



**DR. BABASAHEB AMBEDKAR  
OPEN UNIVERSITY**

# BBA

**BACHELOR OF BUSINESS ADMINISTRATION**



**BBAR-404**

**Production and Operation Management**

# **PRODUCTION AND OPERATION MANAGEMENT**



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## **ROLE OF SELF INSTRUCTIONAL MATERIAL IN DISTANCE LEARNING**

The need to plan effective instruction is imperative for a successful distance teaching repertoire. This is due to the fact that the instructional designer, the tutor, the author (s) and the student are often separated by distance and may never meet in person. This is an increasingly common scenario in distance education instruction. As much as possible, teaching by distance should stimulate the student's intellectual involvement and contain all the necessary learning instructional activities that are capable of guiding the student through the course objectives. Therefore, the course / self-instructional material are completely equipped with everything that the syllabus prescribes.

To ensure effective instruction, a number of instructional design ideas are used and these help students to acquire knowledge, intellectual skills, motor skills and necessary attitudinal changes. In this respect, students' assessment and course evaluation are incorporated in the text.

The nature of instructional activities used in distance education self- instructional materials depends on the domain of learning that they reinforce in the text, that is, the cognitive, psychomotor and affective. These are further interpreted in the acquisition of knowledge, intellectual skills and motor skills. Students may be encouraged to gain, apply and communicate (orally or in writing) the knowledge acquired. Intellectual- skills objectives may be met by designing instructions that make use of students' prior knowledge and experiences in the discourse as the foundation on which newly acquired knowledge is built.

The provision of exercises in the form of assignments, projects and tutorial feedback is necessary. Instructional activities that teach motor skills need to be graphically demonstrated and the correct practices provided during tutorials. Instructional activities for inculcating change in attitude and behavior should create interest and demonstrate need and benefits gained by adopting the required change. Information on the adoption and procedures for practice of new attitudes may then be introduced.

Teaching and learning at a distance eliminates interactive communication cues, such as pauses, intonation and gestures, associated with the face-to-face method of teaching. This is particularly so with the exclusive use of print media. Instructional activities built into the instructional repertoire provide this missing interaction between the student and the teacher. Therefore,

the use of instructional activities to affect better distance teaching is not optional, but mandatory.

Our team of successful writers and authors has tried to reduce this.

Divide and to bring this Self Instructional Material as the best teaching and communication tool. Instructional activities are varied in order to assess the different facets of the domains of learning.

Distance education teaching repertoire involves extensive use of self- instructional materials, be they print or otherwise. These materials are designed to achieve certain pre-determined learning outcomes, namely goals and objectives that are contained in an instructional plan. Since the teaching process is affected over a distance, there is need to ensure that students actively participate in their learning by performing specific tasks that help them to understand the relevant concepts. Therefore, a set of exercises is built into the teaching repertoire in order to link what students and tutors do in the framework of the course outline. These could be in the form of students' assignments, a research project or a science practical exercise. Examples of instructional activities in distance education are too numerous to list. Instructional activities, when used in this context, help to motivate students, guide and measure students' performance (continuous assessment)



## **PREFACE**

We have put in lots of hard work to make this book as user-friendly as possible, but we have not sacrificed quality. Experts were involved in preparing the materials. However, concepts are explained in easy language for you. We have included many tables and examples for easy understanding.

We sincerely hope this book will help you in every way you expect. All the best for your studies from our team!



# **PRODUCTION AND OPERATION MANAGEMENT**

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# **PRODUCTION AND OPERATION MANAGEMENT**

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## **BLOCK-1 INTRODUCTION TO PRODUCTION AND OPERATIONS MANAGEMENT**

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### **UNIT 1**

NATURE AND SCOPE OF PRODUCTION AND OPERATIONS  
MANAGEMENT

### **UNIT 2**

PLANT LOCATION- PLANT LAYOUT

### **UNIT 3**

MATERIAL HANDLING

### **UNIT 4**

PRODUCTION PLANNING AND CONTROL

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## **BLOCK–1 INTRODUCTION TO PRODUCTION AND OPERATIONS MANAGEMENT**

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### **Block Introduction**

The objective of production management is to produce goods services of right quality and quantity at right time and right manufacturing cost. Material management includes decisions regarding the procurement, control, handling, storage, and distribution of materials. Location is concerned with a particular site where entrepreneur is interested to establish his enterprise or plant having lowest cost objective.

In this block, students will get knowledge about Production and Operations Management. The concept related to Plant Location and theories are well explained with features and characteristics. The block will detail about Organization and Steps involved in production Planning. The knowledge about Production Control & planning are explained to the students.

After studying this block, students will be able to understand about various functions of Production and Operations Management. The concept of various features of efficient plant layout gives knowledge to student which will help them know about various aspects of setting of plant layout.

### **Block Objective**

After completing this block, students will be able to :

- Knowledge about Production Planning & Control
- Understanding the role of Network Analysis
- Study the Techniques and Advantages of Plant Layout
- Know about the Scope of Production and Operations Management
- Understanding about Concepts of Production and Operations Management
- Idea about Production and Operations Management

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### **Introduction to Production and Operation Management**

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#### **Block Structure**

Unit 1 : Nature and Scope of Production and Operations Management

Unit 2 : Plant Location- Plant Layout

Unit 3 : Materials Handling

Unit 4 : Production Planning and Control



## NATURE AND SCOPE OF PRODUCTION AND OPERATIONS MANAGEMENT

### : UNIT STRUCTURE :

#### **1.0 Learning Objectives**

#### **1.1 Introduction**

#### **1.2 History of Production and Operations Management**

#### **1.3 Concepts of Production and Operations Management**

#### **1.4 Objectives of Production and Operations Management**

#### **1.5 Functions of Production and Operations Management**

#### **1.6 Scope of Production and Operations Management**

#### **1.7 Problems of Production and Operations Management**

#### **1.8 Difference between Production and Operations Management**

#### **1.9 Let Us Sum Up**

#### **1.10 Answer for Check Your Progress**

#### **1.11 Glossary**

#### **1.12 Assignment**

#### **1.13 Activities**

#### **1.14 Case Study**

#### **1.15 Further Readings**

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#### **1.0 Learning Objectives**

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After reading this Unit, you will be able to :

- Understand the scope of production and operations management.
- Understand different objectives and functions of production and operations management.
- Understand the scope of production and operations management.

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#### **1.1 Introduction**

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Operation system is manufacturing or service sector where a transformation process occurs where value addition takes place in order to have required quantity of products or services with good targeted quality within particular time period in an economical way. Operation Management coordinates and controls activities in operation system to achieve stated objectives.

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#### **1.2 History of Production and Operations Management**

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In 20th century, economic structure in many developed countries was fast changing which results from feudalistic economy to an industrial or capitalistic economy. In this, nature of industrial workers changes where workers are exercised with excess control to have desired output. This changed economic climate produced the new techniques and concepts.

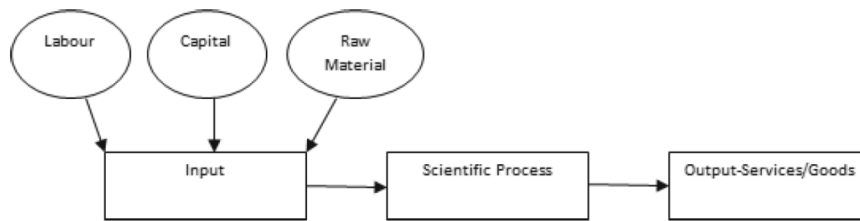


Production results as scientific way that involves transformation of raw material which will serves as input to required product or service serving as output which works together with addition of certain economic value. Production can based on :

Separation, which uses to get desired output by extracting from raw materials which can be oil extraction in various fuel products.

Modification involving chemical and mechanical parameter changes of raw material without altering physical attributes of it.

Assembly, which happens in case of car production and manufacturing of computers.



**Fig 1.3 Production and Operations Management**

### Check your progress 2

1. Management decisions are categorized as
  - a. Strategic
  - b. Tactical
  - c. Operational
  - d. All of these

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### 1.4 Objectives of Production and Operations Management

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It is noted that successful organizations carry well defined and efficient line function and support function where production comes under line function that affects customer experience with future of organization. The idea of having production function is to add values to frame strong and long lasting customer relationship in terms of products or services which can be easily achieved by healthy and productive relation among Marketing and Production team. It is described that an effective planning and control production parameters to create value for customers is by using production management. The objective of production management is to produce goods services of right quality and quantity at right time and right manufacturing cost. Further we see that the main objectives of using Production and Operations Management are to:

- a. Increase the output for a given particular input which increases the efficiency.
- b. Increase production with the given resources thereby increases productivity.
- c. Lead to economical and low priced production.
- d. Obtain the good quality products at lower price.
- e. Lower the processing time by increasing the production in given amount of time.

**Check your progress 3**

1. What are the main objectives of using Production and Operations Management ?
  - a. Lead to economical and low priced production.
  - b. Obtain the good quality products at lower price.
  - c. C.Lower the processing time by increasing the production in given amount of time.
  - d. All of these

---

**1.5 Functions of Production and Operations Management**

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Figure 1.4 describes about the functions of production management.



**Fig 1.4 Functions of Production Management**

**Selection of Product and Design**

Initially, the production management will select correct product with design for production as per companies standard and reputation. The product can be choose once detailed evaluation of possibilities of other products been done. After selecting correct product, the design to be selected should be as per customers' needs.

**Selection of Production Process**

After selecting product and design, now is the time to select correct production process which can be decided based on technology, machines, material handling system, etc.

**Selecting Right Production Capacity**

The work of production management is to choose correct production capacity which will match the demand for product as capacity will create problems. It is the duty of production manager to plan the capacity for both short and long term's production using the break-even analysis for capacity planning.

### **Production Planning**

Production management will include production planning where production manager will decide for routing and scheduling involving correct selection of path of work and sequence of operations, so that best and economical sequence of operations can be followed while manufacturing a product with possibilities of smooth production of work. Scheduling means to decide when to start and when to complete a particular production activity.

### **Production Control**

Production management includes production control where production manager will monitor and control the production of work as per plans which he sometimes need to compare the actual production with plans and locate for any deviations, if exists.

### **Quality and Cost Control**

Production management will cover quality and cost control which serves as great importance in today's competitive world. Customers across the globe requires good quality products at lower prices, so to meet such demand of consumers, production manager need to work continuously to enhance the quality of products. Along with this, he must also take essential steps to reduce the cost of his products.

### **Inventory Control**

Production management caters inventory control where production manager monitors various levels of inventories that lead to over stocking or under stocking of goods. In case of overstocking, there appears blockage of capital and chances of getting materials to be spoiled, wasted or misused. In case of understocking, there occurs lack of production as per schedule which finally affect the deliveries of product.

### **Maintenance and Replacement of Machines**

Production management will make sure about proper maintenance and replacement of machines and equipments. It is the duty of production manager to have efficient system which to be used for continuous inspection or routine checking, cleaning, oiling, maintenance and replacement of machines, equipments, spare parts, etc that helps in preventing breakdown of machines and avoids production halts.

### **Check your progress 4**

1. What are the functions of production management ?
  - a. Quality and Cost Control
  - b. Inventory Control
  - c. Production Planning
  - d. All of these
2. **What is inventory control ?**
  - a. It is about proper maintenance and replacement of machines and equipments
  - b. It refers to monitors various levels of inventories that lead to over stocking or under stocking of goods
  - c. It will cover quality and cost control
  - d. None of these

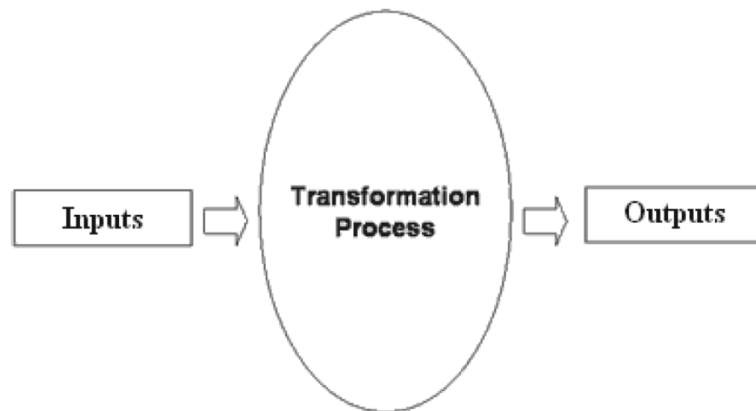


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## 1.6 Scope of Production and Operations Management

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Production and operations management relates with conversion of inputs into outputs with the help of physical resources in order to give required utilities to customer by fulfilling certain objectives like effectiveness, efficiency and adoptability.



**Fig 1.5 Process in Production and operations management**

It is different from other functions in terms of marketing, finance, etc. As it mainly concern with conversion of certain physical resources. There are many activities which are involved in production and operations management functions such as :

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

1. **Location :** While producing a product, location serves as long-term capacity decision that covers long term commitment in terms of geographical static factors which may or may not affect business organization. Selecting proper location is a key- decision since it involves huge investments in building plant and machinery. The need of location study will help in finding optimal location which results in advantage to the organization. An improper location of plant may lead to waste of all the investments made in plant and machinery equipments. With this, location of plant depends on company's expansion plan and policy with diversification plan for products, changing sources of raw materials and certain other factors.
2. **Plant Layout :** Plant layout involves physical arrangement of facilities which involves configuration of departments, work centres and equipment in conversion process in order to meet required output quality at economical price. We see that material handling which is part of layouting of plant is required as it increases the output, improves quality, speeds up deliveries and lowers the cost of production which are normally applied in case of new plant setup.
3. **Product Design :** Product design involves converting ideas into reality where all big business organization frames a design, develop and introduce new products with part of growth strategy. The product design should be so framed that the new products launched serves as biggest challenge by the

organizations. The complete process identifies physical manufactures of product through marketing, product development and manufacturing. Manufacturing has the responsibility of selecting the processes by which the product can be manufactured. Product design and development provides link between marketing, customer needs and expectations and the activities required to manufacture the product.

4. **Process Design :** Process design is the main part which involves decision-making of overall process which can be done by converting raw material into finished goods. These decisions encompass the selection of a process, choice of technology, process flow analysis and layout of the facilities. In this, an important aspect is to analyse workflow for changing raw material into finished product thereby selecting workstation in workflow.
5. **Production Planning and Control :** Production planning and control explained as the process involving planning the production in advance by setting correct route of each item thereby fixing starting and finishing dates for production orders to shops and proper follow up of products as per orders.

The idea of production planning and control starts with Planning of Work and then involves working on desired work Plan by using planning, routing, scheduling, dispatching and follow-up processes.

- Planning is a portrayed layout of the work which bridges the gap from where we are to where we want to go.
- Routing involves selection of path where every part of product will follow that transforms from raw material to finished products. It shows most advantageous path to be followed from department to department and machine to machine till raw material gets its final shape.
- Scheduling is an operational process involving fixation of time and date for each operation with sequence of operations to be followed.
- Dispatching is basically releasing of orders and instructions where required authority will involve in starting of work that was planned earlier under 'Routing' and 'Scheduling'.

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

6. **Quality Control :** After the production of goods, goods will pass through Quality Control process where the quality of finished goods are matched with specifications to check the desired level of quality. It is a regular control of certain factors which affects quality of product and will saves defects at source as per effective feedback system and corrective action procedure.

It is an industrial management technique that is applied to manufacturing product with uniform acceptable quality that involves certain operations in producing optimum quality products at low cost. The main objectives of quality control are :

## INTRODUCTION TO PRODUCTION AND OPERATIONS MANAGEMENT

- It enhances companies income by making production acceptable to customers.
- It lowers companies cost by reducing losses which occur due to defects.
- It achieves interchangeability of manufacture in large scale production.
- It produce ultimate quality at lower price.
- It satisfies customers with high quality productions or services and builds customer goodwill and confidence.
- It makes timely inspection by ensuring quality control.
- It will examine variation occurs at the time of manufacturing.

### 7. **Material Management :**

Materials management is a feature of management function that mainly relates with acquisition, control and use of materials required with flow of goods and services across production process with predetermined objectives such as :

- Lowering of material cost.
- Purchasing, receive, transport and keeping of materials efficiently and to reduce the related cost.
- Cost cutting using simplification, standardisation, value analysis, import substitution, etc.
- Finding new sources of supply and develop healthy relations to ensure continuous supply at affordable prices.

### **Check your progress 5**

1. What is Quality control ?
  - a. It is the process in which the quality of finished goods are matched with specifications to check the desired level of quality
  - b. It is a feature of management function that mainly relates with acquisition, and control.
  - c. It involves decision-making of overall process which can be done by converting raw material into finished goods
  - d. None of these
2. **What is Plant Layout ?**
  - a. It is a feature of management function that mainly relates with acquisition, and control.
  - b. It involves converting ideas into reality where all big business organization frames a design
  - c. It involves physical arrangement of facilities which involves configuration of departments and work centres
  - d. None of these

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## 1.7 Problems of Production and Operations Management

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As an organization develops plans and strategies to deal with the opportunities and challenges that arise in its particular operating environment, it should design a system that is capable of producing quality services and goods in demanded quantities in acceptable time frames.

### Designing the System

Designing the system begins with product development. Product development involves determining the characteristics and features of the good (or service if engaged in a service-oriented industry) to be sold. It should begin with an assessment of customer needs and eventually grow into a detailed product design. The facilities and equipment that will produce the product, as well as the information systems needed to monitor and control performance, are part of this system design process. In fact, manufacturing process decisions are integral to a system's ultimate success or failure. "Of all the structural decisions that the operations manager faces, the one with the greatest impact on the manufacturing operation's success is the process/technology choice," said Thomas S. Bateman and Carl P. Zeithaml in *Management: Function and Strategy*. "This decision addresses the question 'How will the product be made?'" Product development should be a cross-functional decisionmaking process that relies on teamwork and communication to install the marketing, financial, and operating plans needed to successfully launch a product.

Product design is a critical task because it determines the characteristics and features of the product, as well as how the product functions. Product design determines a product's cost and quality, as well as its features and performance. These are important factors on which customers make purchasing decisions. In recent years, new design models such as Design for Manufacturing and Assembly (DFMA) have been implemented to improve product quality and lower costs.

DFMA focuses on operating issues during product design. This can be critical even though design costs are a small part of the total cost of a product, because, procedures that waste raw materials or duplicate effort can have a substantial negative impact on a business's operating profitability. Another innovation similar to DFMA in its emphasis on design is Quality Functional Deployment (QFD). QFD is a set of planning and communication routines that are used to improve product design by focusing design efforts on customer needs.

