functions in such a way as to keep the central nervous system and the internal organs at a constant temperature. It is essential to avoid excessive heat or cold, and wherever possible to keep the climatic conditions under control within the organisation.

IV. VENTILATION

Ventilation is an integral part of the good building system. Ventilation differs from air circulation. Ventilation replaces contaminated air by fresh air, whereas as the air-circulation merely moves the air without renewing it. Where the air temperature and humidity are high, merely to circulate the air is not only ineffective but also increases heat .Therefore, proper steps have to be taken to ensure the ventilation facility.

V. WORK-RELATED WELFARE FACILITIES

Work-related welfare facilities include basically drinking-water and toilets facilities. Others may seem less necessary, but usually have an importance to workers. The planners of the factory building have to see that the organisation has enough work related facilities for its employees. It is al made mandatory in the Factories Act.

1. DRINKING WATER

Safe, cool drinking water is essential for all types of work, especially in a hot environment. Without it fatigue increases rapidly and productivity falls. Adequate drinking water should be provided to employees.

2. SANITARY FACILITIES

Hygienic sanitary facilities should exist in all workplaces. They are particularly important where chemicals or other dangerous substances are used. Sufficient toilet facilities, with separate facilities for men and women workers, should be ensured.

3. FIRST-AID AND MEDICAL FACILITIES

Facilities for rendering first-aid and medical care at the workplace in case of accidents are essential. First-aid boxes should be clearly marked and conveniently located. They should contain only first-aid requisitesabsorption.

4.REST FACILITIES

Rest facilities help workers to recover from fatigue and to get away from a noisy, polluted or isolated workstation. A sufficient number of suitable chairs or benches should be provided. Rest-rooms enable workers to recover during meal and rest breaks.

5. FEEDING FACILITIES

Organisation should arrange food facilities for its employees. A snack bar, buffet or mobile trolleys can provide tea, coffee and soft drinks, as well as light refreshments. Canteens or a restaurant can allow workers to purchase a cheap, well-cooked and nutritious meal for a reasonable price.

6. RECREATIONAL FACILITIES

Recreational facilities offer workers the opportunity to spend their leisure time in activities likely to increase physical and mental well-being. They may also help to improve social relations within the enterprise. Such facilities can include halls for sports, reading-rooms, libraries, clubs for hobbies and cinemas.

Objective of a good layout

1. To reduce material handling cost

2. To provide enough production facility

3. To utilise labour efficiency

4. To provide ease of supervision.

5. To improve productivity

6. To provide safety to employees

7. To reduce the number of accidents

Material requirement planning MRP

Material requirement planning is an inventory system that is computer based and used to manage the manufacturing process .It is designed to assist in the scheduling and filling of orders for raw materials that are manufactured in to finished goods.

The following are the objectives of MRP:

1. Reduction in inventory cost

2. Meeting delivery schedule

3. Improve the performance of production

**Material handling**

The material handling involves the movement of material form one section to another for the purpose of processing. They can be moved either manually or mechanically. For this purpose different types material handling equipment are used. The material handling system in any manufacturing setting plays an important role in the performance of the entire manufacturing system.

Material handling can be defined as the art and science involving the movement, packing and storing of substances in any form.

Objectives of material handling

1. To reduce material handling cost
2. To reduce production life cycle
3. Better control of the flow of material
4. To ensure safety in the movement of goods
5. To avoid damage of the goods

Rules for material handling

1. Makehandling distances as short as possible
2. Use right method and proper material handling
3. Eliminate wasteful material handling methods
4. Use mechanical equipment's wherever it is useful
5. Use relevant handling equipment to the job

# UNIT-3

# CAPACITY PLANNING

Capacity is the amount of goods that a firm is capable of producing over a specified period of time. Capacity can be defined as highest reasonable output rate which can be achieved with the current product specifications, product mix, work force, plant and equipment. Capacity planning for manufacturing and service systems are different. Both must be designed with capacity limitations in mind. The approaches for long-term and short-term capacity planning will help the managers to make best use of resources. Capacity is the maximum possible output or use from a system under normal design or planned conditions in a given time period. The effective capacity utilisation is expressed as percentage of actual capacity used to design capacity.

Capacity requirement planning

A capacity requirement planning is a part of manufacturing resource planning .Capacity resource planning is carried out after a manufacturing resource planning program has been run. The important elements of the capacity requirement planning process are of establishing, measuring and adjusting the limits or levels of the production capacity based on the process of determining the amount of labour and machine resources required to accomplish the tasks of production.

Types of capacity

1. Maximum capacity

Maximum capacity or design capacity is the highest rate of output a process or activity can achieve. It specifies a theoretical upper limit above the usual rate of routine operations. The operation managers calculate the maximum capacity of a manufacturing process .It is based on the number and duration of available shifts, the number of available machines and employees per shift and the working days in a period of the calculation.

2. Effective capacity

Effective capacity identifies the output rate that managers expect for a given activity or process. It is the actual capacity to reflect current conditions and that could be less than or more than design capacity. They base production plans and schedules on this measure of output. Effective capacity normally falls short of maximum capacity by some amount.

3. Demonstrated capacity

Demonstrated or actual capacity deals with actual rather than planned production. It measures the actual level of output for a process or activity over a specified period of time. Planners calculate theoretical values for maximum and effective capacity to guide their arrangements for production purposes. Operation managers calculate demonstrated capacity simply by averaging recorded figures for actual output over a period of time.

Guidelines for calculating capacity

The operation managers need a methodology for evaluating capacity and the activities that determine it in specific situations. The steps in this analysis from a process for calculating capacity are as follows:

1. The first step is to describe the general flow of activities with in the process.

2. Establish the time period.

3. Establish a common unit of measurement for the entire process

4. Identify the maximum capacity for the overall process

5. Identify the effective capacity for the overall process

6. Determine the demonstrated capacity

7. Compare the demonstrated, effective and maximum capacities and take appropriate actions.

**Capacity Planning**

The effective management of capacity is the most important responsibility of production management. The objective of capacity management is to match the level of operations to the level of demand. Capacity planning is to be carried out keeping in mind future growth and expansion plans, market trends, sales forecasting, etc. It is easy to plan the capacity in case of stable demand. But in practice the demand will not be stable. The fluctuation in demand creates problems regarding the procurement of resources and production to meet the customer demand. Capacity decisions are strategic in nature. In simple words, capacity is the rate of productive capability of a facility. Capacity is usually expressed as volume of output per period of time. Production managers are more concerned about the capacity for the following reasons:

1. Sufficient capacity is needed to meet the customers demand in time.

2. Capacity affects the cost efficiency of production.

3. Capacity affects the scheduling system.

4. Capacity creation requires an investment.

Capacity planning is the first step when a manufacturing organisation decides to produce new products. One of the major tasks in capacity management is the decision with regard to capacity planning**.** Capacity planning is the process of predicting and defining the long-term and the short-term capacity needs of an organisation and determining how those needs will be satisfied. Capacity planning decisions are taken based upon the consumer demand. Capacity planning also takes in to consideration the human, material and financial resources of the organisation. Capacity requirements can be evaluated from two perspectives—long-term capacity strategies and short-term capacity strategies.

1. Long-term capacity strategies

It is difficult to predict the long term capacity requirements because the future demands are difficult to predict. Long-range capacity requirements are dependent on marketing plans, product development and life-cycle of the product. Long-term capacity planning is related with accommodating major changes that affect overall level of the output in long-term. Designing and implementing the long-term capacity plans are the major responsibilities of management. Following parameters will affect long-range capacity decisions.

* Multiple products: The manufacturing of multiple products will reduce the risk of failure. Production of a single product is always risky. If we produce multiple products, each products in different stages of their life cycles, it is easy to schedule them to get maximum capacity utilisation.

* Phasing in capacity: The rate of obsolescence is high in the case of high technology industries compared to other types of industries. The products should be brought into the market quickly.

* Phasing out capacity: The out-dated manufacturing facilities cause excessive plant closures. The impact of the closure will be huge in the case of industries. The phasing out also affects the employability of employees and which in turn affect the standard lining of the society. The phasing out options makes alternative arrangements for men like shifting them to other jobs or to other locations, compensating the employees etc.

2. Short-term capacity strategies: Another task in capacity planning is to develop short term capacity strategies. Managers can predict the future demand for the product in the near future based on statistical tools. Managers then compare requirements with existing capacity and then take decisions as to when the capacity adjustments are needed.

Fundamental capacity is fixed for short period. Major facilities will not be changed. Many short-term adjustments for increasing or decreasing capacity are possible. The adjustments to be required depend upon the conversion process like whether it is capital intensive or labour intensive or whether product can be stored as inventory. Capital-intensive processes depend on physical facilities,

plant and equipment. Short-term capacity can be modified by operating these facilities more or less intensively than normal.

**The short-term capacity strategies**

The following are different types of short term capacity strategies**:**

1. Inventories: Stock of finished goods during slack periods to meet the demand during peak period.

2. Backlog: During peak periods, the willing customers are requested to wait and their orders are fulfilled after a peak demand period.

3. Employment level: Hire additional employees during peak demand period and lay off employees when demand decreases.

4. Employee training: Develop multi skilled employees through training so that they can be rotated among different jobs.

5. Subcontracting: During peak periods, hire the capacity of other firms temporarily to producethe component parts or products.

6. Process design: Change job contents by redesigning the job.

Process of capacity planning

The process involved in capacity planning is as follows:

1. Demand forecasting

Capacity planning starts with the setting of up of a business plan which sets out the types of goods or services to be produced. The Manager has to take a long range forecast of demand in order to determine the resources needed to produce and offer specified goods and services. Market trend changes, competitor's role and technological changes have to be carefully examined.

2. Capacity decisions

The demand forecasting of goods and services then must be translated in to a measure of capacity needed. On the basis of forecasting of demand for products, organisation will be able to determine the various resources needed for producing such goods.

3. Facilities planning

Capacity decisions automatically lead to the setting up of necessary facilities in order to produce goods and services as determined the previous steps. Facility planning can be done either by the expansion or contraction of existing facilities or by setting up of additional new facilities.

4. Decisions and implementation

Finally, alternative resource requirements plan should be properly evaluated. The feasibility of plans along with its economic impact needs to be analysed. Detailed study of economic impact of resource requirements is essential to make the capacity planning a reality.

**Importance ofcapacity planning**

1. Capacity decisions have an impact on the ability of the organisation to meet future demands for products and Services.

2. Capacity decisions affect operating costs. It should be seen that capacity and demand requirements will be matched, which will tend to minimize operating costs. In practice, this is not always achieved because actual demand either differs from expected demand or tends to vary. In such cases, a decision might be made to attempt to balance the costs of over and under capacity.

3. Capacity is usually a major determinant of initial cost.

4. Capacity decisions often involve long-term commitment of funds.

5. Capacity decisions can affect competitiveness.

6. Capacity planning reduces the complexity in manufacturing operation.

Principles of capacity planning

The following are the principles for planning for the adequate capacity resources within an infrastructure.

1. Agree on a common definition of capacity planning

Capacity planning means different things to different people. Agreeing on a common, formal definition of the process is essential in designing and implementing an effective capacity planning program. Proper care should be taken in defining various concepts of capacity planning.

2. Select a capacity planning process owner

The next step is to select a suitable qualified individual to serve as the process owner. The person will be responsible for designing, implementing and maintaining the process and will be empowered to negotiate and delegate with developers and other support groups.