Process design describes how the product will be made. The process design decision has two major components: a technical (or engineering) component and a scale economy (or business) component. The technical component includes selecting equipment and selecting a sequence for various phases of operational production.

The scale economy or business component involves applying the proper amount of mechanization (tools and equipment) to make the organization's work force more productive. This includes determining: 1) If the demand for a product is large enough to justify mass production; 2) If there is sufficient variety in customer demand so that flexible production systems are required; and 3) If demand for a product is so small or seasonal that it cannot support a dedicated production facility.

Facility design involves determining the capacity, location, and layout for the production facility. Capacity is a measure of an organization's ability to provide the demanded services or goods in the quantity requested by the customer in a timely manner. Capacity planning involves estimating demand, determining the capacity of facilities, and deciding how to change the organization's capacity to respond to demand.

Facility location is the placement of a facility with respect to its customers and suppliers. Facility location is a strategic decision because it is a long-term commitment of resources that cannot easily or inexpensively be changed. When evaluating a location, management should consider customer convenience, initial investment necessary to secure land and facilities, government incentives, and operating transportation costs. In addition, qualitative factors such as quality of life for employees, transportation infrastructure, and labor environment should also be taken under consideration.

Facility layout is the arrangement of the work space within a facility. It considers which departments or work areas should be adjacent to one another so that the flow of product, information, and people can move quickly and efficiently through the production system.

### **Planning the System**

Planning the system describes how management expects to utilize the existing resource base created as a result of the production system design. One of the outcomes of this planning process may be to change the system design to cope with environmental changes. For example, management may decide to increase or decrease capacity to cope with changing demand, or rearrange layout to enhance efficiency.

Decisions made by production planners depend on the time horizon. Long-range decisions could include the number of facilities required to meet customer needs or studying how technological change might affect the methods used to produce services and goods. The time horizon for long-term planning varies with the industry and is dependent on both complexity and size of proposed changes. Typically, however, long-term planning may involve determining work force size, developing training programs, working with suppliers to improve product quality and improve delivery systems, and determining the amount of material to order on an aggregate basis. Short-term scheduling, on the other hand, is concerned with production planning for specific job orders.

### **Managing the System**

Managing the system involves working with people to encourage participation and improve organizational performance. Participative management and teamwork are an essential part of successful operations, as are leadership, training, and culture. In addition, material management and quality are two key areas of concern.

Material management includes decisions regarding the procurement, control, handling, storage, and distribution of materials. Material management is becoming more important because, in many organizations, the costs of purchased materials comprise more than 50 percent of the total production cost. Questions regarding quantities and timing of material orders need to be addressed here as well when companies weigh the qualities of various suppliers.

### Check your progress 6

1. What is QFD?
  - a. Quality Functional Deployment
  - b. Quality Functional Design
  - c. Both of these
  - d. None of these
2. **What is Facility Design**
  - a. It is the arrangement of the work space within a facility
  - b. It involves determining the capacity, location, and layout for the production ability.
  - c. It is the placement of a facility with respect to its customers and suppliers
  - d. None of these

### 1.8 Difference between Production and Operations Management

There are certain difference among Production Management and operational Management such as :

	<b>Production Management</b>	<b>Operational Management</b>
1.	It occurs on outputs after manufacturing raised in markets.	It occurs on inputs during manufacturing.
2.	It deals with manufacturing / production/ construction.	It covers both products and services with certain product.
3.	It requires more production time.	It works with less time.
4.	It requires heavy capital equipment like lands & factories, investment and less labour.	In this, the services uses more labour and lesser capital investment.
5.	It requires no customer during the production.	It requires customers directly and indirectly along with contacts.
6.	It plans and manages execution of operations plan.	It plans and manage execution of production plan to do end-to-end business.

### Check your progress 7

1. Which of the following requires more time ?
  - a. Production Management
  - b. Operational Management
  - c. Both of these
  - d. None of these

### 1.9 Let Us Sum Up

In this unit we have learnt that in 1931, Walter Shewart came up with theory of Control Charts that works for quality or process control showing charts about simple graphical methodology which helps in monitoring quality characteristics of output.

It is noted that Production/Operation management results as process involving combinations and transformation of resources used in production/operation subsystem of an organization.

We see that the objectives of production management are to generate goods services of right quality and quantity at right time and right manufacturing cost.

Production management includes production control where production manager will monitor and control the production of work as per plans which he sometimes need to compare the actual production with plans and locate for any deviations, if exists.

Designing the system begins with product development. Product development involves determining the characteristics and features of the good to be sold.

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### 1.10 Answer for Check Your Progress

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#### Check your progress 1

Answers: (1-b)

#### Check your progress 2

Answers: (1-d)

#### Check your progress 3

Answers: (1-d)

#### Check your progress 4

Answers: (1-d), (2-b)

#### Check your progress 5

Answers: (1-a), (2-c)

#### Check your progress 6

Answers: (1-a), (2-b)

#### Check your progress 7

Answers: (1-a)

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### 1.11 Glossary

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1. **Manufacturing** : It describes the process of producing or assembling goods by hands or machines for sale.
2. **Continuous process** : Process involving in bulk production of standardized product continuously.

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### 1.12 Assignment

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What do you mean by production system.

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### 1.13 Activities

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Collect some information about the production system in fast food restaurant located around your area.

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### 1.14 Case Study

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Discuss in brief about the objectives of production management.

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### **1.15 Further Readings**

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NATURE AND SCOPE  
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MANAGEMENT





**: UNIT STRUCTURE :**

- 2.0 Learning Objectives**
- 2.1 Introduction**
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**2.0 Learning Objectives**

After reading this Unit, you will be able to understand:

- Need of Plant Layout
- Characteristics of an Efficient Layout
- Plant Layout Location

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**2.1 Introduction**

Plant location refers to the choice of region and the selection of a particular site for setting up a business or factory. But the choice is made only after considering cost and benefits of different alternative sites. It is a strategic decision that cannot be changed once taken. If at all changed only at considerable loss, the location should be selected as per its own requirements and circumstances. Each individual plant is a case in itself. Businessman should try to make an attempt for optimum or ideal location.

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**2.2 Plant Location and theories**

Location is concerned with a particular site where entrepreneur is interested to establish his enterprise or plant having lowest cost objective. If a particular industry is concentrated mainly in one areas is called as localisation of industries. For example, Kolkata and Mumbai are known for jute and textiles industry

respectively. Planned location of industries is a systematic approach by which location of industries is planned to give each region or area or place a variety of industries to promote dispersal of industries.

Layout involves determining the space requirement for the facilities and arranging them in a manner to ensure steady flow of operations with minimum overall cost. In order words, a layout is a floor plan for arranging the desired facilities, machinery, equipment in an optimum locations so as to permit the quickest flow of materials and manpower at the lowest cost and with the least amount of in process handling from receipt of raw material to shipment of finished products.

Since, a layout once made cannot be changed/modified easily and without incurring considerable cost on one hand and disrupting the operations on the other hand, layout decisions are strategic decisions. Hence, layout has to be considered at the time of planning a new venture. A good layout should result in comfort, convenience, better appearance, safety, efficiency and profits. A poorly planned layout causes congestion, disruption in flow of man and/or materials, accidents, delays, rejections leading to frustration and inefficiency. In a production unit layout includes factory design, that is layout of workshop, raw material stock yards, finished goods stores, generator, compressor room etc. In hospitals it involves fixing the location of wards, operation theater, out-patient departments, canteen, doctors and nurses duty rooms etc. At another level layout planning involves layout of different machines, work stations etc., in the shop floor and patient's beds, drug store, doctors and nurses seats and other facilities in a hospital ward.

### Theory

Alfred Weber (1868–1958), with the publication of Theory of the Location of Industries in 1909, put forth the first developed general theory of industrial location. His model took into account several spatial factors for finding the optimal location and minimal cost for manufacturing plants. The point for locating an industry that minimizes costs of transportation and labour requires analysis of three factors:

1. The point of optimal transportation based on the costs of distance to the 'material index'—the ratio of weight to intermediate products (raw materials) to finished product.
2. The labour distortion, in which more favourable sources of lower cost of labour may justify greater transport distances.
3. Agglomeration and degglomerating.

The issue of industry location is increasingly relevant to today's global markets and transnational corporations. Focusing only on the mechanics of the Weberian model could justify greater transport distances for cheap labour and unexploited raw materials. When resources are exhausted or workers revolt, industries move to different countries.

### Check your progress 1

1. What are the problems with poorly planned layout ?
  - a. Congestion
  - b. delays
  - c. Accidents
  - d. All of these

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### 2.3 Factors Influencing Location

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Following are the important factors which are normally to be considered when selecting the location of an enterprise or project :

#### **Availability of Land :**

Land should be large enough to meet out present requirement with provision for further expansion. Land should be for industrial use (land usage pattern to be adhered to) and proper layout of plant and equipment must be possible as per the technical feasibility study. Drainage level of land, soil testing report (should be suitable for the construction of the factory) should be favourable to the project requirements.

#### **Availability of Raw Materials :**

Availability of required quantity and quality of raw materials at a reasonable cost. Cost of materials generally constitutes a major chunk of total cost of production and thus, the impact of raw materials on location depends upon their nature and the source of their deposits.

#### **Supply of Manpower :**

Every enterprise requires an adequate supply of manpower with appropriate skills. Availability of skilled manpower, cost of labour, labour expectations, local culture affect the supply of manpower to the enterprise. Sometimes, it becomes difficult to obtain high skilled people to work at very remote places with big town facilities. Alfred Weber rightly remarked that that "an industrial site will deviate from the point of minimum transportation cost to the cheaper labour centre if the additional cost of transportation at the new centre is more than compensated by the savings in labour cost." However, this situation has been changed. Labour is mobile and there is a level of minimum wages fixed by the Government from time to time. Moreover certain industries are capital intensive and they require less labour.

#### **Transport and Communication Facilities :**

Transport services are required for assembling of materials and distribution of products. At the time of selection of a particular efforts should be made to ensure that transportation facilities are easily available at reasonable rates. Site should be well connected by road and rail or nearer to national highways, major railway yard etc., Transportation of equipment, material, product and personnel is an important requirement and it should be ensured in time and in efficient manner.

#### **Proximity to the Market :**

Availability of consumer market also affects the viability of the enterprise. An entrepreneur can improve his customer relations if they are available in nearby areas and easily render rapid services to them. Enterprises engaged in the production of perishable commodities and those producing for a local market are also interested to develop their plants in potential consumer's area as it would ensure a reduction in transportation cost involved in distributing the finished products. Actually, an enterprise tends to disperse only if they find a new consumer market.

### **Water, Power and Fuel :**

Uninterrupted operations of an enterprise are the result of sufficient supply of water, power and fuel etc. In this context, efforts are required to assess local sources of water. Besides, required water supply to be assessed in terms of water conditions or sub-soil water etc. Availability of power in the region is to be evaluated in terms of actual requirements. Some industries consume lot power (aluminium) or water (Paper industry) and these variables are a very important factor for them. Nowadays, industries are facing the problem of power shortages and they are shifting to the fuel option—coal. For example, coal is the major source of fuel for the iron and steel industry and these industries are located near the coal mines.

### **Regional Development :**

In our country, government is pursuing the policy of balanced regional development to solve the problems like slum, disparity of income and wealth and optimum use of resources. In order to ensure balanced regional development, government has declared certain areas as backward areas and zero industry areas.

Government gives certain benefits like tax benefits but it is necessary to evaluate the process to what extent they would outweigh the disadvantages.

### **External Economies :**

In some cases, an enterprise prefers to be located in those centres where other industrial units are already located. There are certain facilities like transportation, warehousing, banking, insurance, communication and factoring services etc. which are easily available and industrial units tend to be concentrated in these areas. Besides, raw materials are also available at cheaper prices and in large quantity. For example, by product of one enterprise may be used as raw material by another enterprise. Enterprises working as distilleries are generally located in nearby areas of Sugar mills because they supply molasses as raw materials to distilleries.

### **Personal Factors :**

Personal preferences and prejudices of an entrepreneur also effect the selection of location. Entrepreneurial preferences are also affected by law and order, political stability and safety etc. Thus, entrepreneurs prefer to locate their enterprises in those areas which are safe and free from law and order problems.

### **Local Laws and Regulations :**

In certain cases local laws and regulations impose restrictions on the development of industrial units in special areas. For example, consent of various agencies like local Panchayat, municipality, government, state planning bodies is mandatory for the entrepreneurs otherwise they cannot run their enterprises in municipal or local areas. Similarly, high rate of income-tax, sale-tax, octroi, etc. discourage entrepreneur to develop their plant in a particular area or state. But facility of tax holidays encourages them otherwise to develop their units in a particular area or state.

### **Ecological and Environmental Factors :**

Certain industrial units are required to be governed by the ecological and environmental provisions of Pollution Control Act. Industrial units are required to follow the norms of Pollution Control Board. They have to make efforts for the disposal of effluents are directed by the pollution control authorities. They have to arrange the nearest source where effluent (after treatment) could be discharged.

### Check your progress 2

1. Which of the following factors are needed to be considered when selecting the location of an enterprise or project ?
  - a. Local Laws and Regulations
  - b. External Economies
  - c. Both B and C
  - d. None of these

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### 2.4 What Is Plant Layout

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Plant layout is a mechanism which involves knowledge of the space requirements for the facilities and also involves their proper arrangement so that continuous and steady movement of the production cycle takes place.

Moore, a very well known name in the business world, explained plant layout as, 'The plan of or the act of planning, an optimum arrangement of facilities, including personnel, operating equipment, storage space, materials handling equipment and all other supporting services along with the design of the best structure to accommodate these facilities?.'

The problems related to plant layout are generally observed because of the various developments that occur. These developments generally include adoption of the new standards of safety, changes in the design of the product, decision to set up a new plant, introducing a new product, withdrawing the various obsolete facilities etc.

#### Considerations of Plant Layout :

- Maximum use of the available space.
- Compatibility with the production technology and product mix.
- Minimum movement of materials as well as men.
- Provision of proper space for maintenance.
- Arrangement of proper in-transit storage and stacking space.
- Promotes effective supervision.
- Proper lighting and ventilation.
- Provision of maximum flexibility.
- Safety of operators and other staff.
- Minimum handling of materials.
- Provision for future expansion.
- Security against fire, theft, deterioration etc.
- Maximum flexibility to accommodate changes in production volume and product mix.
- Should meet the specific requirement of the production process viz., air conditioning, air cooling, dust control, humidity control and may be required.

### Check your progress 3

1. What should be considered while selecting a plant layout?
  - a. Proper lighting and ventilation.
  - b. Provision of maximum flexibility.
  - c. Safety of operators and other staff.
  - d. All of these

## 2.5 Objectives of Plant Layout

The primary goal of the plant layout is to maximise the profit by arrangement of all the plant facilities to the best advantage of total manufacturing of the product.

The objectives of plant layout are:

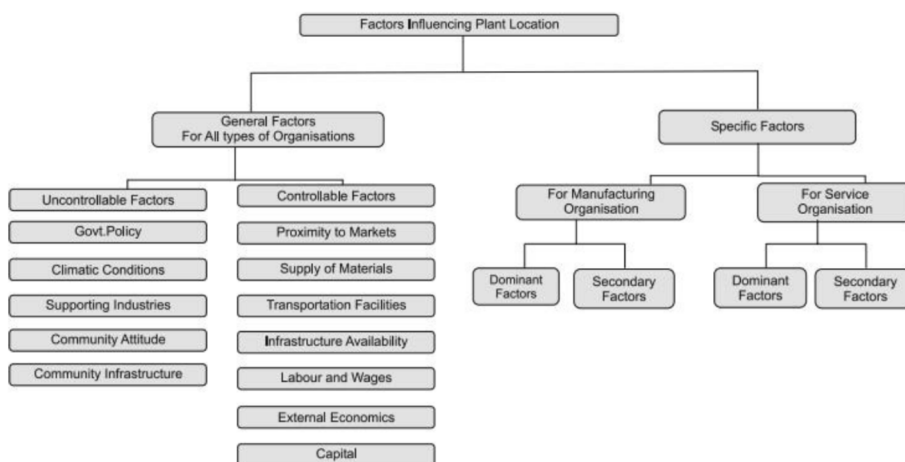
1. Streamline the flow of materials through the plant.
2. Facilitate the manufacturing process.
3. Maintain high turnover of in-process inventory.
4. Minimise materials handling and cost.
5. Effective utilisation of men, equipment and space.
6. Make effective utilisation of cubic space.
7. Flexibility of manufacturing operations and arrangements.
8. Provide for employee convenience, safety and comfort.
9. Minimize investment in equipment.
10. Minimize overall production time.
11. Maintain flexibility of arrangement and operation.
12. Facilitate the organizational structure.

### Check your progress 4

1. What are the main objectives of plant layout ?
  - a. Facilitate the manufacturing process.
  - b. Maintain high turnover of in-process inventory
  - c. Minimize materials handling and cost.
  - d. All of these

## 2.6 Factors Affecting Plant Layout

Facility location is the process of determining a geographic site for a firm's operations. Managers of both service and manufacturing organizations must weigh many factors when assessing the desirability of a particular site, including proximity to customers and suppliers, labour costs, and transportation costs.



**Fig 2.1 Factors influencing Plant location**

Location conditions are complex and each comprises a different characteristic of a tangible (i.e. Freight rates, production costs) and non-tangible (i.e. reliability, Frequency security, quality) nature.

Location conditions are hard to measure. Tangible cost based factors such as wages and products costs can be quantified precisely into what makes locations better to compare. On the other hand non-tangible features, which refer to such characteristics as reliability, availability and security, can only be measured along an ordinal or even nominal scale. Other non-tangible features like the percentage of employees that are unionized can be measured as well. To sum this up non-tangible features are very important for business location decisions.

It is appropriate to divide the factors, which influence the plant location or facility location on the basis of the nature of the organisation as :

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.

**Location factors can be further divided into two categories :**

#### **General Location Factors**

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

#### **Controllable Factors**

- Proximity to markets
- Supply of materials
- Transportation facilities
- Infrastructure availability
- Labour and wages
- External economies
- Capital

#### **Proximity to markets**

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

- The products are delicate and susceptible to spoilage.
- After sales services are promptly required very often.
- Transportation cost is high and increase the cost significantly.
- Shelf life of the product is low.

Nearness to the market ensures a consistent supply of goods to customers and reduces the cost of transportation.

### **Supply of raw material**

It is essential for the organization to get raw material in right qualities and time in order to have an uninterrupted production. This factor becomes very important if the materials are perishable and cost of transportation is very high. General guidelines suggested by Yaseen regarding effects of raw materials on plant location are :

- When a single raw material is used without loss of weight, locate the plant at the raw material source, at the market or at any point in between.
- When weight losing raw material is demanded, locate the plant at the raw material source.
- When raw material is universally available, locate close to the market area.
- If the raw materials are processed from variety of locations, the plant may be situated so as to minimize total transportation costs. Nearness to raw material is important in case of industries such as sugar, cement, jute and cotton textiles.