3. Identify the key resources to be measured

Once the process is selected, the next task is to identify the infrastructure resources to be measured.

4. Compare current utilisation to maximum capacities

This principle aims to determine how much excess capacity is available for selected components. The utilisation or performance of each component measured should be compared to the maximum usable capacity.

**Time and motion study**

Both manufacturing and service organisations are working to increase their rates of productivity. At the individual worker level the productivity of labour is measured in terms of a time standard. Work standards are determined through some means of work measurement such as time study data, historical records, work sampling, motion study. Out of these the time and motion study factors are studied in detail.

TIME STUDY

Time study methods were originally proposed by Frederick Taylor. The time study methods are the most widely used means of work measurement. The objective of time study is to determine as to how much time is required to perform a job that would be considered as average time or normal time. The process of time study involves systematically recording, analysing and synthesizing the times required to perform a motion. By using time study, an analyst is taking a small sample of one worker's activity and using it to derive a standard for tasks of that nature.

The following are the steps involved in conducting a time study:

1. Select the work to be studied under time study.

2. Record all the information available about the job, the operator and the working conditions which may affect the time study work.

3. Breakdown the operation into elements.

4. Measure the time by means of a stop watch taken by the operator to perform each element of the operation. Either continuous method or snap back method of timing could be used.

5. At the same time, assess the employees' effective speed of work relative to the observer's concept of 'normal' speed.

6. Adjust the observed time by rating factor to obtain normal time for each element.

7. Incorporate the suitable allowances to compensate for fatigue, personal needs, and contingencies.

8. Compute allowed time for the entire job by adding elemental standard times considering frequency of occurrence of each element.

9. Make a detailed job description describing the method for which the standard time is established.

10. Review standards.

Uses of time study

1.Setting wages and incentives;

2.Arriving at cost standards per unit of output for the various jobs used for cost control and budgeting for deciding on sales price;

3.Comparing the work efficiency of different employees.

4. Arriving at job schedules for production planning purposes.

5.Human resource planning;

MOTION STUDY

Frank and Lillian Gilbreth developed the concept of motion study as an engineering and management technique. The concept of motion study is a widely discussed management tool.

The objectives of motion study are:

1.To eliminate all non-productive and ineffective motions.

2. To develop more effective and productive patterns of movements.

3. To modify tools, lighting and other factors to help in optimizing the effects of motions.

Principles of Motion study

There are a number of principles concerning the economy of movements which have been developed as a result of experience at the workplace. These are first used by Frank Gilbreth, the founder of motion study.

The principles are grouped into three headings:

1. Use of the human body.

2. Arrangement of workplace.

3. Design of tools and equipment.

1. USES OF HUMAN BODY

1. The two hands should begin and complete their movements at the same time.

2. The two hands should not be idle at the same time except during periods of rest.

3. Motions of the arms should be made simultaneously.

4. Hand and body motions should be made at the lowest classification at which it is possible to do the work satisfactorily.

2. ARRANGEMENT OF THE WORKPLACE

1. Definite and fixed stations should be provided for all tools and materials to permit habit formation.

2. Tools and materials should be pre-positioned.

3. Tools, materials and controls should be located within a maximum working area and as near to the worker as possible.

3. DESIGN OF TOOLS AND EQUIPMENTS

1. The colour of the workplace should contrast with that of work and thus reduce eye fatigue.

2. The hands should be relieved of all work of 'holding' the work piece where this can be done by foot operated device.

3. Two or more tools should be combined where possible.

**WORK MEASUREMENT**

Work measurement is also called time study. Work measurement is absolutely essential for both the planning and control of operations. Without measurement one cannot determine the capacity of facilities and costs.

**Objectives of Work Measurement**

The use of work measurement as a basis for incentives is only a small part of its total application. The objectives of work measurement are as follows:

1. Comparing alternative methods.

2. Manpower requirement planning.

3. Planning and control.

4. Realistic costing.

5. Financial incentive schemes.

6. Delivery date of goods.

**Techniques of Work Measurement**

For the purpose of work measurement, work can be regarded as:

1. Repetitive work: The type of work in which the main operation repeats continuously during the time spent at the job.

2. Non-repetitive work: It includes some type of maintenance and construction work, where the work cycle is not repeated.

Various techniques of work measurement are:

1. Time study

2. Synthesis

3. Work sampling

4. Predetermined motion and time study

5. Analytical estimating

1. Time study: A work measurement technique for recording the times and rates of working for the elements of a specified job carried out under specified conditions. Time study is for analysing the data so as to determine the time necessary for carrying out the job at the defined level of performance.

2. Synthetic data: It is the method of totaling element times obtained previously from time studies on other jobs containing the elements concerned or from synthetic data.

3. Work sampling: A technique in which a large number of observations are made over a period of time of one or group of machines, processes or workers. Each observation records what is happening at that instant and the percentage of observations recorded for a particular activity, or delay, is a measure of the percentage of time during which that activities delay occurs.

4. Predetermined motion time study: A work measurement technique whereby times established for basic human motions are used to build up the time for a job.

5. Analytical estimating: A work measurement technique, whereby the time required carrying out elements of a job at a defined level of performance is estimated partly from knowledge and practical experience.

**Maintenance management**

Equipment must be kept at the best operating condition. Otherwise, there will be interruption of production if it is used in a mass production line. Poor working of equipment will lead to quality related problems. It is a necessity to maintain the equipment in good operating conditions with economical cost. Therefore, an integrated approach to minimize the cost of maintenance is essential. In certain cases, the equipment will be obsolete over a period of time. If a firm wants to be in the same business competitively, it has to take decision on whether to replace the equipment or to retain the old equipment by taking the cost of maintenance into account.

**Types of maintenance**

Equipment requires periodic maintenance. Belts need adjustment, alignment needs to be maintained, and proper lubrication on rotating equipment is required. In some cases, certain components need replacement. The following are the different types of maintenance are given below:

1. Break down maintenance

Under this type of method, a machine allows to operate till it breaks. No actions or efforts are taken to maintain the equipment as the designer originally intended to ensure design life is reached. In the case of new equipment, we can expect minimal incidents of failure.

**Advantages**

1. Low cost investment for maintenance.

2. Less staff is required for maintenance.

**Disadvantages**

1. Increased cost due to unplanned downtime of equipment.

2. Increased labour cost.

3. Possible process damage from equipment failure.

2. Preventive maintenance

This type of maintenance is preventive in nature. Preventive maintenance is for increasing the reliability of the equipment. By simply expending the necessary resources to conduct maintenance activities intended by the equipment designer, equipment life is extended and its reliability is increased.

**Advantages**

1. Cost effective.
2. Flexibility allows for the adjustment of maintenance periodicity.
3. Increased component life cycle.
4. Energy savings.
5. Reduced equipment or process failure.

**Disadvantages**

1. Labour intensive.

2. Includes performance of unneeded maintenance.

3. Predictive maintenance

Predictive maintenance differs from preventive maintenance. Preventive maintenance is time-based. Predictive maintenance can be defined as Measurements that detect the onset of a degradation mechanism, thereby allowing causal stressors to be eliminated or controlled prior to any significant deterioration in the component physical state. Results indicate current and future functional capability.

**Advantages**

1. Increased component operational life.

2. Allows for pre-emptive corrective actions.

3. Decrease in equipment or process downtime.

4. Decrease in costs for parts and labour.

5. Better product quality.

6. Improved worker and environmental safety.

**Disadvantages**

1. High investment in diagnostic equipment.

2. High investment in staff training.

3. Savings potential not readily seen by management.

**Maintenance planning**

Maintenance planning deals with taking decisions in advance about maintenance activities, It deals with what, How, where, when the maintenance activities are to be taken.

Reliability cantered maintenance:

Reliability cantered maintenance (RCM) is defined as a process used to determine the maintenance requirements of any physical asset in its operating context. It recognizes that equipment design and operation differs and that different equipment will have a higher probability to undergo failures from different degradation mechanisms than others. Therefore different types of maintenance have to be followed.

# UNIT-4

# OPERATION PLANNING AND CONTROL

Planning and control of Operational functions are essential to every organisation. In a modem industrial enterprise, production is a complex system and therefore, steps must be taken to ensure that goods are produced in the most efficient way economically. Ensuring the production of qualitative goods at minimum cost is the major objective of operation planning and control.

## PRODUCTION PLANNING

Operation planning is concerned with deciding in advance what is to be produced, when to be produced, where to be produced and how to be produced. It involves foreseeing every step in the process of production so as to avoid all difficulties and inefficiency in the operation of the plant. It determines the requirements for materials, machinery and man-power; establishes the exact sequence of operations for each individual item and lays down the time schedule for its completion.

### Objectives of Operation Planning

The basic objectives of operation planning are as under:

1. To estimate resource requirements like men, materials, machines, methods etc. in proper quantities and qualities.
2. It also estimates when and where these resources will be required so that the production of the desired goods is made most economically.

3. It also aims to make all necessary arrangements to see that production target is reached.

For an effective planning of operation activities, the manager concerned should have complete information regarding the following:

1.Information regarding the machine operations

2. The various types of tools and equipment required.

3. Full information regarding the type, quality and quantity of the raw material to be used in each process or operation.

4. The characteristics of each job and the degree of skill and experience required for the operation.

5.Information obtained from job analysis.

**Levels or Categories of Production Planning**

Production planning can be done at three levels namely

1. Factory Planning,

2. Process Planning

3. Operation Planning.

1. Factory Planning

At the factory level the broad operation planning has to be done.The sequence of work task is planned in terms of building, machines and equipment required for manufacturing the desired goods and services. This stage deals with plant location and layout.

**2. Process Planning**

There are many operations involved in factory planning for transforming the inputs into outputs. In process planning these operations are located and the sequence of these operations in the production process is determined. Plans are also made for the layout of work centres in each process.

**3. Operation Planning**

Operation planning is concerned with planning the details of the methods required to perform each operation .It involves the selection of work centres, and designing of tools required for various operations. The sequences of work elements involved in each operation are planned. Specifications about each transfer, work centres, nature of tools required and the time necessary for the completion of each operation are specified in advance.

**OPERATION CONTROL**

Operation control is an integral part of the total operation management. In small organizations, the operation control may be performed by one person. But in large industries the operation control department is separately established. Production control makes use of production plans. It involves the use of various control techniques to ensure production performance as per plans. Co-ordinating men and materials and machines are the major tasks of operation control.

Operation control is the art and science of ensuring that all which occurs is in accordance with the rules established and the instructions issued. Operation control regulates the orderly flow of materials in the manufacturing process from the raw material stage to the finished product. Operation control aims at achieving production targets, optimum use of available resources, increased profits through productivity, better and more economic goods and services etc. An effective operation control system requires reliable information, sound organisation structure and trained personnel. Effective operation control also

maintains working inventories at a minimum. Thus, good operation control helps a company operate and produce more efficiently and achieve lowest possible costs.

**Objectives of Production Planning and Control**

The success of an enterprise mainly depends on the performance of its production control department. The objectives of production and planning department are given below:

1. Provision of raw material, equipment, machines and labour to production system.

2. To organize production schedule in conformity with the demand forecasts.

3.To ensure that the cost of production is minimised and delivery date is maintained.