### **Transportation facilities :**

Speedy transport facilities ensure timely supply of raw materials to the company and finished goods to the customers. The transport facility is a prerequisite for the location of the plant. There are five basic modes of physical transportation, air, road, rail, water and pipeline. Goods that are mainly intended for exports demand a location near to the port or large airport. The choice of transport method and hence the location will depend on relative costs, convenience, and suitability. Thus transportation cost to value added is one of the criteria for plant location.

### **Infrastructure availability :**

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

### **Labour and wages :**

The problem of securing adequate number of labour and with skills specific is a factor to be considered both at territorial as well as at community level during plant location. Importing labour is usually costly and involve administrative problem. The history of labour relations in a prospective community is to be studied. Prospective community is to be studied. Productivity of labour is also an important factor to be considered. Prevailing wage pattern, cost of living and industrial relation and bargaining power of the unions' forms in important considerations.



### **External economies of scale :**

External economies of scale can be described as urbanization and locational economies of scale. It refers to advantages of a company by setting up operations in a large city while the second one refers to the 'settling down' among other companies of related Industries. In the case of urbanization economies, firms derive from locating in larger cities rather than in smaller ones in a search of having access to a large pool of labour, transport facilities, and as well to increase their markets for selling their products and have access to a much wider range of business services.

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. This led to manufacturing districts where many companies of related industries are located more or less in the same area. As large corporations have realized that inventories and warehouses have become a major cost factor, they have tried reducing inventory costs by launching 'Just in Time' production system (the so called Kanban System). This high efficient production system was one main factor in the Japanese car industry for being so successful. Just in time ensures to get spare parts from suppliers within just a few hours after ordering. To fulfill these criteria corporations have to be located in the same area increasing their market and service for large corporations.

### **Capital :**

By looking at capital as a location condition, it is important to distinguish the physiology of fixed capital in buildings and equipment from financial capital. Fixed capital costs as building and construction costs vary from region to region. But on the other hand buildings can also be rented and existing plants can be expanded. Financial capital is highly mobile and does not very much influence decisions.

### **Uncontrollable Factors**

- Government policy
- Climate conditions
- Supporting industries and services
- Community and labour attitudes
- Community Infrastructure

### **Government policy :**

The policies of the state governments and local bodies concerning labour laws, building codes, safety, etc., are the factors that demand attention. In order to have a balanced regional growth of industries, both central and state governments in our country offer the package of incentives to entrepreneurs in particular locations. 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, subsidy in electricity charges and investment subsidy. Some of these incentives may tempt to locate the plant to avail these facilities offered.

### **Climatic conditions :**

The geology of the area needs to be considered together with climatic conditions (humidity, temperature). Climates greatly influence human efficiency and behaviour. Some industries require specific climatic conditions e.g., textile mill will require humidity.

### **Supporting industries and services :**

Now a day the manufacturing organisation will not make all the components and parts by itself and it subcontracts the work to vendors. So, the source of supply of component parts will be the one of the factors that influences the location. The various services like communications, banking services professional consultancy services and other civil amenities services will play a vital role in selection of a location.

### **Community and labour attitudes :**

Community attitude towards their work and towards the prospective industries can make or mar the industry. Community attitudes towards supporting trade union activities are important criteria. Facility location in specific location is not desirable even though all factors are favouring because of labour attitude towards management, which brings very often the strikes and lockouts.

### **Community infrastructure and amenity :**

All manufacturing activities require access to a community infrastructure, most notably economic overhead capital, such as roads, railways, port facilities, power lines and service facilities and social overhead capital like schools, universities and hospitals.

These factors are also needed to be considered by location decisions as infrastructure is enormously expensive to build and for most manufacturing activities the existing stock of infrastructure provides physical restrictions on location possibilities.

Specific Locational Factors for Manufacturing Organisation

### **Dominant Factors**

Factors dominating location decisions for new manufacturing plants can be broadly classified in six groups. They are listed in the order of their importance as follows.

- Favourable labour climate
- Proximity to markets
- Quality of life
- Proximity to suppliers and resources
- Utilities, taxes, and real estate costs

### **Favorable labour climate :**

A favorable labour climate may be the most important factor in location decisions for labour-intensive firms in industries such as textiles, furniture, and consumer electronics. Labour climate includes wage rates, training requirements, attitudes toward work, worker productivity, and union strength. Many executives consider weak unions or a low probability of union organizing efforts as a distinct advantage.

**Proximity to markets :**

After determining where the demand for goods and services is greatest, management must select a location for the facility that will supply that demand. Locating near markets is particularly important when the final goods are bulky or heavy and outbound transportation rates are high. For example, manufacturers of products such as plastic pipe and heavy metals all emphasize proximity to their markets.

**Quality of life :**

Good schools, recreational facilities, cultural events, and an attractive lifestyle contribute to quality of life. This factor is relatively unimportant on its own, but it can make the difference in location decisions.

**Proximity to suppliers and resources :**

In many companies, plants supply parts to other facilities or rely on other facilities for management and staff support. These require frequent coordination and communication, which can become more difficult as distance increases.

**Utilities, taxes, and real estate costs :**

Other important factors that may emerge include utility costs (telephone, energy, and water), local and state taxes, financing incentives offered by local or state governments, relocation costs, and land costs.

**Check your progress 5**

1. Which of the following is an example of Dominant Factor?
  - a. Proximity to markets
  - b. Supporting industries and services
  - c. Community and labour attitudes
  - d. None of these
2. Location Factors are divided into types
  - a. Three
  - b. Two
  - c. Four
  - d. None of these

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**2.7 Characteristics of an Efficient Layout**

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**Principles of a good plant layout are –**

- A good plant layout is the one which is able to integrate its workmen, materials, machines in the best possible way.
- A good plant layout is the one which sees very little or minimum possible movement of the materials during the operations.
- A good layout is the one that is able to make effective and proper use of the space that is available for use.
- A good layout is the one which involves unidirectional flow of the materials during operations without involving any back tracking.
- A good plant layout is the one which ensures proper security with maximum flexibility.

- Maximum visibility, minimum handling and maximum accessibility, all form other important features of a good plant layout.

### Check your progress 6

1. Which of the following are the features of good plant layout?
  - a. It should be able to integrate its workmen, materials, machines in the best possible way.
  - b. It involves unidirectional flow of the materials during operations without involving any back tracking
  - c. Both of these
  - d. None of these

## 2.8 Techniques and Advantages of Plant Layout

Layout involves determining the space requirement for the facilities and arranging them in a manner to ensure steady flow of operations with minimum overall cost. In order words, a layout is a floor plan for arranging the desired facilities, machinery, equipment in an optimum locations so as to permit the quickest flow of materials and manpower at the lowest cost and with the least amount of in process handling from receipt of raw material to shipment of finished products.

### Advantages :

- Increase in Productivity
- Maximum utilization of Space
- Effective Supervision and Control
- Economy in Material
- Improved Safety and Handling
- Improved Working Environment and Morale
- Better Quality Control.

### Check your progress 7

1. What are the main advantages of a Plant layout?
  - a. Increase in Productivity
  - b. Maximum utilization of Space
  - c. Improved Working Environment and Morale
  - d. All of these

## 2.9 Types of Layout

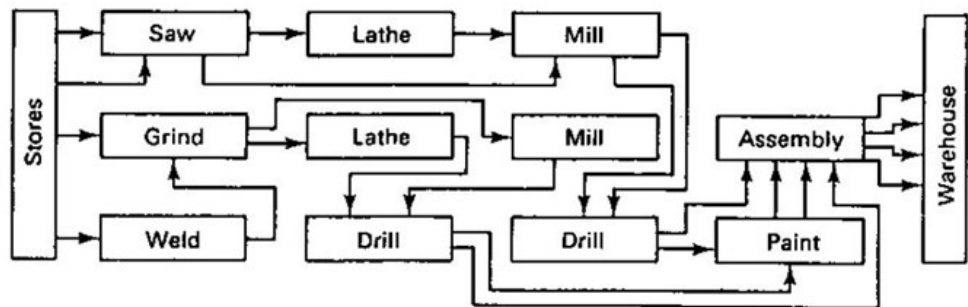
Layouts can be classified into the following five categories :

- Process layout
- Product layout
- Combination layout
- Fixed position layout
- Group layout

## Process Layout

Process layout is recommended for batch production. All machines performing similar type of operations are grouped at one location in the process layout e.g., all lathes, milling machines, etc. are grouped in the shop will be clustered in like groups. Thus, in process layout the arrangement of facilities are grouped together according to their functions. A typical process layout is shown in Fig. 2.5. The flow paths of material through the facilities from one functional area to another vary from product to product. 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. Typically, job shops employ process layouts due to the variety of products manufactured and their low production volumes.

**Process layout diagram**



### Advantages :

- In process layout machines are better utilized and fewer machines are required.
- Flexibility of equipment and personnel is possible in process layout.
- Lower investment on account of comparatively less number of machines and lower cost of general purpose machines.
- Higher utilisation of production facilities.
- A high degree of flexibility with regards to work distribution to machineries and workers.
- The diversity of tasks and variety of job makes the job challenging and interesting.
- Supervisors will become highly knowledgeable about the functions under their department.

### Limitations

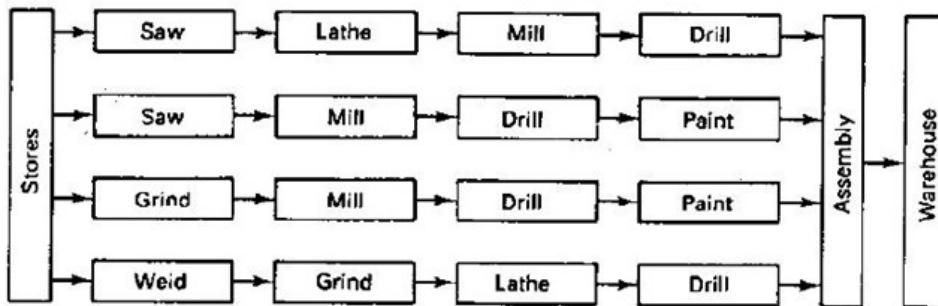
- Backtracking and long movements may occur in the handling of materials thus, reducing material handling efficiency.
- Material handling cannot be mechanised which adds to cost.
- Process time is prolonged which reduce the inventory turnover and increases the inprocess inventory.
- Lowered productivity due to number of set-ups.
- Throughput (time gap between in and out in the process) time is longer.
- Space and capital are tied up by work-in-process.

### Product Layout

In this type of layout, machines and auxiliary services are located according to the processing sequence of the product. If the volume of production of one or

more products is large, the facilities can be arranged to achieve efficient flow of materials and lower cost per unit. Special purpose machines are used which perform the required function quickly and reliably. The product layout is selected when the volume of production of a product is high such that a separate production line to manufacture it can be justified. In a strict product layout, machines are not shared by different products. Therefore, the production volume must be sufficient to achieve satisfactory utilisation of the equipment.

### Product Layout



### Advantages

- The flow of product will be smooth and logical in flow lines.
- In-process inventory is less.
- Throughput time is less.
- Minimum material handling cost.
- Simplified production, planning and control systems are possible.
- Less space is occupied by work transit and for temporary storage.
- Reduced material handling cost due to mechanized handling systems and straight flow.
- Perfect line balancing which eliminates bottlenecks and idle capacity.
- Manufacturing cycle is short due to uninterrupted flow of materials.
- Small amount of work-in-process inventory.
- Unskilled workers can learn and manage the production. Limitations
- A breakdown of one machine in a product line may cause stoppages of machines in the downstream of the line.
- A change in product design may require major alterations in the layout.
- The line output is decided by the bottleneck machine.
- Comparatively high investment in equipments is required.
- Lack of flexibility. A change in product may require the facility modification.

### Combination Layout

A combination of process and product layouts combines the advantages of both types of 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 manufacture 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

### **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 :

- Helps in job enlargement and upgrades the skills of the operators.
- The workers identify themselves with a product in which they take interest and pride in doing the job.
- Greater flexibility with this type of layout.
- Layout capital investment is lower.

### **Group Layout (or Cellular Layout)**

There is a trend now to bring an element of flexibility into manufacturing system as regards to variation in batch sizes and sequence of operations. A grouping of equipment for performing a sequence of operations on family of similar components or products has become all the important.

Group technology (GT) is the analysis and comparisons of items to group them into families with similar characteristics. GT can be used to develop a hybrid between pure process layout and pure flow line (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.

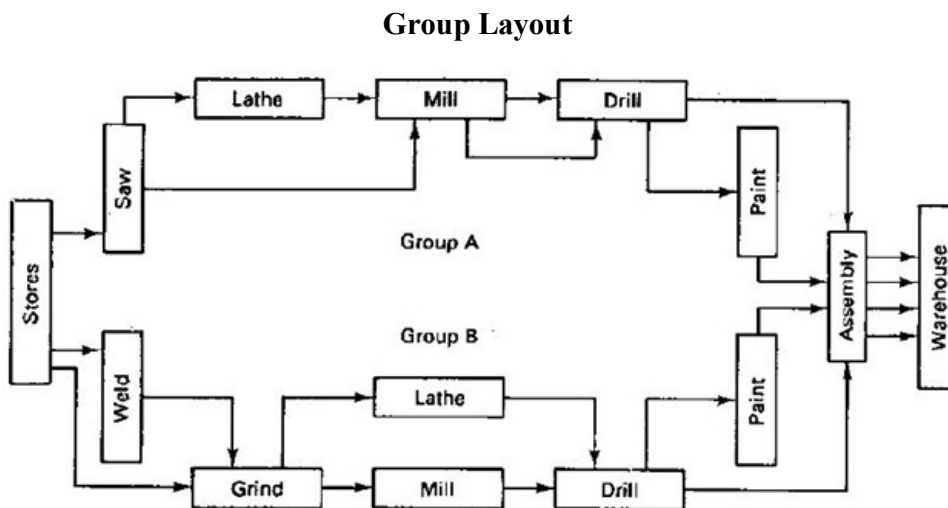
The application of group technology involves two basic steps; first step is to determine component families or groups. The second step in applying group technology is to arrange the plants equipment used to process a particular family of components. This represents small plants within the plants. The 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. If there are m-machines and n- components, in a group layout (Group-Technology Layout), the m-machines and n-components will be divided into distinct number of machine-component cells (group) such that all the components assigned to a cell are almost processed within that cell itself. Here, the objective is to minimize the intercell movements.

The basic aim of a group technology layout is to identify families of components that require similar of satisfying all the requirements of the machines are grouped into cells. Each cell is capable of satisfying all the requirements of the component family assigned to it.

The layout design process considers mostly a single objective while designing layouts. In process layout, the objective is to minimize the total cost of materials handling. Because of the nature of the layout, the cost of equipments will be the minimum in this type of layout. In product layout, the cost of materials handling will be at the absolute minimum. But the cost of equipments would not be at the minimum if the equipments are not fully utilized.

In-group technology layout, the objective is to minimize the sum of the cost of transportation and the cost of equipments. So, this is called as multi-objective layout.



### Advantages

Group Technology layout can increase —

- Component standardization and rationalization.
- Reliability of estimates.
- Effective machine operation and productivity.
- Customer service. It can decrease the—
- Paper work and overall production time.
- Work-in-progress and work movement.
- Overall cost.

### Limitations

This type of layout may not be feasible for all situations. If the product mix is completely dissimilar, then we may not have meaningful cell formation.

### Check your progress 8

1. What is fixed position layout?
  - a. In this , a grouping of equipment for performing a sequence of operations is done
  - b. In this layout, the material, or major components remain in a fixed location and tools, machinery, men and other materials are brought to this location.
  - c. It is required where an item is being made in different types and sizes
  - d. All of these
2. Group Technology is the combination of .
  - a. Product and Process layout
  - b. Product and Combination Layout
  - c. Fixed position and product layout
  - d. None of these

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## 2.10 Let Us Sum Up

In this unit we have learnt that location is related with particular site where entrepreneur is interested to establish an enterprise or plant having lowest cost objective.

Layout shows the space needed for facilities and arranging in manner to ensure steady flow of operations with minimum overall cost. It is a floor plan for arranging the desired facilities, machinery, equipment in an optimum.



It is noticed that availability of Land should be large enough to meet present requirement with provision for further expansion. It should be for industrial use and proper layout of plant and equipment must be possible as per the technical feasibility study.

Plant layout involves knowledge of space requirements for facilities which involves proper arrangement for continuous and steady movement of production cycle

Facility location is the process of determining a geographic site for a firm's operations. Managers of both service and manufacturing organizations must weigh many factors when assessing the desirability of a particular site, including proximity to customers and suppliers, labour costs, and transportation costs

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## 2.11 Answer for Check Your Progress

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### Check your progress 1

Answers: (1-d)

### Check your progress 2

Answers: (1-c)

### Check your progress 3

Answers: (1-d)

### Check your progress 4

Answers: (1-d)

### Check your progress 5

Answers: (1-a), (2-b)

### Check your progress 6

Answers: (1-c)

### Check your progress 7

Answers: (1-d)

### Check your progress 8

Answers: (1-b), (1-a)

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## 2.12 Glossary

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1. **Layout** : Demographical factors involving in design and appearance of plan
2. **Production capacity** : It is the ability to produced goods in terms of units

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## 2.13 Assignment

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Write note on requirements for setting of an enterprise.

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## 2.14 Activities

---

Collect information on type of layout for setting a company.

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## 2.15 Case Study

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Explain various features of production as per layout for an enterprise?

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## 2.16 Further Readings

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1. Morgan, Mechanization Takes Command in Images of Organizations, Sage Press, 1986.
2. Meal, Putting production decisions where they belong, HBR, 1984.
3. Zeithaml, Berry, Parasuraman, Communication and control processes in the delivery of service quality, Journal of marketing, 1988.