4. Determination of economic production runs with a view to reduce setup costs.

5. Proper co-ordination of the operations of various sections responsible for production.

6. To ensure regular and timely supply of raw material.

7. To perform inspection of semi-finished and finished goods and use quality control techniques to ascertain that the produced items are of required specifications.

8. It is also responsible for product design and development.

**Factors Determining Production Control Operations**

The following factors affect the nature of production control methods.

1. Nature of production

In job-oriented production system, operations are designed for some particular order which mayor may not be repeated in future. Production usually requires more time than other type of manufacturing.

2. Nature of activities

The nature of activities also determines the pattern of production and control system. Therefore, the control procedure requires continuous modifications and adjustments to suit the requirements of each order.

3. Magnitude of operations

Decentralisation of production control function becomes necessary in a highly complicated manufacturing system. The degree to which the performance of an activity should be decentralised depends upon the scope of operations.

**Objectives of operation Control**

The objective of operation control is given below:

1.Operational control tries to ensure the continuous flow of operation through well-planned routing and scheduling of work.

2.Production planning and controlling seeks to ensure the availability of all the inputs for the smooth production purpose.

3. It aims at minimum investment in inventories without disturbing the production process.

4.Production planning and controlling aims at increased productivity by increasing efficiency of the operating activities

**Importance of operation Control**

The following are the significances of operation control:

1operation planning and control activities help in providing better services to customers in terms of better quality goods .

2. A sound system of operation management system helps in maintaining inventory at proper levels.

3.An efficient operation control system makes the most effective use of equipment and other production facilities.

4. Operation control system helps in reducing the idle time involved in the production system.

**Limitations of Production Planning and Control**

Operation planning and control system is not free from mistakes. The following are the limitations of operational control system:

1.Operation planning and control is based on certain assumptions about availability of materials, power, equipment etc. In case these assumptions do not go right, the whole system will suffer.

2.Operation planning and controlling is a time consuming process.

3.Operation planning and control is a costly affair. Its effectiveimplementation requires services of specialists.

4. The effectiveness of operation planning and control is sometimes limited because of external factors which are beyond the control of production manager.

**Steps in operation Planning and Control**

The implementation of operation planning and control involves number of stages. They are discussed briefly below:

1. Routing
2. Loading
3. Scheduling
4. Dispatching
5. Expediting or Follow up
6. Corrective Action

1. Routing

Production routing involves fixation of path through which work will flow. It is the order in which various operations will be carried out. It consists of the determination of operations through which the product must pass. It is the arrangement of operations in the sequence that requires a minimum of handling, transportation, storage.

The following routing procedure is followed

1. Determining What to Make and What to Buy
2. Ascertaining the Requirements of Materials
3. Preparation of Route Sheet
4. Determining Lot Sizes
5. Determining Scrap Factors
6. Estimation of the cost of the Product:
7. Preparation of Production Control Forms

2. Loading

Loading deals with the amount of work assigned to a machine. It deals with the record of work-load of different shops. The total time required to perform the operations is computed by multiplying the unit operation time given on the standard process sheet by the number of parts to be processed. The total time is then added to the work already planned for the work station.

3. Scheduling

Scheduling involves fixing priorities for different tasks. It establishes the time sequence of operations .It indicates the time required for each job and operation. A schedule is a time-table of operations specifying the time and date when each operation is to be started and completed. Scheduling is the process of determination of the time that should be required to perform each operation and also the time necessary to perform the entire series.

4. Dispatching

Dispatching is the process of setting of productive activities in motion through release of orders and instructions, in accordance with previously planned timings. Dispatch provides official authorization for

(i) Movement of materials to different work stations,
(ii) movement of tools and fixtures necessary for each operation,
(iii) beginning of work on each operation,
(iv) recording of beginning and completion time,
(v) movement of work in accordance with a routing schedule

5. Expediting or Follow Up

This is the last step in operation planning and control. It involves determination of the progress of work, removing bottlenecks in the flow of work and ensuring that the productive operations are taking place in accordance with the plans.

6. Corrective Action

Corrective action is needed to make the system effective. By resorting to corrective measures, the production manager maintains full control over the production activities. The production manager should try to rectify the routes and lay down realistic and flexible schedules. Workload of machines and workers should also be determined scientifical1y. If schedules are not being met, the causes should be fully investigated. It should also be ensured that there is optimum utilisation of the plant capacity.

# UNIT-5

# QUALITY CONTROL

A widely accepted definition of the quality of a product is its fitness for use for its intended purpose. For example, a ball pen should write well throughout its life. For a cricket ball, some of the quality characteristics are like its weight, size, shining, and quality of stitches etc. Therefore, quality is some prescribed or desired characteristics present in raw material, semi-finished or finished items. It is a relative term and is generally used with reference to the end use of the product viz. fitness for purpose, degree of preference, degree of excellence, fulfillment of the promises made to the customer, quality of design, etc.

In every organization there are always some standard specifications. It is important that the finished products meet established specifications. A good quality item is one which conforms to the specifications. Producer is responsible for the production and marketing of his product. His fundamental objective is to manufacture the product of desired quality in the most economical manner with minimum risk of being rejected by the consumer. For that quality of the product should be ensured.

Cost of quality

It is to be noted that poor quality creates dissatisfied customers and eventually leads to loss of business. The following are the important costs of quality:

1. Prevention costs

This is the cost of all activities incurred to prevent poor quality in products and services. They include cost of developing and implementing a quality plan.

2. Appraisal cost

This is the cost associated with measuring, evaluating, auditing products and services to assure conformance to standards and performance requirements.

3. Failure costs

This is the cost resulting from products and services not conforming to requirements or customer needs.

Quality planning

Quality planning is a process that translates quality policy in to measurable objectives and requirements and lays down a sequence of steps for realizing them within a specified timeframe.

## Quality Control

Quality control is the process of verification or correction in the quality of the product when the deviations in the quality are found to be more. According to A. Y. Feigarbaum, 'Quality-control is an effective system for integrating the quality development, quality maintenance and quality improvement efforts of the various groups in an organization, so as to enable production of goods and services at the most economical levels which allow full customer satisfaction'.

## OBJECTS OF QUALITY CONTROL

The basic purpose of Quality Control is to maintain the quality standard of the manufactured product at an optimum cost. The following are the objectives of quality control:

1. To assess the quality standards at different stages of the production process.
2. To recommend for the corrective action when the process goes out of control.
3. To suggest suitable improvements in the quality of the product without affecting the cost of production.
4. Quality control operations enhance confidence, goodwill and reputation for the manufacturer.
5. Reliability regarding the quality of the product is improved.

## Functions of Quality Control

The functions of quality control include the following:

1. To see that the product or service is designed in such a way so that it meets customers' specifications.

2 To maintain discipline amongst the employees and to increase their morale .3. To see that the materials, parts, components, tools, equipment etc. of standard quality only are purchased and used.

4. To make the employees quality conscious by fixing their responsibility at various stages of production.

5. To reduce the proportion of scrap, waste and spoilage during the process:

Uses of control charts

1. It is a proven technique for improving productivity
2. It is an effective system in defect prevention
3. It prevents unnecessary process adjustments
4. It provides diagnostic information
5. It provide about process capability

## METHODS USED TO ASSURE OR TO CONTROL THE QUALITY

Quality of a product can be assured by the following methods:

1. Inspection method

2. Statistical Quality Control Method

1. Inspection

Inspection is the process of examining an object for identification of verification in quality and quantity. It is an important tool for ascertaining and controlling the quality of product. Inspection is the art of applying tests, preferably by the aid of measuring appliances to observe whether a given item or product is within the specified limits of variability or not. According to Sprigel and Lansburg, 'Inspection is the process of measuring the qualities of a product or services in terms of established standards'.

### Functions of Inspection

The following are some of the important functions of inspection :

1. Maintenance of specified standards of the quality of products.

2. Developing means for conducting inspection at lower cost.

3. Maintaining inspection equipment in good condition.

4. Detection of defects at source to reduce defective work.

5. Furnishing advice to Managers when production difficulties arise.

6. Reporting source of manufacturing troubles to management.

### Essential steps for inspection

The following are the different steps involved in the process of inspection:

(i) Carefully define the characteristics of the items to be inspected.

(ii) To take decision regarding the time and place of conducting the inspection.

(iii) Take decision on total number of items to be inspected.

(iv) If sampling is employed, the sampling scheme for the selection of items from the lots should be selected.

(vi) Specification limits for the acceptance and rejection of items should be formulated.

## STATISTICAL QUALITY CONTROL

Statistica1 quality control (SQC) is the term used to describe the set of statistical tools used by quality professionals for the purpose of quality control. Statistical quality control can be sub divided into three broad groups:

1. Descriptive statistics

2. Statistical process control

3. Acceptance sampling

1. Descriptive statistics

Descriptive statistics are used to describe quality characteristics and relationships. It includes statistical methods such as the mean, standard deviation, the range, and the measure of the distribution of data. Descriptive statistics are used to describe certain quality characteristics, such as the central tendency and variability of observed data.

2. Statistical process control (SPC)

Statistical process control involves inspecting a random sample of the output from a process .Based on this data deciding whether the process is producing products with characteristics that fall within a predetermined range. In short, SPC answers the question of whether the process is functioning properly or not.

3. Acceptance sampling

Acceptance sampling is the process of randomly inspecting a sample of goods and deciding whether to accept the entire lot based on the results. It determines whether a batch of goods should be accepted or rejected. Although this information is helpful in making the quality acceptance decision after the product has been produced, it does not help us identify and catch a quality problem during the production process.

All three of these statistical quality control categories are useful in evaluating the quality of products or services. Statistical process control tools are used most frequently because they identify quality problems during the production process.

## SOURCES OF VARIATION

There are mainly two sources of quality variations:

1. Common or random causes

Common causes of variation are based on random causes that we cannot clearly identify. These types of variation are unavoidable and are due to slight differences in processing. For example if we look at bottles of a soft drink in a

grocery store we will notice that no two bottles are filled to exactly the same level. Some are filled slightly higher and some slightly lower. These types of differences are completely normal. No two products are exactly alike because of slight differences in materials, workers, machines, tools, and other factors.Common causes of variation are based on random causes that we cannot identify. These types of variation are unavoidable and are due to slight differences in processing.

2. Assignable causes

Another type of variation that can be observed involves variations where the causes can be precisely identified and eliminated. These are called assignable causes of variation. Examples of this type of variation are poor quality in raw materials, an employee who needs more training, or a machine in need of repair. In these entire cases problem can be identified and corrected. We can assign the variation to a particular cause (machine needs to be readjusted) and we can correct the problem (readjust the machine).

DESCRIPTIVE STATISTICS

Descriptive statistics are helpful in describing certain characteristics of a product and a process. The most important descriptive statistics are measures of central tendency such as the mean, measures of variability such as the standard deviation and range, and measures of the distribution of data.

1. The Mean

The mean is a statistic that measures the central tendency of a set of data. Knowing the central point of a set of data is highly important. Mean is the sum all the observations and divided by the total number of observations.

2. The Range and Standard Deviation

Information regarding range provides us with the amount of variability of the data. It tells us how spread out the data is around the mean. There are two measures that can be used to determine the amount of variation in the data. The first measure is the range. Range is the difference between the largest and smallest observations. Second measure of variation is the standard deviation.