### **: UNIT STRUCTURE :**

- 3.0 Learning Objectives**
- 3.1 Introduction**
- 3.2 Objectives of Material Handling**
- 3.3 Principles of Material Handling**
- 3.4 Materials Handling and Equipment**
- 3.5 Guidelines for Effective Utilisation of Material Handling Equipments**
- 3.6 Relationship between Plant Layout and Material Handling**
- 3.7 Let Us Sum Up**
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- 3.9 Glossary**
- 3.10 Assignment**
- 3.11 Activities**
- 3.12 Case Study**
- 3.13 Further Readings**

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#### **3.0 Learning Objectives**

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After reading this Unit, you will be able to :

- Understand material handling
- Different material handling equipments
- Relationship between material handling and plant layout

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#### **3.1 Introduction**

---

Material Handling is the art and science involving the movement, handling and storage of material during different stages of manufacturing. Material Handling can be defined as “the function dealing with the preparation, placing and positioning of materials to facilitate their movement or storage”. Generally, any activity or process should add value to the product but material handling does not add any value rather it increases only cost to the product. Keeping it minimum is necessity to control the overall cost of product. That makes material handling an art and science. Through scientific techniques of material handling considerable time and eventually cost can be reduced to a certain point. Out of the total time taken manufacturing product almost 4/5 time is spent on material movement. Poor material handling may lead to idle equipment which will increase the cost of production.

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#### **3.2 Objectives of Material Handling**

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

1. **Cost reduction by :**
  - Decreasing Inventory level
  - Utilizing space to better advantage
  - Increasing productivity.
2. **Waste Reduction by :**
  - Eliminating damage to material during handling
  - Flexible to meet specific handling requirements of different nature.
  - Making proper control over stock during in and out handling.
3. **Improve Working Conditions by :**
  - Increasing productivity per man-hour
  - Increase in machine efficiency through reduction of machine down time
  - Smoothing out workflow
  - Improving production control.
4. **Improve Working Conditions by :**
  - Providing safe working conditions
  - Reducing worker's fatigue
  - Improving personal comfort
  - Upgrading employees/workers to productive work.
5. **Improve Distribution by :**
  - Decreasing damage to products during handling and shipping.
  - Improving location of storage facilities.
  - Increasing the efficiency of shipping and receiving.

#### **Check your progress 1**

1. What are the objectives of material handling?
  - a. Cost reduction
  - b. Improve Distribution
  - c. Waste Reduction
  - d. All of these
2. How can work conditions in material handling be improved?
  - a. Providing safe working conditions
  - b. Upgrading employees/workers to productive work
  - c. Both A and B
  - d. None of these

---

### **3.3 Principles of Material Handling**

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Following are the principles of Material Handling :

1. **Planning Principle :** All handling activities should be planned.
2. **Systems Principle :** Make a system which integrates all the handling activities like receiving, storage, production, inspection, packing, warehousing, supply and transportation.

3. **Space Utilization Principle** : Optimum use of total space area.
4. **Gravity Principle** : Utilise gravity to move a material wherever practical.
5. **Sequencing Principle** : To optimize material flow, sequencing of material must be planned accordingly.
6. **Simplification principle** : Unnecessary movement of equipment and material must be reduced.
7. **Safety Principle** : Material handling methods must be safe.
8. **Flexibility Principle** : Use methods and equipments that can perform different task and applications.
9. **Equipment selection Principle** : All aspects related to material handling like movement of material, size of material, weight of material must be considered before selecting equipment to handle material.
10. **Mechanization Principle** : Use of automated material handling equipment must be increased to optimize the time consumption and cost of material handling.

### Check your progress 2

1. Unnecessary movement of materials and equipments should be reduced as per \_\_\_\_\_ principle.
 

a. mechanization	b. Flexibility
c. simplification	d. None of the above
2. \_\_\_\_\_ principle suggests use of automated material handling equipment.
 

a. Equipment selection	b. Safety
c. Mechanization	d. None of the above

---

### 3.4 Materials Handling and Equipments

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Material handling is the movement, protection, storage and control of materials and products throughout manufacturing, warehousing, distribution, consumption and disposal. As a process, material handling incorporates a wide range of manual, semi-automated and automated equipment and systems that support logistics and make the supply chain work. Their application helps with:

- Forecasting
- Resource allocation
- Production planning
- Flow and process management
- Inventory management and control
- Customer delivery
- After-sales support and service

#### Material handling equipment

The instruments encompasses a diverse range of tools, vehicles, storage units, appliances and accessories involved in transporting, storing, controlling, enumerating and protecting products at any stage of manufacturing, distribution consumption or disposal.

## **Categories of Material Handling Equipment**

The four main categories of material handling equipment include: storage, engineered systems, industrial trucks and bulk material handling.

### **Storage and Handling Equipment**

Storage equipment is usually limited to non-automated examples, which are grouped in with engineered systems. Storage equipment is used to hold or buffer materials during 'downtimes,' or times when they are not being transported. These periods could refer to temporary pauses during long-term transportation or long-term storage designed to allow the buildup of stock. The majority of storage equipment refers to pallets, shelves or racks onto which materials may be stacked in an orderly manner to await transportation or consumption. Many companies have investigated increased efficiency possibilities in storage equipment by designing proprietary packaging that allows materials or products of a certain type to conserve space while in inventory.

#### **Examples of storage and handling equipment include :**

- Racks, such as pallet racks, drive-through or drive-in racks, push-back racks, and sliding racks
- Stacking frames
- Shelves, bins and drawers
- Mezzanines

### **Engineered Systems**

Engineered systems cover a variety of units that work cohesively to enable storage and transportation. They are often automated. A good example of an engineered system is an Automated Storage and Retrieval System, often abbreviated AS/RS, which is a large automated organizational structure involving racks, aisles and shelves accessible by a 'shuttle' system of retrieval. The shuttle system is a mechanized cherry picker that can be used by a worker or can perform fully automated functions to quickly locate a storage item's location and quickly retrieve it for other uses.

Other types of engineered systems include :

- Conveyor systems
- Robotic delivery systems
- Automatic guided vehicles (AGV)

### **Industrial Trucks**

Industrial trucks refer to the different kinds of transportation items and vehicles used to move materials and products in materials handling. These transportation devices can include small hand-operated trucks, pallet-jacks, and various kinds of forklifts. These trucks have a variety of characteristics to make them suitable for different operations. Some trucks have forks, as in a forklift, or a flat surface with which to lift items, while some trucks require a separate piece of equipment for loading. Trucks can also be manual or powered lift and operation can be walk or ride, requiring a user to manually push them or to ride along on the truck. A stack truck can be used to stack items, while a non-stack truck is typically used for transportation and not for loading.

There are many types of industrial trucks :

- Hand trucks
- Pallet trucks
- Platform trucks
- Sideloader
- Pallet jacks
- Walkie stackers
- Order picker
- Many types of AGV

### **Bulk Material Handling Equipment**

Bulk material handling refers to the storing, transportation and control of materials in loose bulk form. These materials can include food, liquid, or minerals, among others. Generally, these pieces of equipment deal with the items in loose form, such as conveyor belts or elevators designed to move large quantities of material, or in packaged form, through the use of drums and hoppers.

- Conveyor belts
- Reclaimers
- Grain elevators
- Silos
- Stackers
- Bucket elevators
- Hoppers

### **Check your progress 3**

1. Material Handling is used for?
  - a. Resource allocation
  - b. Production planning
  - c. Flow and process management
  - d. All of these
2. Which of the following is the type of industrial trucks?
  - a. Hoppers
  - b. Walkie stackers
  - c. Conveyor belts
  - d. All of these

---

### **3.5 Guidelines for Effective Utilization of Material Handling**

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The following guidelines are invaluable in the design and cost reduction of the materials handling system :

- (1) Ideally there should not be any handling as material handling activity does not add any value to the product. So, material handling should be eliminated wherever possible.
- (2) Sequence the operations in logical manner so that handling is unidirectional and smooth.
- (3) Use gravity wherever possible as it results in conservation of power and fuel.
- (4) Standardize the handling equipments to the extent possible as it means interchangeable usage, better utilization of handling equipments and lesser space holding.

- (5) Install a regular preventive maintenance program for material handling equipments so that downtime is minimum.
- (6) Weight of unit load must be maximum so that each handling trip is productive.
- (7) Location of the stores should be as close as possible to the plant which uses the materials. This avoids handling and minimizing investment in material handling system.
- (8) The system design should be safe and simple to operate.
- (9) OR techniques like queueing should be applied for optimal utilization of material handling equipments.
- (10) Non-productive operations in material handling such as slinging, loading, etc., should be kept at minimum.

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### **3.6 Relationship between Plant Layout and Material Handling**

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There is a close connection between the concepts of plant layout and material handling. A good plant structure can ascertain the least material handling process and inexpensive material handling equipment. The material handling factors to be considered while designing the plant layout are:

- 1) Excessive material movement damages the materials and causes loss of valuable man-hours in shifting materials. A layout should be designed such that it suits the manufacturing requirement of the products and reduces the material handling to minimum.
- 2) If the workers are compelled to search through the entire workshop for a particular material, their productive time is bound to go wasted. For maximum utilization of their time the plant should be equipped with:
  - Clearly identified and well-named functional areas.
  - Distinct areas for raw materials, tools, work-in-process, inspection and finished goods.
- 3) For an effective and speedy movement of materials there should be an effective use of:
  - Bins, trolleys, racks and trays to keep materials instead of placing them on floors
  - Proper packaging techniques before dispatching
  - Conveyors, chutes, inclined planes and gravity feed bins to automate, materials movement.
  - 1) Public utilities should be located at easily accessible distances and should not require distant walks on part of the workers
  - 2) Economical use of space should be aimed. Machines and equipment's should be placed in such a way that there is a minimal or no wastage of space and yet there should be optimum choice for expansion.

- 3) Maximum opportunity for greater width of aisles, heights of ceilings and other areas of storage so the need of later alterations will be reduced

A good plant layout thus facilitates an efficient material handling system. It offers minimum material handling by making material movements shorter, faster and economical. Overcrowding is prevented. Delays in supplying are avoided due smooth manufacturing activity and hence it is generally desirable to adopt a good plant layout that facilities minimum handling.

#### Check your progress 4

1. For maximum utilization of time the plant should be equipped with .
  - a. Clearly identified and well-named functional areas.
  - b. Distinct areas for raw materials, tools, work-in-process, inspection and finished goods.
  - c. Both A and B
  - d. None of these

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### 3.7 Let Us Sum Up

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In this unit we have learnt that Material handling is the movement, protection, storage and control of materials and products throughout manufacturing, warehousing, distribution, consumption and disposal.

Cost reduction is the primary principle of material handling. Material handling is something which does not add any value to the product. It only adds cost to it. Different principles of material handling should be considered to reduce the material handling cost to an extent.

Plant layout and material handling are linked together. If plant layout is designed in accordance with the principles of material handling then overall cost of material handling can be reduced.

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### 3.8 Answer for check your progress

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#### Check your progress 1

Answers: (1-d), (2-c)

#### Check your progress 2

Answers: (1-c), (2-c)

#### Check your progress 3

Answers: (1-d), (2-b)

#### Check your progress 4

Answers: (1-c)

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### 3.9 Glossary

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**Material Handling :** Material handling is the movement, protection, storage and control of materials and products throughout manufacturing, warehousing, distribution, consumption and disposal.



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**3.10 Assignment**

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Write a note on industrial vehicles used for material handling purpose.

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**3.11 Activities**

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Collect details on different types of Material Handling Equipments

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**3.12 Case Study**

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Material Handling System Design: A Case study in Bosch Rexroth Japan

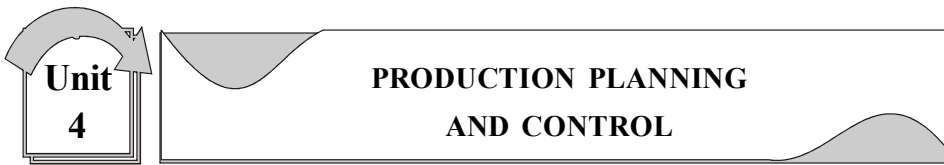
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**3.13 Further Readings**

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**UNIT STRUCTURE :**

- 4.0 Learning Objectives**
- 4.1 Introduction**
- 4.2 Production Planning**
  - 4.2.1 Objective**
  - 4.2.2 Characteristics**
  - 4.2.3 Importance**
  - 4.2.4 Organization and Steps involved in production Planning**
- 4.3 Production Control**
  - 4.3.1 Objective**
  - 4.3.2 Advantage**
  - 4.3.3 Techniques and Functions**
- 4.4 Production Planning & Control:**
  - 4.4.1 Objective**
  - 4.4.2 Scope**
  - 4.4.3 Phase**
  - 4.4.4 Benefits**
  - 4.4.5 Limitation**
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- 4.12 Further Readings**

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**4.0 Learning Objectives**

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After reading this Unit, you will be able to understand :

- Need of Production Planning
- Different phases of Production Planning & Control
- Techniques and Functions of Production Control
- Different methods of Network Analysis and stages of work involved in Network Analysis.

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## 4.1 Introduction

---

This unit will introduce you to the concept of Production planning and control. Production planning and control (PPC) is most essential for any organisation. Planning process within an organisation is dynamic and continuous. In this unit we are going to discuss how production process is planned and scheduled and ultimately implemented in a production unit. For production purpose, all the facilities should be arranged and the factory itself has to be properly set up. PPC involves the planning of production, a decision on the sequence of operations to achieve what has been planned, the setting of starting and finishing time for production, proper dispatching of the material, and follow up action to check the progress of operations.

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## 4.2 Production Planning

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Production planning is an activity that is performed before the actual production process takes place. It involves determining the schedule of production, sequence of operations, economic batch quantities, and also the dispatching priorities for sequencing of jobs. Production planning consists of the evaluation and determination of production inputs such as labour, machinery and equipment, materials and utilities to achieve the desired goal. The productivity of an organisation can be improved by better planning efforts.

### 4.2.1 Objective

The need, main functions or objectives of production planning are as follows:

- Effective utilization of resources.
- Steady flow of production.
- Estimate the resources.
- Ensures optimum inventory.
- Coordinates activities of departments.
- Minimize wastage of raw materials.
- Improves the labour productivity.
- Helps to capture the market.
- Provides a better work environment.
- Facilitates quality improvement.
- Results in consumer satisfaction.
- Reduces the production costs.

### Effective utilization of resources

Production planning results in effective utilization of resources, plant capacity and equipment. This results in low-cost and high returns for the organization.

### Steady flow of production

Production planning ensures a regular and steady flow of production. Here, all the machines are put to maximum use. This results in a regular production, which helps to give a routine supply to customers.

### **Estimate the resources**

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

### **Ensures optimum inventory**

Production planning ensures optimum inventory. It prevents over-stocking and under-stocking. Necessary stocks are maintained. Stock of raw material is maintained at a proper level in order to meet the production demands. Stock of finished goods is also maintained to meet regular demands from customers.

### **Coordinates activities of departments**

Production planning helps to coordinate the activities of different departments. For e.g. the marketing department coordinates with production department to sell the goods. This results in profit to the organization.

### **Minimize wastage of raw materials**

Production planning minimizes wastage of raw materials. It ensures proper inventory of raw materials and materials handling. This helps to minimize wastage of raw material. It also ensures production of quality products or goods. This results in a minimum rejects. So proper production planning and control results in minimum wastage.

### **Improves the labour productivity**

Production planning improves the labour productivity. Here, there is maximum utilization of manpower. Training is provided to the workers. The profits are shared with the workers in form of increased wages and other incentives. Workers are motivated to perform their best. This results in improved labour efficiency.

### **Helps to capture the market**

Production planning helps to give delivery of goods to customers in time. This is because of regular flow of quality production. So the company can face competition effectively, and it can capture the market.

### **Provides a better work environment**

Production planning provides a better work environment to the workers. Workers get improved working conditions, proper working hours, leave and holidays, increased wages and other incentives. This is because the company is working very efficiently.

### **Facilitates quality improvement**

Production planning facilitates quality improvement because the production is checked regularly. Quality consciousness is developed among the employees through training, suggestion schemes, quality circles, etc.

### **Results in consumer satisfaction**

Production planning helps to give a regular supply of goods and services to the consumers at fair prices. It results in consumer satisfaction.

### **Reduces the production costs**

Production planning makes optimum utilization of resources, and it minimizes wastage. It also maintains optimum size of inventories. All this reduces the production costs.

#### **4.2.2 Characteristics**

Production planning and subsequent production control follow adaption of product design and finalization of a production process. Production planning and control address a fundamental problem of low productivity, inventory management and resource utilization. Production planning is required for scheduling, dispatch, inspection, quality management, inventory management, supply management and equipment management. Production control ensures that production team can achieve required production target, optimum utilization of resources, quality management and cost savings.

#### **4.2.3 Importance**

Production planning ensures materials, equipment and employees are all available to meet production goals for a business. It also provides a detailed plan on how a company will reach its production goals and how long it will take to achieve it, which can be useful for letting customers how long it will take before they can expect their orders. Production planning helps to maximize profits and make sure the needs of the customer are being met. Other advantages of production planning include eliminating wasted time by improving process flow, reducing inventory costs, optimizing equipment usage, using employees' time to the fullest advantage and improving the delivery time of products and services.

#### **4.2.4 Organization and Steps involved in production Planning**

Production planning is the lifeblood of any manufacturing company. It involves finding the delicate balance between satisfying customers and managing suppliers. A company can have a dynamic business model and waste hours of time and dollars on redundant processes. While no two production plans are alike, mapping out the process is a common way production engineers look for areas of opportunity.

#### **Map the Process**

From sales and marketing to research and development, the product cycle is the most critical process in a manufacturing firm. Sales and marketing need to know the timing of additional output, targets and estimated lead times for customized orders. Operations identifies the necessary resources and procurement finds the best prices. The result is an effective production plan with three major steps: buy at the lowest price for the best quality, produce the best quality using an optimal level of manpower, and sell materials at a higher price than cost. The better a manufacturing company is at these three things, the more successful it will be.

#### **Look for Value Opportunities**

Form a process engineering team to analyze and create process flow diagrams for all major processes in the production cycle. Look for common and/or redundant processes. Depending on the type of business, you may want to segment your product groups. Determine if certain product groupings are easier to forecast in terms of sales. See what trends you can find by looking at the data from different perspectives.

## Capacity Planning

Focus on capacity planning. This is the process of identifying resources. Capacity Planning, as a department, is usually the group that must create the balance discussed in the introduction. At some point, depending on your sales cycle, customer orders must be replaced with forecasts and accuracy becomes a primary concern. Determining capacity is a function of historical trends and information about production development cycles. Timing is critical since bottlenecks can have future effects and require additional manpower; that is, bottlenecks are not static. The right system will look for opportunities to extend both capacity and queue time. Creating this bubble can greatly increase operational flexibility and responsiveness to changes in the demand cycle.

### Check your progress 1

1. What is the need of production planning?
  - a. Effective utilization of resources.
  - b. Steady flow of production.
  - c. Estimate the resources.
  - d. All of these
2. What are the main steps of production planning?
  - a. Map the Process
  - b. Look for Value Opportunities
  - c. Capacity Planning
  - d. All of these

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## 4.3 Production Control

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Production control is mainly involved in implementing production schedules and is the corollary to short-term production planning or scheduling. Production control includes initiating production, dispatching items, progressing and then finally reporting back to production planning. In general terms, production planning means planning of the work to be done later and production control refers to working out or the implementation of the plan.