3. Distribution of Data

Another method of statistic used to measure quality characteristics is the shape of the distribution of the observed data. When a distribution is symmetric, there are the same numbers of observations below and above the mean. This is what we commonly find when only normal variation is present in the data. When a disproportionate number of observations are either above or below the mean, we say that the data has a skewed distribution.

STATISTICAL PROCESS CONTROL METHODS

Before using statistical process control we want to determine the amount of variation that is common or normal. After that we monitor the production process to make sure production stays within this normal range or not. We want to make sure the process is in a state of control. The most commonly used tool for monitoring the production process is a control chart. Different types of control charts are used to monitor different aspects of the productionProcess.

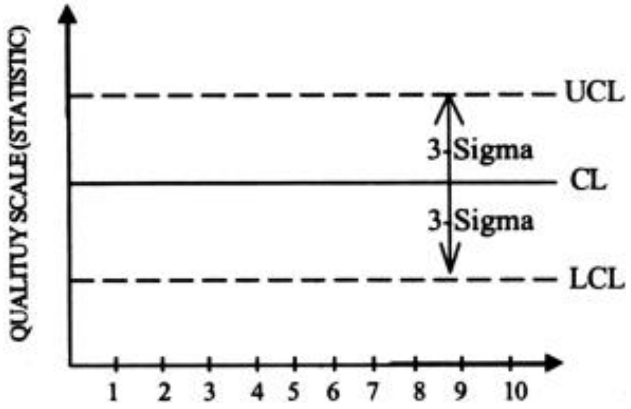
CONTROL CHARTS

A control chart (also called process chart or quality control chart) is a graph that shows whether a sample of data falls within the common or normal range of variation. A control chart has upper and lower control limits that separate common from assignable causes of variation. The common range of variation is defined by the use of control chart limits.We can say that a process is out of control when a plot of data reveals that one or more samples fall outside the control limits.

The control charts give us a very simple graphic method of finding if a process is in statistical control or not. Its construction is based on plotting 3σ limits and a sequence of suitable sample statistics, e.g. mean (x), range (R), standard deviation (s), fraction defective (p), etc., computed from independent samples drawn at random from the product of the process. These sample points depict the frequency and extent of variations from specified standards. Any sample point going outside 3-σ control limits is an indication of the lack of statistical control, i.e., presence of some assignable causes of variation, which must be identified and eliminated. A typical control chart consists of the following 3 horizontal lines : together with a number of sample points as exhibited in the following fig.

1. Upper Control Limit (UCL)
2. Lower control Limit (LCL)
3. Central Line (CL)

OUTLINE OF A CONTROL CHART




SAMPLE (SUB-GROUP) NUMBER

In the control chart Upper Control Limit and Lower Control Limit are usually plotted as dotted lines and central line CL is plotted as a bold line.

**Types of Control Charts**

Control charts are one of the widely used tools in statistical process control. They can be used to measure any characteristic of a product, such as the weight, the number of chocolates in a box, or the volume of bottled water. Thedifferent characteristics that can be measured by control charts can be divided intotwo groups:

1. Variables

2. Attributes.

A control chart for variables is used to monitor characteristics that can be measured and have a continuum of values, such as height.A control chart for attributes, on the other hand, is used to monitor characteristics that have discrete values and can be counted.

**CONTROL CHARTS FOR VARIABLES**

Control charts for variables monitor characteristics that can be measured and have a continuous scale, such as height, weight, volume, or width. When an item is inspected, the variable being monitored is measured and recorded. For example, if we were producing candles, height might be an important variable. We could take samples of candles and measure their heights. Two of the most commonly used control charts for variables monitor both the central tendency of the data (the mean) and the variability of the data (either the standard deviation or the range). Note that each chart monitors a different type of information. When observed values go outside the control limits, the process is assumed not to be in control.

Mean (x-Bar) Charts

Mean chart is the most commonly used tool to evaluate the quality of products. A mean control chart is often referred to as an x-bar chart. It is used to monitor changes in the mean of a process. To construct a mean chart we first need to construct the centre line of the chart. To do this we take multiple samples and compute their means. Usually these samples are small in size.

Construction of X— Chart

The control chart for mean is drawn on a graph paper by taking the sample number along the horizontal scale, (x-axis) and the statistic x along the vertical scale (y-axis). Sample points (sample means x-- 1, x-- 2, ....., x--k (are then plotted as points (dots) against the corresponding sample number. These points mayor may not be joined. The central line is drawn as a bold (dark) horizontal line at μ = μ' (if μ is Known) or at x-- (if μ is not known). This UCL x-- and LCL x-- are plotted as dotted horizontal lines at the computed values.

Range (R) Charts

Range (R) charts are anotherimportant type of control chart for variables. Whereas x-bar charts measure shift in the central tendency of the process, range charts monitor the dispersion or variability of the process. The method for developing and using R-charts is the same as that for x-bar charts.

Construction of R-chart

As in case of x---chart, the sample number is taken along horizontal scale and the statistic (Range) is taken along vertical scale. The sample points R1, R2, ….,Rn are then plotted as points (dots) against the corresponding sample numbers. The central line is taken as bold horizontal line at R and UCLR and LCLR are plotted as dotted horizontal lines at the computed values.

## CONTROL CHARTS FOR ATTRIBUTES

Control charts for attributes are used to measure quality characteristics that are counted rather than measured. Attributes are discrete in nature. P-charts are appropriate when both the number of defectives measured and the size of the total sample can be counted. A proportion can then be computed and used as the statistic of measurement. C-charts count the actual number of defects. For example, we can count the number of complaints from customers in a month, the number of bacteria on a petri dish

P-Charts

P-charts are used to measure the proportion that is defective in a sample. The computation of the centre line as well as the upper and lower control limits is similar to the computation for the other kinds of control charts. The centre line is computed as the average proportion defective in the population.

C-Charts

C-charts are used to monitor the number of defects per unit. Examples are the number of returned meals in a restaurant, the number of trucks that exceed their weight limit in a month. Note that the types of units of measurement we are considering are a period of time, a surface area, or a volume of liquid.

Management of quality

Quality is said to be achieved when a product meets the customers' requirements. The primary emphasis of modern business is on the satisfaction of customers' needs and requirements better than competitors do. Quality of the product is one of the important factors which decide the acceptance of the product in the market.

One of the purposes of quality management is to find out errors and defects as early in the project as possible. Quality management is concerned with controlling activities with the aim of ensuring that products and services are fit for their purpose and meets the specifications. There are two parts in quality management. They are discussed below;

1. QUALITY CONTROL

Quality control is concerned with checking and reviewing work that has been done. Quality control is the process of detecting defective output, rather than preventing it.

2. Quality assurance

Quality assurance covers all activities from design, development, production, installation, servicing and documentation. Quality assurance is planned system of review procedure conducted by personnel not directly involved in the inventory compilation or development process. Review is generally conducted by a third party.

ISO 9000

ISO9000 is an international standard that many companies use to ensure that their quality assurance system is in place and effective. Conformance to ISO9000 is said to guarantee that a company delivers quality products and services. The company desiring to get the certification of this authority has to go through different formalities to ensure quality of the products .Then the agency examines the company's quality assurance system objectively. Once the company is assured of quality, the authority will issue certificate for the same.

Quality circle

Quality circle can be a most important supporter in solving problems and effecting significant efficiencies in an organisations operation. Quality control technique has played an important role in industrial development of Japan. Quality circle is a unique management tool with which a suitable atmosphere is created in which people attempt to solve the problems in their own work area. Quality circle was born in Japan in 1961.

Quality circle is a small group of employees who voluntarily meet at regular intervals to identify, analyse and solve quality and other problems in their work areas. Normally members of a particular quality circle come from the same work shop that face and share similar problems in their daily work life. Ideally the group size should seven or eight to give enough time to each member to actively participate and contribute in each meeting.

**Methods of operation**

QC normally composed of a small number of volunteers from a particular work area or department who focus on improving quality, productivity and cost reduction. The circle meets under the guidance of a facilitator to identify problems and suggest possible solutions. When possible solution are generated the circle meets to identify which of these are likely to be most appropriate given the company's culture, structure, and the costs and time frame of implementation.in most quality circles there are no direct financial rewards for coming up with good ideas or cost savings. However people are indirectly paid for attendance in the circle meeting. Quality circle regularly meets on regular basis.

**Objective of quality circle**

The following are the objective of quality circle.

1. To improve quality

The primary objective in developing quality circle is to improve the quality of the products.

2. To improve productivity

Customers always seek qualitative products. For this purpose the creative capacity of the employees must be utilised for improving the quality of the products.

3. To improve employee morale

Another objective of quality control is to develop the morale of employees. Employees are given the opportunity to take part in the quality improvement programmes. It leads to employee morale and satisfaction.

**Benefits of quality circle**

1. Increase in quality consciousness of employees

2. Development of an attitude of problem prevention

3. Promotion of employee motivation

4. Improvement in the human relations.

5. Utilisation of employee problem solving skills

6. Increase job security

7. Development of safety awareness.

**KAIZEN**

Kaizen is a system for generating and implementing employees ideas developed in Japan. It helped many companies to improve quality and productivity which allowed them to offer better products at lower prices and therefore increase their market share .Kaizen is a group of workers who do similar works .They meet voluntarily, regularly, under the leadership of their supervisor to identify work related problems and to recommend solutions to management.

**Total quality management TQM**

Total quality management is an approach that seeks to improve quality and performance which will meet or exceed customer expectations. TQM takes in to account all quality measures taken at all levels and involving all company

employees .TQM is a management system for a customer focused organisation that involves all employees in continual improvement at all aspects of the organisation.

TQM focuses on identifying the basic causes of quality problems and correcting them at the source instead of inspecting the product after it has been produced. TQM not only covers the entire organisation but it also stresses that quality is customer driven. TQM attempts to achieve quality in every aspect of the organisation. It is concerned with technical aspects of quality as well as the involvement of people in quality such as customers, employees and suppliers.

Principles of TQM

The main principles of TQM are given below:

1. Customer focus

Total quality management focuses on customer satisfaction .Quality should be customer driven. The companies need to collect information from the customers .Based on the needs and expectations of the customers products have to be manufactured. A company should always remember that they would not exist in the absence of their customers.

2. Continuous improvement

Continuous improvement requires that the company continually strive to be better through learning and problem solving. It is difficult to achieve full percentage perfection in the quality of products. But the firm should thrive towards improving the quality of products on a continuous basis.

**PLAN-DO-STUDY-ACT CYCLE (PDSA)-**

This cycle represents that continuous improvement of quality of products. It is a never ending process and that should be undertaken without break. This cycle is also called as She whart or Demining cycle.

3. Employee empowerment

The new concept provides incentives for employees to identify quality problems. Employees are rewarded for solving quality problems. The contributions of employees are highly valued and their suggestions are implemented. In order to perform this function employees are given continual and extensive training in quality is essential.

4. Team approach

TQM promotes team approach with in the organisation. Team is give due consideration at the time of planning and implementing the problems. Team usually meet weekly during work hours in a place designated for this purpose. They follow pre-set process for analysing and solving quality problems.

5. Measuring and controlling

Selecting correct measurement tools is essential .TQM provides better tools for analysing and solving problems. A systematic controlling mechanism is also followed.

**Benefits of TQM**

1. It increases the productivity and efficiency of the organisation2.

2. It develops customer satisfaction

3. It insures flexibility in the manufacturing system

4. It promotes better relation with the customers

5. It enhances the customer satisfaction.

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