Production control is the process of planning production in advance of operations, establishing the exact route of each individual item part or assembly, setting, starting and finishing for each important item, assembly or the finishing production and releasing the necessary orders as well as initiating the necessary follow-up to have the smooth function of the enterprise. The production control is of complicated nature in small industries. The production planning and control department can function at its best in small scale unit only when the work manager, the purchase manager, the personnel manager and the financial controller assist in planning production activities. The production controller directly reports to the works manager but in small scale unit, all the three functions namely material control, planning and control are often performed by the entrepreneur himself. Production control starts with dispatching and ends up with corrective actions.

### 4.3.1 Objective

Production 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 production control system requires reliable information, sound organization structure, a high degree of standardization and trained personnel for its successful operation.

The success of an enterprise greatly depends on the performance of its production control department. The production control department generally has to perform the following functions :

- Provision of raw material, equipment, machines and labour.
- To organize production schedule in conformity with the demand forecasts.
- The resources are used in the best possible manner in such a way that the cost of production is minimized and delivery date is maintained.
- Determination of economic production runs with a view to reduce setup costs.
- Proper co-ordination of the operations of various sections/departments responsible for production.
- To ensure regular and timely supply of raw material at the desired place and of prescribed quality and quantity to avoid delays in production.
- To perform inspection of semi-finished and finished goods and use quality control techniques to ascertain that the produced items are of required specifications.
- It is also responsible for product design and development.

### 4.3.2 Advantage

Production control is a critical part of such programs, because it aims to remove waste from manufacturing processes through planning and organizing. Its many benefits can be discussed with production line workers and managers.

#### **Higher Product Quality**

Product quality directly impacts customer satisfaction, brand reputation and bottom-line profit. If customers purchase defective products, businesses may lose their customer base and future revenue-generating capability. Production control helps managers, line supervisors and employees catch defects before they reach the customer. Analyzing the captured defects helps to identify system errors that, once corrected, can lead to process improvement initiatives. Producing high-quality products is one of the most effective ways manufacturers can outperform their competition.

#### **Reduced Waste**

Over processing, scrap, rework and excess transport are a few of the wastes that can exist in a production facility. It is challenging to identify waste and remove it without using a standardized approach. Production control incorporates technical measurements and quality assurance principles to eradicate manufacturing

inefficiencies. Implemented properly, production control can improve production turnaround times. It can also enhance employee morale, because efficient operations make it easier to perform job duties.

### **Lower Operating Costs**

Production control makes it possible to lower the costs associated with poor quality. Scrap and other forms of waste can be tied back to general ledger expense accounts and assigned a dollar amount. This process helps leaders determine the costs associated with wasteful, inefficient operations. Overhead costs are a major determinant in a company's ability to compete in the marketplace; by removing waste, companies can gain market share and improve bottom-line profit.

### **Better Decision Making**

Without the right information, it is hard for operations managers to direct their personnel and monitor production systems. Quality tools such as control charts allow management to discern normal process variations from serious process deficiencies. Special causes of variation are attributable to flawed equipment, ineffective procedures or human error. Production control identifies system deficiencies, allowing management to make better decisions about operations.

### **4.3.3 Techniques and Functions**

Production control ensures usual and smooth flow of material and synchronizes different manufacturing operations through the methods of programming, Scheduling, dispatching, and progressing and inventory control.

#### **Production Programming :**

Reliable delivery to the customer : This depends on attainment of output target as per production programme and on quoting the customer achievable delivery dates. When delivery times are long, the annual production programme must be used, otherwise short term programme is to be used. To realize reliable delivery it is necessary that delivery promises should only be given if the production programme still contains unallocated products for the period concerned.

- Even loading of plant by ensuring production at an even rate throughout the year.
- Even loading of labour in total man-hours per week
- Well-organized use of capital: The production programmes are arranged such that minimum capital is attached in stocks.

#### **Scheduling :**

It refers to set time table for output indicating when each activity in proper sequence should take place. The purpose of preparing time table is to determine the time to be taken by each process of production. There are different types of schedules that include master schedule, operation schedule, and daily operation schedule.

In order to have control over schedules, the help of the production control chart is taken such as Gantt chart, bar chart load chart, man- machine chart (Singla, 2010).



**Dispatching :**

Dispatching is the practice of setting production activities in action through the discharge of order and instructions according to previously planned times and sequence embodied in route sheets and schedule charts. It considers each processing department one by one and plans the output from machines, tools and other work centres so as to complete the orders by due date. After ordering, next step is to bring together the inputs, that are plant, labour, special tools and material required for each production operation on each part and assembly. The concerned operators are issued required instructions. The decision of assigning different jobs to different machines is identified as Dispatching. It is one of the limited areas where the foreman still exercises his judgment within the framework of a well- developed production control system. A schedule usually sets general priorities on jobs and the date by which each job should leave an area but the foreman takes.

**Check your progress 2**

1. Which of the following statement is true about production control?
  - a. It is the planning of the work to be done later
  - b. It refers to working out or the implementation of the plan.
  - c. Both of these
  - d. None of these
2. What is dispatching?
  - a. It includes assigning different jobs to different machines
  - b. It refers to set time table for output indicating when each activity in proper sequence should take place
  - c. It depends on attainment of output target as per production programme and on quoting the customer achievable delivery dates
  - d. None of these

---

**4.4 Production Control & planning**

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Production planning and control can be defined as 'the process of planning or deciding on the resources the firm will require for its future manufacturing operations and of allocating and time scheduling these resources to produce the desired products on time at the least total cost.' Generally PPC is used in manufacturing organisations. But it can also be used in different non manufacturing units also. For example, we can use PPC in any restaurant to provide customer service more efficiently.

**4.4.1 Objective**

The ultimate objective of production planning and control, like that of all other manufacturing controls, is to contribute to the profits of the enterprise. Specific objectives of production planning and control are to establish routes and schedules for work that will ensure the optimum utilization of materials, workers, and machines and to provide the means for ensuring the operation of the plant in accordance with these plans.

1. To determine capacity of all manufacturing departments and to plan systematically coordinated and related production activities within the scope of the enterprise to meet sales requirements.
2. To translate orders received from sales department into orders on the works department and to ensure steady plans of production activities.
3. To find ways and means through which product manufacturing requirements such as materials and their necessary constituents such may be available in right quality and quantity at the right time.
4. To coordinate a number of different department groups so that a fine balance of activities may be maintained.
5. To promote fuller utilization of plants.
6. To assist labour towards right and greater earnings.
7. To train staff in the effective performance of their duties.

#### 4.4.2 Scope

PPC comprise the planning, routing, dispatching in the manufacturing process so that the movement of material, performance of machines and operation of labour however are subdivided and are directed and coordinated as to quantity, quality, time and place.

1. **Materials :** Materials should be made available at the right quality, right quantity, right price & right price. Inventory control & regular supply of materials should be guaranteed.
2. **Manpower :** It is important to carry out manpower planning to maintain operational & managerial staff possessing requisite skills & expertise.
3. **Methods :** It is always desirable to consider all the available alternatives & select the best method of processing. Simultaneously, to plan for tooling, jigs & fixtures & to determine the best sequence of operations.
4. **Machines & equipments :** The choices of manufacturing methods depend on available production facilities & utilization of plant, machines equipments.
5. **Routing :** The routing function specifies what work is to be done where & when it is to be performed.
6. **Estimating :** it involves establishing performance standard of each work after duly analyzing operation sheets. These sheets indicate feeds, speeds, depth of cuts, use of special attachments & methods.
7. **Loading & scheduling :** Loading & scheduling machines have to be made as per the production requirements. Machine loading generates accurate information on work standard, scrap allowances, machine-time requirements & machine capacities. Scheduling is a time-table for performing the job on the available machines so that delivery dates are maintained.
8. **Dispatching :** Dispatching is the release of orders & instructions to start production as per the route sheets & schedule charts.
9. **Expediting :** It refers to follow-up which is done after the dispatching function.

10. **Inspection** : It is related to maintenance of quality in production & processes, methods labour so that improvements can be made to achieve the quality standards.
11. **Evaluating** : It provides a feedback mechanism on a long term basis so that past experience can be used to improve upon use of methods, facilities & resources in future period.
12. **Cost control** : In manufacturing products, costs can be kept within control through wastage reduction, value analysis, inventory control & efficient use of resources.

#### 4.4.3 Phase

Production planning and control has three phases.

1. Planning Phase
2. Action Phase
3. Control Phase

#### **Planning phase :**

It is a phase that practice intelligent anticipation to establish an objective to fulfill where outcome of planning is either dropping the whole idea or the formulation of a new plan in-line with the objective. Production planning determines the optimal schedule and sequence of operations, economic batch quantity, machine assignment and dispatching priorities for sequencing.

#### **Action phase :**

Action phase directly deals with dispatching. Dispatching is the transition from planning phase to action phase. The employee is ordered to start manufacturing the product. The tasks that are included in dispatching are: job order, store issue order, tool order, time ticket, inspection order, move order etc.

#### **Control phase :**

Control phase includes (a) progress reporting & (b) corrective action. Progress reporting helps to make comparison with the present level of performance. Corrective action makes provisions for an unexpected event e.g., capacity modifications, schedule modifications etc.

#### 4.4.4 Benefits

Following are the advantages of using PPC in any plant :

- PPC forecasts sales orders and makes sales order more economical in production.
- It co-ordinates the operations of several departments.
- It ensures better service to customers by delivering quality goods within the specified time period.
- Reduces production costs through orderly scheduling of work activities and reducing wastages.
- Reduces employee idle time.
- Ensures a better control of material and contributes to efficient buying.

#### 4.4.5 Limitation

Production planning and control has certain limitations :

- Time consuming
- Costly
- Changes in situation makes planning ineffective
- Internal inflexibility: psychological, policy, capital
- External in flexibilities: Political climate, trade unions, technological changes.

#### 4.4.6 Techniques

It should be obvious that there is no single pattern for the organization of the production planning and control activity. In many small plants the routing, loading, and scheduling functions may well be included in the duties of the operating line; the shop manager, superintended, and foremen. But it is difficult to combine day-to-day work with adequate planning, and as a result it is often more feasible to break away the production planning and control functions and assign them to qualified specialists. These groups should be organized as staff sections normally reporting to the top manufacturing executive.

##### **Centralized Production Planning and Control**

Centralization or decentralization of duties of the production control staff depends upon the design of the production planning and control system. In a completely centralized setup, determination of shipping promises; analysis of sales, stock, and shop orders; preparation of routes, load charts, and schedule charts; and dispatching of work to the shop complete with job tickets and all other necessary paper would be accomplished by a central production planning and control unit. In addition, as work is completed, a careful analysis of the actual performance would be made, and if corrective action were required, it would be initiated by this group.

##### **Decentralized Production Planning and Control**

We have discussed at great length that no matter how general the planning may be in a central office, the plan must eventually be developed into a detailed plan on the shop floor. Some companies are now endeavoring to make each foreman a manager of his own departmental operation. In these cases the foreman is furnished with a complete staff for the production planning and control of the activities in the department.

##### **Planning Phase**

We have already indicated in some details the duties involved in the production planning phase. Working from the basic data mentioned earlier, the personnel in this part of the activity routes and load and schedule charts.

##### **Control Phase**

The completed job ticket, or its equivalent, is the key to this phase of the production planning and control system. It is the means of reporting back from the shop floor that indicates that a job is completed; or if daily job tickets are turned in, the daily progress of a job can be determined.

**Check your progress 3**

1. Which of the following production planning and control phase directly deals with dispatching?
  - a. Planning phase
  - b. Action phase
  - c. Control phase
  - d. None of these
2. Which of the following is the advantage of PPC?
  - a. Costly
  - b. Internal inflexibility
  - c. It ensures better service to customers by delivering quality goods within the specified time period
  - d. None of these

---

**4.5 Network Analysis**

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Network analysis is the general name given to certain specific techniques which can be used for the planning, management and control of projects. Network analysis is a vital technique in PROJECT MANAGEMENT. It enables us to take a systematic quantitative structured approach to the problem of managing a project through to successful completion. Network Analysis is a generic name which is becoming accepted as a standard term for a number of specialised techniques in the field of planning and control, principally critical-path scheduling, PERT (Programme Evaluation and Review Technique), RAMPS (Resource Allocation in Multi-Project Scheduling) and CPM (Critical Path Method). There are four stages of work involved in network analysis:

- Arranging the individual jobs of the project in a logical network;
- Identifying the critical jobs i.e. the jobs that control the completion date of the overall project;
- Allocating resources (staff, machinery, materials etc.) to individual jobs to optimise the performance of the whole system in terms of cost and duration;
- Monitoring progress and re-allocating resources as necessary to achieve stated aims such as maintaining a planned completion date or maintaining a cost ceiling.

**Check your progress 4**

1. What is Network Analysis ?
  - a. It is the general name given to certain specific techniques which can be used for the planning, management and control of projects
  - b. It is used to the critical jobs i.e. the jobs that control the completion date of the overall project;
  - c. It enables us to take a systematic quantitative structured approach to the problem of managing a project
  - d. All of these

2. What is PERT ?
  - a. Programme Evaluation and Review Technique
  - b. Program execution and Review Technique
  - c. Program execution and resource Technique
  - d. None of these

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#### 4.6 Let Us Sum Up

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In this unit we have learnt that production process is planned and scheduled and ultimately implemented in a production unit.

We see that Production planning and control is essential for an organisation as it involves planning of production, decision on sequence of operations to get proper planning, setting of starting and finishing time for production, proper dispatching of the material, and follow up action to check the progress of operations.

Production control is implementing production schedules which is corollary to short-term production planning or scheduling which includes initiating production, dispatching items, progressing and reporting.

Production planning and control is a process of planning or deciding on resources where the firm needs for future manufacturing operations and allocating time scheduling to produce desired products on time at the least total cost.

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#### 4.7 Answer for Check Your Progress

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##### Check your progress 1

Answers: (1-d), (2-d)

##### Check your progress 2

Answers: (1-b), (2-a)

##### Check your progress 3

Answers: (1-b), (2-c)

##### Check your progress 4

Answers: (1-d), (2-a)

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#### 4.8 Glossary

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1. **Production capacity** : It is the ability to produced goods in terms of units
2. **Handling cost** : It is the cost of carrying material or storage cost.
3. **Overhead cost** : It is an operating costs of business enterprise that are not directly traced to particular unit of product

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#### 4.9 Assignment

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Write any two advantages of PPC.

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#### 4.10 Activities

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Collect information on different elements of PPC.

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#### **4.11 Case Study**

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Do you think the follow up stage is important in any production plan? If yes, explain your comment.

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#### **4.12 Further Readings**

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1. Morgan, Mechanization Takes Command in ?Images of Organizations, Sage Press, 1986.
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## **Block Summary**

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This block give detailed information about objective, scope, phase, benefits and limitation about product planning and control. The block explained more about Materials Handling and Equipments for future use. The knowledge about difference among Production and Operations Management are well detailed.

After studying this block, students understand correctly about Factors Affecting Plant Layout. The concept of Production and Operations Management gives knowledge to student which will help them know to compare about various management tools needed.



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**Block Assignment**

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**Short Answer Questions**

1. What do you mean by locational analysis ?
2. What is production control ?
3. What is the importance of location in business ?
4. Write about any two types of plant layout
5. What are the various factors influencing the layout of Hospital ?

**Long Answer Questions**

1. What do you mean by Production planning and control ?
2. Describe the factors that should be taken into account in deciding the location of plant ?
3. Distinguish between product layout and process layout ?

**Enrolment No. :**

1. How many hours did you need for studying the units?

Unit No    1    2    3    4

Nos of Hrs

2. Please give your reactions to the following items based on your reading of the block :

Items	Excellent	Very Good	Good	Poor	Give specific example if any
Presentation Quality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Language and Style	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Illustration used (Diagram, tables etc)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Conceptual Clarity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Check your progress Quest	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Feed back to CYP Question	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____

3. Any Other Comments

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**Dr. Babasaheb  
Ambedkar  
OpenUniversity**

**BBAR-404**

# **PRODUCTION AND OPERATION MANAGEMENT**

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## **BLOCK 2 QUALITY CONTROL AND MATERIALS AND MAINTENANCE MANAGEMENT**

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### **UNIT 1**

QUALITY CONTROL

### **UNIT 2**

CONCEPT OF WASTE AND QUALITY ASSURANCE

### **UNIT 3**

MATERIAL MANAGEMENT

### **UNIT 4**

MAINTENANCE MANAGEMENT

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## BLOCK 2 QUALITY CONTROL AND MATERIALS AND MAINTENANCE MANAGEMENT

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### Block Introduction

Quality assurance and control are ways which will make sure about the quality of a service or product. They aim to prevent defects with focus on process that are applied to create certain product. The objective of Quality assurance is to enhance the development and testing processes for certain product in order to safe guard from defects that occur when product is being developed.

In this block, students will get knowledge about Concepts of Quality Management with knowledge about its constituents and components. The concept and working of Quality Assurance: ISO 9000 are well explained with features and characteristics. The block will detail about various features and different concepts related to Purchase Management which help students to know about the role of Purchase Manager. The knowledge about product quality and enhancement are explained.

After studying this block, students will be able to understand correctly about Maintenance Management, and how various tools are associated with it. The concepts of product replacement policies make them to aware about rules in which the product maintenance be done which will help them know about various criteria's.

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### Block Objective

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**After completing this block, students will be able to :**

- Understand the concept of Quality Control
- Understand the concept of Waste and Quality Assurance
- Study about Material Management
- Know about the challenges of Quality Assurance: ISO 9000
- Understand different tools of Quality Control
- Understand the concept of supply chain management
- Understand the concept of Maintenance Management

### Block Structure

<b>Unit 1</b>	Quality Control
<b>Unit 2</b>	Concept of Waste and Quality Assurance
<b>Unit 3</b>	Material Management
<b>Unit 4</b>	Maintenance Management



**: UNIT STRUCTURE :**

- 1.1 Introduction**
- 1.2 Concepts of Quality Management**
- 1.3 Inspection and Testing**
- 1.4 Quality Control**
- 1.5 Objectives of Quality Control**
- 1.6 Benefits of Quality Control**
- 1.7 Difference between Inspection and Quality Control**
- 1.8 Seven tools for Quality Control**
- 1.9 Control Charts**
- 1.10 Acceptance Sampling**
- 1.11 Let Us Sum Up**
- 1.12 Answer for Check Your Progress**
- 1.13 Glossary**
- 1.14 Assignment**
- 1.15 Activities**
- 1.16 Case Study**
- 1.17 Further Readings**

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**1.0 Learning Objectives**

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**After reading this Unit, you will be able to :**

- Understand the concept of Quality Control
- Inspection and Testing
- Understand the Seven tools for Quality Control
- Understand the Control charts and its usage

---

**1.1 Introduction**

---

Quality assurance and quality control are often used interchangeably to refer to ways of ensuring the quality of a service or product. Quality Assurance is a set of activities for ensuring quality in the processes by which products are developed. It aims to prevent defects with a focus on the process used to make the product. It is a proactive quality process. The goal of QA is to improve development and test processes so that defects do not arise when the product is being developed.

Quality Control is a set of activities for ensuring quality in products. The activities focus on identifying defects in the actual products produced. It aims to identify (and correct) defects in the finished product. Quality control, therefore, is a reactive process. The goal of QC is to identify defects after a product is developed and before it's released.

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## 1.2 Concepts of Quality Management

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The idea of “quality” as an important feature of the production of goods and the provision of services has led to its being an important factor in the management of companies and other organisations. The procedures are divided into “quality assurance”, the steps which need to be taken to produce goods or provide services of high quality; and “quality control”, the procedures devised to check that the aimed for or promised quality is achieved.

The concept of quality management is also applied to the provision of services as well as the production of goods. Since these are not tangible in the same way as goods, the idea of customer satisfaction has been introduced and quality has been equated with this – slogans such as “quality means meeting customer expectations” or “quality means exceeding customer expectations” have been used. In the provision of services the “contract” between the provider and the consumer of services is a relational one and the quality of the service is often defined through the keeping of promises which are expressed in the form of “customer charters” or service guarantees. For example, a railway promises that if its trains do not arrive within x minutes or the announced time the customers will have part of their fare re–imbursed; or a hotel chain will give guarantees about the speed or range of services provided.

Quality Management is the assembly and management of all activities aimed at the production of quality by organizations of various kinds. In the present case this implies the introduction and proper running of a “Quality System” in laboratories. A statement of objectives and policy to produce quality should be made for the organization or department concerned. This statement also identifies the internal organization and responsibilities for the effective operation of the Quality System.

### Check your progress 1

1. What is meant by quality control ?
  - a. It is a set of activities for ensuring quality in products.
  - b. It a set of activities for ensuring quality in the processes by which products are developed.
  - c. Both A and B
  - d. None of these

---

## 1.3 Inspection and Testing

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The term “inspection” generally refers to the activity of checking products, whereas “audit” applies to analyzing manufacturing processes and organizations. The quality inspector usually follows a pre–established checklist that is based on the product specifications. Inspected products can be the components used for production, semi–finished goods, or (most often) finished goods before shipment to a customer.

The ISO 2859 standard defines an inspection as an “activity such as measuring, examining, testing or gauging one or more characteristics of a product or service, and comparing the results with specified requirements in order to establish whether conformity is achieved for each characteristic”.

Industrial activities which ensure that manufactured products, individual components, and multicomponent systems are adequate for their intended purpose. Inspection and testing are the operational parts of quality control, which is the most important factor to the survival of any manufacturing company. Quality control directly supports the other factors of cost, productivity, on-time delivery, and market share. Therefore, all quality standards needed to produce the components of a product and perform its assembly must be specified in a manner such that customers' expectations are met. Global competitive pressures force manufacturing companies to become more customer-oriented and focused in terms of offering higher-quality products and services. Inspection and testing are performed before, during, and after manufacturing to ensure that the quality level of the product is within acceptable design standards.

Whereas inspection is the activity of examining the product or its components to determine if they meet the design standards, testing is a procedure in which the item is observed during operation in order to determine whether it functions properly for a reasonable period of time.

### Check your progress 2

1. The activity of analyzing manufacturing processes and organizations is called as
  - a. Inspection
  - b. Audit
  - c. Both of these
  - d. None of these
2. Quality control directly supports other factors like
  - a. Cost
  - b. Productivity
  - c. On-time delivery
  - d. All of these

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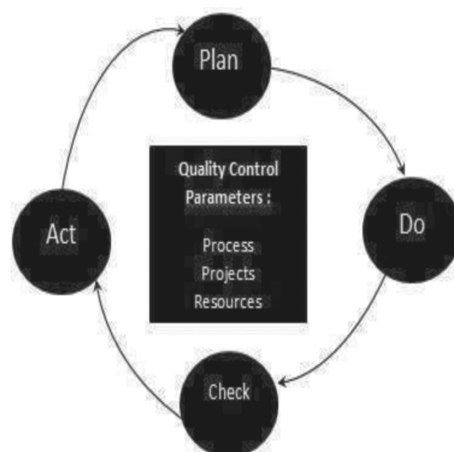
## 1.4 Quality Control

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Quality control is a set of methods used by organizations to achieve quality parameters or quality goals and continually improve the organization's ability to ensure that a software product will meet quality goals.

The three class parameters that control software quality are :

- Products
- Processes
- Resources



**Fig 1.1 Quality Control Process**

The quality control process consists of:

- Plan – It is the stage where the Quality control processes are planned
- Do – Use a defined parameter to develop the quality
- Check – Stage to verify if the quality of the parameters are met
- Act – Take corrective action if needed and repeat the work

Quality control (QC) is a procedure or set of procedures intended to ensure that a manufactured product or performed service adheres to a defined set of quality criteria or meets the requirements of the client or customer.

QC is similar to, but not identical with, quality assurance (QA). QA is defined as a procedure or set of procedures intended to ensure that a product or service under development (before work is complete, as opposed to afterwards) meets specified requirements. QA is sometimes expressed together with QC as a single expression, quality assurance and control (QA/QC).

### Check your progress 3

1. What are the parameters that control software quality?
  - a. Products
  - b. Processes
  - c. Resources
  - d. All of these
2. The quality control process consists of .
  - a. Plan
  - b. Do
  - c. Check
  - d. All of these

---

### 1.5 Objectives of Quality Control

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Following are the objectives of Quality Control :

- (1) To reduce cost by reducing losses due to defects.
- (2) To produce products at optimal quality at reduced cost.
- (3) To make inspection prompt to ensure quality control.
- (4) To check for the deviations in production.
- (5) To make sure customers are satisfied with products or services.

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### 1.6 Benefits of Quality Control

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- Improving the quality of products or services.
- Reducing manufacturing and corporate cost.
- Reducing price of products and services.
- Assuring on time deliveries and availability of products.
- Improving the marketability of products and services.
- Increasing the efficiency and productivity of manufacturing process.

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### 1.7 Difference between Inspection and Quality Control

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Quality inspection or Quality Assurance is a set of activities for ensuring quality in the processes by which products are developed. Moreover quality assurance is defined as all the planned and systematic activities implemented within the quality system that can be demonstrated to provide confidence that a product or service will fulfill requirements for quality.

- (1) **Based on :** The quality inspection aims to prevent defects with a focus on the process used to make the product. It is a proactive quality process.
- (2) **The aim :** The goal of quality assurance is to improve development and test processes so that defects do not arise when the product is being developed.
- (3) **How :** Quality Inspection process establish a good quality management system and the assessment of its adequacy. Periodic conformance audits of the operations of the system.
- (4) **What :** Prevention of quality problems through planned and systematic activities including documentation. Everyone on the team involved in developing the product is responsible for quality assurance.

**Type of tool: it's a managerial tool**

Quality control is a set of activities for ensuring quality in products. The activities focus on identifying defects in the actual products produced. Moreover quality control is defined like “The operational techniques and activities used to fulfill requirements for quality”.

- (1) **Based on :** The quality inspection aims to identify (and correct) defects in the finished product. Quality control is a reactive process.
- (2) **The aim :** The goal of quality control is to identify defects after a product is developed and before it's released.
- (3) **How :** Quality Control process finds and eliminates sources of quality problems through tools and equipment so that customer's requirements are continually met.
- (4) **What :** The activities or techniques used to achieve and maintain the product quality, process and service.
- (5) **Type of tool :** It's a corrective tool.

---

**1.8 Seven Tools for Quality Control**

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To make rational decisions using data obtained on the product or process or from the customers, organization uses certain graphical tools. These tools are known as seven quality control tools.

- (1) **Check Sheet :** A Check Sheet is a simple document that is used for collecting data in real time and at the location where data is generated. How often certain events are happening can be known with the help of check sheet.
- (2) **Cause and Effect Diagram (Ishikawa) :** It shows the relationship of all factors (causes) that lead to the given situation (effect). It identifies major causes and breaks them into sub causes and further sub division if possible. It is usually preceded by cause and effect analysis. It is also known as fishbone diagram.
- (3) **Flow Chart :** It is a type of diagram that represents a process step by step with the help of various kind of box shapes and connecting these with arrows. It gives visual representation of process. It also helps to identify the steps and materials needed for the process.



- (4) **Pareto Analysis** : A bar chart that helps to prioritize actions by arranging elements in descending order of occurrence. It separates important from non-important causes contributing to a problem.
- (5) **Scatter Diagram** : Scatter diagram is a tool used to study the possible relationship between two variables. Diagram makes it clear whether a relationship exists and shows the strength of that relationship.
- (6) **Histogram** : A Histogram displays the variation within the process, also called a frequency distribution because the frequency of occurrence of any given value is represented by the height of the bars. It allows quickly to visualize what's going on within a large amount of data.
- (7) **Control Chart** : It is a line graph used to display variation on time ordered interval. It indicates whether a process is in control or not. It ensures product quality level.

#### Check your progress 4

1. Quality assurance is a tool.
  - a. Corrective
  - b. Managerial
  - c. Both of these
  - d. None of these
2. What is the aim of quality control?
  - a. To identify defects after a product is developed and before it's released.
  - b. to improve development and test processes so that defects do not arise when the product is being developed
  - c. Both of these
  - d. None of these

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### 1.9 Control Charts

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The control chart is a graph used to study how a process changes over time. Data are plotted in time order. A control chart always has a central line for the average, an upper line for the upper control limit and a lower line for the lower control limit. These lines are determined from historical data. By comparing current data to these lines, you can draw conclusions about whether the process variation is consistent (in control) or is unpredictable (out of control, affected by special causes of variation).

Control charts for variable data are used in pairs. The top chart monitors the average, or the centering of the distribution of data from the process. The bottom chart monitors the range, or the width of the distribution. If your data were shots in target practice, the average is where the shots are clustering, and the range is how tightly they are clustered. Control charts for attribute data are used singly.

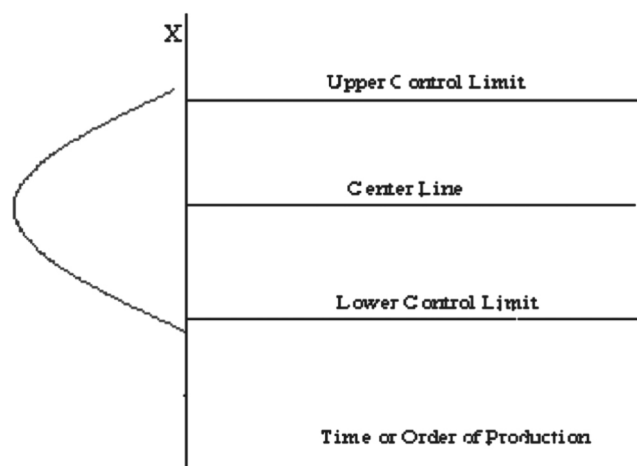
#### When to Use a Control Chart

- When controlling ongoing processes by finding and correcting problems as they occur.
- When predicting the expected range of outcomes from a process.

- When determining whether a process is stable (in statistical control).
- When analyzing patterns of process variation from special causes (non-routine events) or common causes (built into the process).
- When determining whether your quality improvement project should aim to prevent specific problems or to make fundamental changes to the process.

If a single quality characteristic has been measured or computed from a sample, the control chart shows the value of the quality characteristic versus the sample number or versus time. In general, the chart contains a center line that represents the mean value for the in-control process. Two other horizontal lines, called the upper control limit (UCL) and the lower control limit (LCL), are also shown on the chart. These control limits are chosen so that almost all of the data points will fall within these limits as long as the process remains in-control. The figure below illustrates this.

### Theoretical Basis for a Control Chart



**Fig 1.2 Control Chart**

### Elements of a Control Chart

There are three main elements of a control chart.

- A control chart begins with a time series graph.
- A central line ( $\bar{X}$ ) is added as a visual reference for detecting shifts or trends
- Upper and lower control limits (UCL and LCL) are computed from available data and placed equidistant from the central line. This is also referred to as process dispersion.

Control limits (CLs) ensure time is not wasted looking for unnecessary trouble – the goal of any process improvement practitioner should be to only take action when warranted. Control limits are calculated by :

- Estimating the standard deviation,  $\sigma$ , of the sample data
- Multiplying that number by three
- Adding ( $3\sigma$  to the average) for the UCL and subtracting ( $3\sigma$  from the average) for the LCL

### Check your progress 5

1. What is control chart?
  - a. It is used to control product quality
  - b. The control chart is a graph used to study how a process changes over time.
  - c. Both A and B
  - d. None of these
2. When we should use control charts?
  - a. When controlling ongoing processes by finding and correcting problems as they occur.
  - b. When predicting the expected range of outcomes from a process.
  - c. When determining whether a process is stable
  - d. All of these

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### 1.10 Acceptance Sampling

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In quality control, the statistical procedure employed in determining whether to accept or reject a production batch. If the proportion of the units having a certain negative characteristic exceeds the acceptable limit for a given batch, it is rejected.

Two types of acceptance sampling are :

- (1) Attributes sampling, in which the presence or absence of a characteristic in the inspected item is only taken note of.
- (2) Variable sampling, in which the presence or absence of a characteristic in the inspected item is measured on a predetermined scale.

It is an important component of quality control and is useful when the cost of testing is high compared to the cost of passing a defective item or when testing is destructive. It is a compromise between doing 100% inspection and no inspection at all. Acceptance sampling can be done on attributes or measurements of the product.

Acceptance sampling is an approach to sampling a lot to determine the proper disposition of that lot. The lot disposition is determined by inspecting an appropriately sized random sample from the lot. Because acceptance sampling is a statistically valid process, the probability of wrongly accepting a defective lot (Type II error) or wrongly rejecting an acceptable lot (Type I error) can be estimated for each sampling plan using the operating characteristics (OC) curve.

In many a manufacturing process the producer in order to ensure that the manufactured goods are according to specifications of the consumer, gets his lot checked at strategic stages. On the other hand, the consumer is anxious to satisfy himself about the quality of goods he accepts. An ideal way of doing this seems to inspect each and every item presented for acceptance i.e., to resort to 100% inspection. Cent percent inspection should be resorted under the following conditions.

The occurrence of a defect may cause loss of life or serious casualty to personnel.

A defect may cause serious malfunction of the equipment. 100% inspection may also be resorted when (i) the lot size is small, and (ii) the incoming quality is poor or unknown.

If testing is destructive, as for instance in the case of crackers, shells, bulbs etc., it is absolutely non-sense to talk of cent percent inspection. Even in these cases where 100% inspection is possible, it may not be desirable because

- a) It is costly and time consuming and
- b) Due to fatigue, impossibility of proper check and variations in efficiencies of inspection in time, persons, and place, however careful one may be, the inspection lot is likely to contain a small number percentage of defective items.

Acceptance sample is a rather limited method of ensuring good quality :

- It is too far downstream in the production process; we want a method which identifies where things are going wrong.
- It is 0/1 (i.e. defective/OK) and so does not make efficient use of data; we have seen that large samples are required. It is better to have quality measurements on a continuous scale; there will be an earlier warning of deteriorating quality and less need for large sample sizes.

### Check your progress 6

1. What are the types of acceptance sampling?
  - a. Attributes sampling
  - b. Variable sampling
  - c. Both of these
  - d. None of these
2. What is attributes sampling?
  - a. It is an approach to sampling a lot to determine the proper disposition of that lot.
  - b. It is the sampling in which the presence or absence of a characteristic in the inspected item is only taken note of.
  - c. It is the sampling in which the presence or absence of a characteristic in the inspected item is measured on a predetermined scale.
  - d. None of these

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### 1.11 Let Us Sum Up

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In this unit we have learnt that Quality Control are set of activities that ensures quality in products which focus on finding defects in actual products produced.

We see that Quality Management serves as assembly which aims at production of quality by organizations of various kinds.

Inspection refers to activity of checking products while audit analyze manufacturing processes and organizations.

Quality inspection is a set of activities that ensures quality in processes by which products are developed which are planned and systematic in quality system which can be shown to provide confidence about product or services.

We noted that control chart is a graph that studies about process change over time by plotting of data with respect to time.

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### 1.12 Answer for Check Your Progress

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#### Check your progress 1

Answers: (1–a)

#### Check your progress 2

Answers: (1–b), (2–d)

#### Check your progress 3

Answers: (1–d), (2–d)

#### Check your progress 4

Answers: (1–b), (2–a)

#### Check your progress 5

Answers: (1–b), (2–d)

#### Check your progress 6

Answers: (1–c), (2–b)

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### 1.13 Glossary

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1. **Quality Control** – Activities to check quality of a product.
2. **Quality Management** – Relates to management of activities concerning production quality.
3. **Inspection** – An activity of checking products.

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### 1.14 Assignment

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Write a detailed note on seven tools of quality control.

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### 1.15 Activities

---

Collect information on Quality control methods.

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### 1.16 Case Study

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Discuss about control chart in details.

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### 1.17 Further Readings

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1. Sower, J. Motwani, & M. Savoie. “Acceptance Sampling and Statistical Process Control” Quality Progress, 1993.



## CONCEPT OF WASTE AND QUALITY ASSURANCE

### UNIT STRUCTURE:

- 2.0 Learning Objective
- 2.1 Introduction
- 2.2 Types of Waste
- 2.3 Concept of Quality Assurance
- 2.4 ISO 9000
- 2.5 Total Quality Management (TQM)
- 2.6 Six Sigma
- 2.7 Gap Analysis
- 2.8 Difference between Quality Control and Quality Assurance
- 2.9 Let Us Sum Up
- 2.10 Answer for Check Your Progress
- 2.11 Glossary
- 2.12 Assignment
- 2.13 Activities
- 2.14 Case Study
- 2.15 Further Readings

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### 2.0 Learning Objectives

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After reading this Unit, you will be able to :

- Understand meaning of waste
- Understand meaning of quality assurance
- Understand how quality assurance is different from quality control
- Understand different tools of quality assurance

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### 2.1 Introduction

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The industrial waste and scrap consists of spoiled raw-materials, rejected components, defective parts, waste from production departments etc. involves some commercial values. They should be disposed of periodically and proper credit of the amount should be taken in the books of accounts. Hence, waste management places an important role in managing operations. Waste can be categorized into obsolete, surplus and scrap items. Obsolete items are those materials and equipments which are not damaged and which have economic worth but which are no longer useful for company's operation owing to many reason such as, changes in product line, process, materials and so on. Surplus items are those materials and equipments which have no immediate use but have accumulated due to faulty planning. Scrap is process wastage such as, turning, borings, sprues and flashes.

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## 2.2 Types of Waste

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- (1) **Defects** : It is one of the most visible examples of waste. Defects refer to any product or service that doesn't meet commercial specifications and must be discarded or fixed via additional resources.
- (2) **Overproduction** : It occurs when you produce more product that is required by customers. Companies tend to make the mistake of producing a product in large batches. Over production leads to additional expenditure on storage space and preservation.
- (3) **Transportation** : It involves the unnecessary movement of product or raw material that doesn't add value. It only adds cost and time to product. Work space should be organized in such a way to reduce such type of waste.
- (4) **Inventory** : It occurs when a product or material is waiting to be sold. This is often the result of poor monitoring systems and misunderstood customer needs. The difference between inventory waste and overproduction waste is that inventory is material or product that has value but is not moving fast enough to meet customer demand.
- (5) **Extra Processing** : It involves performing work on a product that does not conform to the customers' expectations. This occurs when a company doesn't know the requirement of customer. Concept of going extra mile should not be confused with extra processing which does not add any value to the customer.

### Check your progress 1

1. Unnecessary movement of raw material or product is known as which type of waste?
  - a. Inventory
  - b. Transportation
  - c. Overproduction
  - d. All of these

---

## 2.3 Concept of Quality Assurance

---

Quality Assurance is subset of quality management which gives confidence that desired level of quality requirement is fulfilled by giving attention to every minute details at every stage of process of production or delivery. Different tools are invented to ensure the quality is in takt. People do not make mistakes on their own every time. There are high chances that process is faulty that led people to make mistakes. Quality assurance makes process smooth so that mistakes can be reduced or nullified from the process. Quality assurance does not deal with check system of products that produced units are defective or not or what to do with defective products or how to reduce number of defective products in a lot. It deals with how the whole system (process) should be engineered that mitigates chances of committing mistakes. The term quality assurance is more useful in context of service rather than product.

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## 2.4 ISO 9000

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ISO 9000 is a series of standards, developed and published by the International Organization for Standardization (ISO), that define, establish, and maintain an effective quality assurance system for manufacturing and service industries. The ISO 9000 standard is the most widely known and has perhaps had

the most impact of the 13,000 standards published by the ISO. It serves many different industries and organizations as a guide to quality products, service, and management.

ISO 9001 certification is suitable for all sizes and types of organisations and is well established around the world as an invaluable Quality Management System standard. It is suitable for organisations in all industry sectors and will help your organisation to improve management processes to compete locally and/or globally.

The process encompasses the entire organisation and requires senior management buy-in, it is not just a function of the Quality Department. To achieve

- Continually improve, streamline operations and reduce costs
- Win more business and compete in tenders
- Satisfy more customers
- Be more resilient and build a sustainable business
- Show you have strong corporate governance
- Work effectively with stakeholders and your supply chain

ISO 9001 certification your organisation needs to demonstrate that it can meet the regulatory requirements and apply the system effectively to be of real benefit to your customers.

ISO 9001 is the internationally recognized Quality Management System (QMS) standard that can benefit any size organization. Designed to be a powerful business improvement tool, ISO 9001 Quality Management certification can help you to :

- Continually improve, streamline operations and reduce costs
- Win more business and compete in tenders
- Satisfy more customers
- Be more resilient and build a sustainable business
- Show you have strong corporate governance
- Work effectively with stakeholders and your supply chain

### **Check your progress 2**

1. What are the use of quality management certifications ?
  - a. To Continuously improve, streamline operations and reduce costs
  - b. To make strong corporate governance
  - c. To Work effectively with stakeholders and your supply chain
  - d. All of these

---

## **2.5 Total Quality Management (TQM)**

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Total Quality Management is a management approach that originated in the 1950s and has steadily become more popular since the early 1980s. Total Quality is a description of the culture, attitude and organization of a company that strives to provide customers with products and services that satisfy their needs. The culture requires quality in all aspects of the company's operations, with processes being done right the first time and defects and waste eradicated from operations.



## QUALITY CONTROL AND MATERIALS AND MAINTENANCE MANAGEMENT

Total Quality Management, TQM, is a method by which management and employees can become involved in the continuous improvement of the production of goods and services. It is a combination of quality and management tools aimed at increasing business and reducing losses due to wasteful practices.

TQM views an organization as a collection of processes. It maintains that organizations must strive to continuously improve these processes by incorporating the knowledge and experiences of workers. The simple objective of TQM is “Do the right things, right the first time, every time.” TQM is infinitely variable and adaptable. Although originally applied to manufacturing operations, and for a number of years only used in that area, TQM is now becoming recognized as a generic management tool, just as applicable in service and public sector organizations. There are a number of evolutionary strands, with different sectors creating their own versions from the common ancestor. TQM is the foundation for activities, which include :

- Commitment by senior management and all employees
- Meeting customer requirements
- Reducing development cycle times
- Just in time/demand flow manufacturing
- Improvement teams
- Reducing product and service costs
- Systems to facilitate improvement
- Line management ownership
- Employee involvement and empowerment
- Recognition and celebration
- Challenging quantified goals and benchmarking
- Focus on processes / improvement plans
- Specific incorporation in strategic planning

Total Quality management can be divided into four categories :

1. Plan
2. Do
3. Check
4. Act

### **Planning Phase**

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

### Doing Phase

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

### Checking Phase

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

### Acting Phase

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

### Check your progress 3

1. TQM includes activities like
  - a. Line management ownership
  - b. Employee involvement and empowerment
  - c. Recognition and celebration
  - d. All of these
2. How many categories does TQM have?
  - a. Two
  - b. Three
  - c. Four
  - d. Six

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## 2.6 Six Sigma

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Six Sigma ( $6\sigma$ ) is a set of techniques and tools for process improvement. The specific value of 6 Sigma is a benchmark for process excellence.

The “Sigma Level” of a process can be used to express its capability means how well it performs with respect to customer requirements.

Sigma ( $\sigma$ ) is a statistical symbol for standard deviation which measures variability. The term six sigma originated from statistical modelling of manufacturing process. Statistically, six sigma means only 3.4 defects per million.

Six Sigma action takes part in following:

- (1) Improvement of customer satisfaction level
- (2) Reduction of errors and
- (3) Reduction of cycle time.

Most people presumed that level of quality is attached with the technology. Customer satisfaction and quality management may not have any relation with technology. Consider the case of Mumbai Dabbawala who have achieved customer service excellence of six sigma quality without using tech.

The fundamental objective of the Six Sigma methodology is the implementation of a measurement-based strategy that focuses on process improvement and variation reduction through the application of Six Sigma improvement projects. This is accomplished through the use of two Six Sigma sub-methodologies: DMAIC and DMADV. The Six Sigma DMAIC process (define, measure, analyze, improve, control) is an improvement system for existing processes falling below specification and looking for incremental improvement.

The Six Sigma DMADV process (define, measure, analyze, design, verify) is an improvement system used to develop new processes or products at Six Sigma quality levels. It can also be employed if a current process requires more than just incremental improvement. Both Six Sigma processes are executed by Six Sigma Green Belts and Six Sigma Black Belts, and are overseen by Six Sigma Master Black Belts.

### **Six Sigma Certifications**

To be efficient members of Six Sigma project team, quality management professionals need to obtain one or more Six Sigma certifications. This opens the doors to Six Sigma infrastructure of experts in Six Sigma methods. There are 5 levels of Six Sigma certifications :

- Lean Six Sigma Black Belt
- Lean Six Sigma Green Belt
- Lean Six Sigma Master Black Belt
- Lean Six Sigma Yellow Belt
- Six Sigma Lean & DFSS

Six Sigma Black Belt certification (usually help by CEOs and other top managers in the manufacturing industry) validates the knowledge and capabilities of using statistical analysis software programs to streamline the processes, improve delivery timelines and bring down costs. Six Sigma Black Belt credential holders can carry out projects that target process and quality improvement, and supervise other Six Sigma professionals. Six Sigma Black belt credential also certifies the skills required for leading and managing DMAIC process (one of Six Sigma business process methodologies), as well as comprehensive product design.

Six Sigma Green Belt credential and certification validate the holder's knowledge and understanding of the basics of Six Sigma strategy and methodology, which includes all Six Sigma tools and techniques applicable to improvement of business processes in organization, streamlining internal communication, improving and enforcing relevant measurement system and other steps essential to improving the results of the process – either in manufacturing or other industries.

Other Six Sigma certifications, including Yellow Belt and DFSS have similar purposes – to analyze and streamline the process within the organization to ensure more consistent output with fewer deviations and higher profit, improved product manufacturing and delivery timelines, and more efficient processes overall.

### **Check your progress 4**

1. Which of the following is the type of six sigma level certification?
  - a. Lean Six Sigma Green Belt
  - b. Lean Six Sigma Red Belt
  - c. Lean Six Sigma White Belt
  - d. None of these
2. What is meant by six sigma?
  - a. It focuses on process improvement and variation reduction through the application
  - b. It is the measure of quality that strives for near perfection
  - c. It is a disciplined, data-driven approach and methodology for eliminating defects
  - d. All of these

---

## 2.7 GAP Analysis

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A technique that businesses use to determine what steps need to be taken in order to move from its current state to its desired, future state. Also called need-gap analysis, needs analysis, and needs assessment.

Gap analysis consists of:

- Listing of characteristic factors (such as attributes, competencies, performance levels) of the present situation (“what is”)
- Listing factors needed to achieve future objectives (“what should be”)
- Highlighting the gaps that exist and need to be filled.

Gap analysis forces a company to reflect on who it is and ask who they want to be in the future.

Gap Analysis compares your current situation with the future state that you want to achieve once your project is complete. By conducting a Gap Analysis, you can identify what you need to do to “bridge the gap” and make your project a success. You can use it at any stage of a project to analyze your progress, but it’s most useful at the beginning.

The first step in conducting a gap analysis is to establish specific target objectives by looking at the company’s mission statement, strategic goals and improvement objectives. The next step is to analyze current business processes by collecting relevant data on performance levels and how resources are presently allocated to these processes. This data can be collected from a variety of sources depending on what’s being analyzed, such as by looking at documentation, conducting interviews, brainstorming and observing project activities. Lastly, after a company compares its target goals against its current state, it can then draw up a comprehensive plan that outlines specific steps to take to fill the gap between its current and future states, and reach its target objectives.

The important points to be noted before performing any Gap-analysis can be listed as below :

- The current followed processes should be well-known.
- All the current business affecting factors should be well defined. No matter how simple the process is, but it should be well-drafted and described.
- There should be no ambiguity in the future goal and objectives. All the future plans, goals, attributes, objectives and processes should be described and the initial draft of the same should be approved by the business owners.
- Identify the possible gaps within each section and the same can be adorned by using different charts, templates or figures.
- Possible feedback on the initial draft version of the gap analysis should be collected and later different sessions should be organized in order to avoid the differences in the feedback.

- All the responses should be compiled and final version of the gap-analysis should be drafted so that all the responsible parties should be informed and necessary actions can be taken.

### Check your progress 5

1. Gap analysis also known as.
  - a. need-gap analysis
  - b. needs assessment.
  - c. Both A and B
  - d. None of these
2. What is gap analysis ?
  - a. It is a technique that is used to determine what steps need to be taken in order to move from its current state to its desired, future state
  - b. It is an approach to sampling a lot to determine the proper disposition of that lot.
  - c. It is used to control product quality.
  - d. All of these

---

### 2.8 Difference between Quality Control and Quality Assurance

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Following are the points of differences between quality control and quality assurance :

- (1) Quality control is a set of activities for ensuring quality in products. The activities focus on identifying defects in the actual products produced while quality assurance deals with ensuring quality in the processes by which products are developed.
- (2) Quality control is a reactive process as it aims to identify and correct defects in the finished products while quality assurance is proactive process as it aims to prevent defects in the process used to make the product.
- (3) Goal of quality control is to identify the defects after product is developed and before it is released in the market while goal of quality assurance is to improve development and test processes so that defect do not arise when the product is being developed.
- (4) Quality control is activity or techniques used to achieve and maintain the product quality while quality assurance is prevention of quality problems through planned and systematic activities including documentation.
- (5) Quality control is usually the responsibility of a specific team that tests the product for defects while quality assurance involves everyone as it deals with the development of processes.
- (6) Validation or software testing is an example of quality control while verification is an example of quality assurance.
- (7) Quality control is a corrective tool and quality assurance is a managerial tool.

### Check your progress 6

1. Quality Assurance is \_\_\_\_\_ tool.
  - a. Proactive
  - b. Reactive
  - c. Both A and B
  - d. None of these
2. Quality Assurance involves \_\_\_\_\_
  - a. Specific designated team only
  - b. All the employees
  - c. Top managers only
  - d. All of these

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### 2.9 Let Us Sum Up

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In this unit we have learnt the concept of quality assurance. How quality assurance differentiates from quality control. Different tools of quality assurance like ISO 9000, TQM, Six sigma, Gap Analysis.

Total Quality Management is management approach started in 1950s and became popular by 1980s. It shows description about culture, attitude and organization of a company that strives to provide customers with products and services that satisfy their needs

Gap analysis is a technique which is applied in businesses to show steps that are required to be taken to move from current state to future state.

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### 2.10 Answer for Check Your Progress

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#### Check your progress 1

Answers: (1–b)

#### Check your progress 2

Answers: (1–d)

#### Check your progress 3

Answers: (1–d), (2–c)

#### Check your progress 4

Answers: (1–a), (2–d)

#### Check your progress 5

Answers: (1–c), (2–a)

#### Check your progress 6

Answers: (1–a), (2–b)

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### 2.11 Glossary

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1. **Quality Assurance** : Set of activities for ensuring quality in processes by which products are developed.
2. **Waste** : material, substance, or by–product eliminated or discarded as no longer useful or required after the completion of a process.

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### 2.12 Assignment

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List some features about Quality Assurance: ISO 9000.

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**2.13 Activities**

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Collect information on Quality Assurance methods.

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**2.14 Case Study**

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Study case of Mumbai Dabbawala in the context of six sigma.

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**2.15 Further Reading**

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Ann Gravells. "Principles and Practices of Quality Assurance: A Guide for Internal and External Quality Assurers in the FE and Skills Sector". 2016.

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## MATERIAL MANAGEMENT

### : UNIT STRUCTURE :

- 3.0 Learning Objective**
- 3.1 Introduction**
- 3.2 What is Material Management?**
- 3.3 Manufacturing Strategy**
- 3.4 Concept of Purchase Management**
- 3.5 Concept of Store Management**
- 3.6 Concept of Supply Chain Management**
- 3.7 Let Us Sum Up**
- 3.8 Answer for Check Your Progress**
- 3.9 Glossary**
- 3.10 Assignment**
- 3.11 Activities**
- 3.12 Case Study**
- 3.13 Further Readings**

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### **3.0 Learning Objectives**

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After reading this Unit, you will be able to :

- Need of Material Management
- Uses of Purchase Management
- Features about Store Management

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### **3.1 Introduction**

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The planning and control functions supports the entire flow of materials along with information flow which includes:

- |                     |                   |
|---------------------|-------------------|
| • Identification    | • Cataloguing     |
| • Standardization   | • Determination   |
| • Scheduling        | • Procurement     |
| • Inspection        | • Quality control |
| • Packaging         | • Storage         |
| • Inventory control | • Distribution    |
| • Disposal          |                   |

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### **3.2 What is Material Management**

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Materials Management relates to controlling about amount, location, movement and timing of certain commodities which are there in production by industrial organisations. It involves planning, directing, controlling and coordinating of certain activities that are related with materials and inventory needs from view of inception to introduction in manufacturing process.



## QUALITY CONTROL AND MATERIALS AND MAINTENANCE MANAGEMENT

Materials management is logically linked with acquisition, control and use of materials required with flow of goods and services that are linked with production process carrying predetermined objectives thereby controlling and regulating flow of material in relation to alter in variables which includes demand, prices, availability, quality, delivery schedules etc.

It serves as an important function of an organisation which covers many aspects of input process, which deals with raw materials, procurement of machines and other equipment's that are required for production process and spare parts for the maintenance of the plant. Thus in a production process materials management can be considered as an preliminary to transformation process.

It involves planning and programming for the procurement of material and capital goods of desired quality and specification at reasonable price and at the required time.

It is also concerned with market exploration for the items to be purchased to have up to date information, stores and stock control, inspection of the material received in the enterprise, transportation and material handling operations related to materials and many other functions. In the words of Bethel, Its responsibility end when the correct finished product in proper condition and quantity passes to the consumer.

### **Objectives:**

Materials management serves as an important contributor in survival and profits of an enterprise by way of providing ample supply of materials at lowest costs. It has certain objectives like:

- Selecting the correct material as per specification and needs in agreement with sales programme by analysing requisition order of buying department by considering low cost in procurement, replacement of materials.
- It will attempt to keep low operating costs with increase in margins of profits without making any concessions in quality.
- Receives and control material safely with good condition.
- Issue material on receipt of required authorities.
- Locate surplus stocks and taking appropriate measures to produce it.

### **Functions :**

There are many functions of material management such as materials requirements planning which is operated in multinational companies by using "Just in Time" technique and in purchasing of materials with its suppliers. The success depends on the competence by which this particular function of purchasing and procuring the requisite materials at appropriate time will be done and its availability is assured. In order to get success in purchasing function, organizations must consider that the requisition of material is needed by proper authority to initiate its purchase. It is important to select appropriate supplier for the materials requisitioned, before placing an order. Company must negotiate about the price of the material from the supplier and it will be purchased at the cheapest price. The quality of material must

be assured and should not be compromised with the cost of the material. The material should be purchased of right quantity and right quality at proper time at the cheapest cost. It is recommended to set the proper purchase policy and procedure. Other function of material management is inventory planning and control which explains that the materials should be purchased and brought in the stores just before it enters the production or sold out so that inventory cost is negligible.

### Check your progress 1

1. What are the objectives of material management?
  - a. Selecting the correct material as per specification
  - b. Receives and control material safely with good condition
  - c. Issue material on receipt of required authorities
  - d. All of these
2. What is material management?
  - a. It involves planning, directing, controlling and coordinating of certain activities that are related with materials and inventory
  - b. a set of activities for ensuring quality in the processes by which products are developed
  - c. Both of A and B
  - d. None of these

---

### 3.3 Manufacturing Strategy

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Developing a manufacturing strategy is a difficult proposition for any company. A manufacturing strategy should be developed alongside a company's marketing and corporate philosophy, and should cater to the end needs of the distributor. While the type of manufacturing a company produces — single piece vs. multiple items, low volume vs. high volume — may impact a strategy, manufacturing needs and capabilities should also be considered. Just as there are many business philosophies that may fit inside an industry, no single manufacturing strategy works best in any situation.

Every firm wants to optimize their manufacturing with certain criteria's by simply assuming cost and direct labour cost along with capital cost. Apart from this, certain other factors which optimizes will be ability to deliver/produce:

- Quickly
- High Quality
- New Products Quickly
- Volume Fluctuations
- Reliably
- High Variety
- Locations

These various dimensions of manufacturing performance often conflict. For example low cost and high variety often require different types of equipment and different plant layouts. Moreover, a manufacturing system, like any other engineering design, cannot optimize all dimensions simultaneously. The question of which dimension is most important constantly shifts in many firms. Near the end of the month, delivery is most important. After the first of the month, cost labor cost is most important. When an important customer complains, quality is most important.

### Check your progress 2

1. What are the factors which when optimize, affect delivery of products?
  - a. Locations
  - b. Reliably
  - c. high quality
  - d. All of these

---

### 3.4 Concept of Purchase Management

---

Purchasing involves acquiring materials of right quality, at the right quantity, at right time from a right source and at a reasonable price. A separate purchase department should be established to perform purchasing activities. The size of purchasing department depends upon the quantity to be purchased by the company. The purchase department determine the quality, quantity, items, price and time of purchase of materials. The function of purchase department is to purchase materials, supplies, machines and tools at the most favorable terms and conditions in a way that helps maintain the quality. It is an important function of material management and control.

It is often helpful to state the goals of purchasing for your business. In this way, you will never lose sight of the purpose of the purchasing function and will be able to make more intelligent purchasing decisions. Here is a sample list of purchasing objectives:

- To provide an uninterrupted flow of materials and services for company operations
- To find reliable alternative sources of supply
- To buy at the most economic order quantities
- To buy the best value: a combination of right quality at the best price with the best supplier service
- To maintain good relations with vendors

#### **Purchasing Management involves :**

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

#### **Objectives of Purchasing:**

The classical definition of objectives of purchasing is to buy materials and services of the right quality , in the right quantity, at the right place , from the right source and at the right time. However , in general management parlance the objectives of purchasing are :

- To support company operations with an uninterrupted flow of materials and services.
- To buy competitively and wisely

- To help keep a minimum Inventory
- To develop reliable alternate sources of supply
- To develop good vendor relationship and a good continuing supplier relationship
- To achieve maximum integration with the other departments of the firm
- To train and develop highly competent personnel who are motivated to make the firm as well as their department succeed
- To develop policies and procedures which permit accomplishment of the preceding seven objectives at the lowest reasonable operating cost

### Check your progress 3

1. What are the functions of purchase department?
  - a. To purchase materials and supplies
  - b. To determine the quality and quantity of products
  - c. To find reliable alternative sources of supply
  - d. All of these
2. SCM stand for
  - a. Supply chain management
  - b. Software chain management
  - c. Sampling chain management
  - d. None of these

---

### 3.5 Concept of Store Management

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Storekeeping is a service function which deals with the physical storage of goods under the custodianship of a person called storekeeper or stock controller. Goods stored may be either, stores or stock. Unworked materials or raw materials are usually referred to as stores and the place where they are kept is known as stores room. Finished products ready for shipment are usually called stocks and are housed in a place called stock–room. Storekeeping, therefore, is that aspect of materials which is concerned with physical storage of goods.

Store functions concern receiving, movement, storage and issue of items–raw materials, bought out parts, tools, spares, consumables etc. –required for production, maintenance and operation of the plant and finished goods until is dispatch to customers. Store, therefore, is the custodian of all goods that are received in the company until they are consumed or sold and naturally it assumes the responsibility of receiving, storage, preservation, issue, and accounting functions.

#### **Store management benefits the organization in the following ways :**

- Scientific stock control, it reduces losses due to accumulation of inventories.
- Efficient stores issues, it reduces down time in production and increases profit.

## QUALITY CONTROL AND MATERIALS AND MAINTENANCE MANAGEMENT

- Periodic reviews, it detects obsolete and non–moving items and helps the firm to get rid of unproductive inventory.
- Follow up with purchase; it helps to avoid stock outs and the production losses.
- Paper records keeping, it provides exact picture of inventory in store to higher management.

Typically and at times essentially, a Stores has to follow certain activities that are managed through use of various resources and are thus called Stores Management.

The task of storekeeping relates to safe custody and preservation of the materials stocked, to their receipts, issue and accounting.

The objective is to efficiently and economically provide the right materials at the time when it is required and in the condition in which it is required.

The basic job of the Stores Manager hence is to receive the goods and act as a caretaker of the materials and issue them as and when Production demands it. Needless to say storekeeping activity does not add any value to the product. In fact it only adds to the cost. The organization has to spend money on space i.e. expenditure on land, building and roads, equipment, machinery and other facilities provided such as electricity, people i.e. salaries and wages, insurance, maintenance costs, stationary, communication expenses and the cost to maintain the inventory etc. All of these get added to the organisational overheads and finally get reflected in the costing of the finished product. However, it is an essential function in any manufacturing or marketing organization.

### **Check your progress 4**

1. What are the advantages of store management
  - a. Scientific stock control
  - b. Efficient stores issues
  - c. Periodic reviews
  - d. All of these
2. What is the task of store manager?
  - a. To receive the goods and act as a caretaker of the materials
  - b. To issue goods as and when Production demands it.
  - c. Both of A and B
  - d. None of these

---

### **3.6 Concept of Supply Chain Management**

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The concept of Supply Chain Management is based on two core ideas. The first is that practically every product that reaches an end user represents the cumulative effort of multiple organizations. These organizations are referred to collectively as the supply chain.

The second idea is that while supply chains have existed for a long time, most organizations have only paid attention to what was happening within their

“four walls.” Few businesses understood, much less managed, the entire chain of activities that ultimately delivered products to the final customer. The result was disjointed and often ineffective supply chains.

Supply chain management, then, is the active management of supply chain activities to maximize customer value and achieve a sustainable competitive advantage. It represents a conscious effort by the supply chain firms to develop and run supply chains in the most effective & efficient ways possible. Supply chain activities cover everything from product development, sourcing, production, and logistics, as well as the information systems needed to coordinate these activities.

The organizations that make up the supply chain are “linked” together through physical flows and information flows. Physical flows involve the transformation, movement, and storage of goods and materials. They are the most visible piece of the supply chain. But just as important are information flows. Information flows allow the various supply chain partners to coordinate their long-term plans, and to control the day-to-day flow of goods and material up and down the supply chain.

Supply chain management flows can be divided into three main flows :

- The product flow
- The information flow
- The finances flow

The product flow includes the movement of goods from a supplier to a customer, as well as any customer returns or service needs. The information flow involves transmitting orders and updating the status of delivery. The financial flow consists of credit terms, payment schedules, and consignment and title ownership arrangements.

There are two main types of SCM software: planning applications and execution applications. Planning applications use advanced algorithms to determine the best way to fill an order. Execution applications track the physical status of goods, the management of materials, and financial information involving all parties. Some SCM applications are based on open data models that support the sharing of data both inside and outside the enterprise (this is called the extended enterprise, and includes key suppliers, manufacturers, and end customers of a specific company). This shared data may reside in diverse database systems, or data warehouses, at several different sites and companies.

### **Check your progress 5**

1. What are the types of SCM software?
  - a. Planning applications
  - b. Execution applications.
  - c. Both A and B
  - d. None of these
2. What is meant by information flow?

- a. It Includes The Movement Of Goods From A Supplier To A Customer
- b. It Involves Transmitting Orders And Updating The Status Of Delivery
- c. It Consists Of Credit Terms, Payment Schedules, And Consignment
- d. None Of These

---

### 3.7 Let Us Sum Up

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In this unit we have learnt that Materials Management relates to controlling about amount, location, movement and timing of certain commodities which are there in production by industrial organisations.

We see that a manufacturing strategy be developed alongside company's marketing and corporate philosophy that will take care about end needs of the distributor.

It is noted that purchasing involves getting materials of right quality, right quantity at right time from correct source at cheaper price.

Supply Chain Management shows that every product which reaches at end user shows cumulative effort of multiple organizations.

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### 3.8 Answer for Check Your Progress

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#### Check your progress 1

Answers: (1-d), (2-a)

#### Check your progress 2

Answers: (1-d)

#### Check your progress 3

Answers: (1-d), (2-a)

#### Check your progress 4

Answers: (1-d), (2-c)

#### Check your progress 5

Answers: (1-c), (2-b)

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### 3.9 Glossary

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1. **Materials Management** : Science of controlling amount, location, movement and timing of commodities during production by industry.
2. **Purchasing** : Relates to acquiring materials of correct quality, quantity and from required source at reasonable price.
3. **Supply Chain Management** : Concept relates to product for end user with cumulative effort of organizations.

---

### 3.10 Assignment

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Write about the features of Material Management.

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**3.11 Activities**

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Collect information on role of store Manager in a Company.

---

**3.12 Case Study**

---

Detailed about the information on Supply Chain Management.

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**3.13 Further Readings**

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1. Sower, J. Motwani, & M. Savoie. "Acceptance Sampling and Statistical Process Control" Quality Progress, 1993.





**: UNIT STRUCTURE :**

- 4.0 Learning Objective**
- 4.1 Introduction**
- 4.2 Concept of Maintenance Management**
- 4.3 Objectives of Maintenance Management**
- 4.4 Types of Maintenance System**
- 4.5 Functions of Maintenance Management**
- 4.6 Replacement Policies**
- 4.7 Let Us Sum Up**
- 4.8 Answer for Check Your Progress**
- 4.9 Glossary**
- 4.10 Assignment**
- 4.11 Activities**
- 4.12 Case Study**
- 4.13 Further Readings**

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**4.0 Learning Objectives**

**After reading this Unit, you will be able to :**

- Need of Maintenance Management
- Objectives of Maintenance Management
- Idea about replacement policies

---

**4.1 Introduction**

Maintenance management describes certain activities which make sure that the assets operate at particular state and whether the maintenance is done in the required manner to get continuous improvements in terms of:

- Reliability
- Maintainability
- Availability

With over 100 years of experience the British Standards Institute is recognized as the UK's National standards body. Their committees work with the manufacturing and service industries, government, businesses and consumers to facilitate the production of British, European and International standards.

According to BS EN 13306:2017, maintenance management concerns with every activities of management which describes maintenance objectives, strategies and responsibilities along with implementation using maintenance planning, maintenance control, and improvement of maintenance activities and economics. Normally, maintenance management is performed in three levels:

- The first level involves formulation of maintenance strategy so that it should be consistent with other business strategies in the company.
- The second level involves planning and schedule maintenance which assures efficient maintenance operations.

- The third level involves execution and collection of data from maintenance actions.
- To ensure product and service quality and satisfaction of customers
- To increase reliability and life of machines and equipment to ensure plant safety and minimize industrial accident.
- To minimize operating cost
- To ensure continuity in production
- To maximize the utilization of capacity

As maintenance has been an increasingly important discipline the last decades, improvement of the maintenance management have been the focus of attention

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## 4.2 Concept of Maintenance Management

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Maintenance is primarily concerned with day to day problem of machinery equipment in maintaining good working condition. It is very essential to ensure a continuous production flow by utilizing maximum capacity of plant. The main objective of the maintenance policy is to minimize total cost of maintaining an acceptable level of equipment reliability. All these objective of the maintenance can be outlined as below :

- To ensure product and service quality and satisfaction of customers
- To increase reliability and life of machines and equipment to ensure plant safety and minimize industrial accident.
- To minimize operating cost
- To ensure continuity in production
- To maximize the utilization of capacity

Therefore, the equipment reliability can be maintained and improved in two ways :

- a. Improving engineering design.
- b. Management of implant inventory level.

Maintenance management is essential to the success of any organization because a poorly–organized maintenance program can bring the entire company to a halt. For instance, if maintenance employees are fixing a broken photocopier instead of an essential piece of production equipment, a factory can stop producing anything. If the maintenance manager doesn't understand company processes well enough to know what is most important, this type of scheduling problem becomes more likely. If the maintenance manager schedules four employees when only one is needed, the company will lose money. If materials such as chemicals are not stored and disposed of properly, the company could have compliance issues.

Maintenance is an important factor in quality assurance, which is another basis for the successful competitive edge. Inconsistencies in equipments lead to variability in product characteristics and result in defective parts that fail to meet the established specifications. Beyond just preventing break downs, it is necessary to keep equipments operating within specifications (i.e. process capability) that will produce high level of quality.

Good maintenance management is important for the company's cost control. As companies go in for automation to become more competitive, they increasingly rely on equipments to produce a greater percentage of their output. It becomes more important that, equipments operate reliably within specifications.

### Check your progress 1

1. The reliability of equipments can be maintained and improved by–
  - a. Improving engineering design.
  - b. Management of implant inventory level.
  - c. Both A and B
  - d. None of these

---

### 4.3 Objectives of Maintenance Management

---

The following are some of the objectives of maintenance management :

- Minimizing loss of productive time because of equipment.
- Minimizing the repair time and repair cost.
- Minimizing the loss due to production stoppages.
- Efficient use of maintenance personnel and equipments.
- Prolonging the life of capital assets by minimizing the rate of wear and tear.
- To keep all productive assets in good working conditions.
- To maximize efficiency and economy in production through optimum use of facilities.
- To minimize accidents through regular inspection and repair of safety devices.
- To minimize the total maintenance cost which includes the cost of repair, cost of preventive maintenance and inventory carrying costs, due to spare parts inventory.
- To improve the quality of products and to improve productivity.

### Check your progress 2

1. What are the objectives of maintenance management?
  - a. Minimizing the loss of productive time because of equipment failure
  - b. Minimizing the loss due to production stoppages
  - c. To keep all productive assets in good working conditions
  - d. All of these

---

### 4.4 Types of Maintenance System

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Normally, there are 5 types of maintenance which are differentiated by the nature of the tasks they include such as :

#### Corrective maintenance :

The set of tasks is destined to correct the defects to be found in the different equipment and that are communicated to the maintenance department by users of the same equipment.

**Preventive Maintenance :**

Its mission is to maintain a level of certain service on equipment, programming the interventions of their vulnerabilities in the most opportune time. It is used to be a systematic character, that is, the equipment is inspected even if it has not given any symptoms of having a problem.

**Predictive Maintenance :**

It pursues constantly know and report the status and operational capacity of the installations by knowing the values of certain variables, which represent such state and operational ability. To apply this maintenance, it is necessary to identify physical variables (temperature, vibration, power consumption, etc.). Which variation is indicative of problems that may be appearing on the equipment. This maintenance it is the most technical, since it requires advanced technical resources, and at times of strong mathematical, physical and / or technical knowledge.

**Zero Hours Maintenance (Overhaul) :**

The set of tasks whose goal is to review the equipment at scheduled intervals before appearing any failure, either when the reliability of the equipment has decreased considerably so it is risky to make forecasts of production capacity . This review is based on leaving the equipment to zero hours of operation, that is, as if the equipment were new. These reviews will replace or repair all items subject to wear. The aim is to ensure, with high probability, a good working time fixed in advance.

**Periodic maintenance (Time Based Maintenance TBM) :**

The basic maintenance of equipment made by the users of it consisting of series of elementary tasks for which no extensive training is necessary, but perhaps only a brief training and is based on Total Productive Maintenance.

**Check your progress 3**

1. What is meant by Periodic Maintenance?
  - a. It pursues constantly know and report the status and operational capacity of the installations by knowing the values of certain variables
  - b. It consists of a series of elementary tasks, for which no extensive training is necessary
  - c. The set of tasks is destined to correct the defects to be found in the different equipment
  - d. None of these
2. What is corrective Maintenance?
  - a. The set of tasks is destined to correct the defects to be found in the different equipment
  - b. It consists of a series of elementary tasks, for which no extensive training is necessary
  - c. Both of these
  - d. None of these

---

#### 4.5 Functions of Maintenance Management

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The following are seventeen or can be more tasks that are typically the responsibility of the maintenance engineer :

1. Ensures that equipment is properly designed, selected, and installed based on a life-cycle philosophy of an asset

Many companies today consistently purchase equipment based on the low bid. Quite simply, if they are not performing the tasks listed for the maintenance foreman and maintenance planner, the company lacks the data to purchase equipment based on life-cycle philosophy. Without the data, the purchasing and accounting departments will purchase the lowest cost items. This may or may not be the best long-term decision, and that is one of the reasons why collecting maintenance-cost data is so important.

2. Ensures that equipment is performing effectively and efficiently

This task is different from tracking uptime. This task means ensuring that when the equipment is running, it is running at design speed and capacity. When focusing only on maintenance, many companies set goals in terms of uptime. However, many companies do not realize, as they move into this aspect of maintenance, that the equipment may be running at only 50% or 60% of capacity. Thus, understanding design capacity and speed ultimately is more important than measuring uptime.

3. Establishes and monitors programs for critical equipment analysis and condition monitoring techniques

The maintenance engineer is responsible for ensuring that the appropriate monitoring techniques are used for determining equipment conditions. This information is then given to the planner so that effective overhaul schedule can be determined. These techniques should also help eliminate unplanned maintenance downtime.

4. Reviews deficiencies noted during corrective maintenance

As mentioned in 5. of maintenance planner , the maintenance engineer and the planner periodically review equipment maintenance records. If they observe continual problems with equipment, and the problems are not with the preventive or predictive maintenance program, then the maintenance engineer will be responsible for finding solutions to the problems.

5. Provides technical guidance for CMMS

The maintenance engineer also reviews the data in the CMMS (SAP, Maximo, etc.). He or she makes recommendations about the types of data and the amount of data being collected. The maintenance engineer may also recommend problem, cause, and action codes for properly tracking maintenance activities.

6. Maintains and advises on the use and disposition of stock items, surplus items, and rental equipment

The maintenance engineer reviews spare parts policies for plant equipment. This review is to ensure that the right parts are in stock and in the right amounts.

7. Promotes equipment standardization

The maintenance engineer will help to ensure that the company is purchasing standardized equipment. Equipment standardization reduces the number of spare parts required, the amount of training necessary, and, overall, reduces the maintenance budget. Standardization requires data from the CMMS. If the organization is not collecting data through the maintenance foreman's and maintenance planner, then the maintenance engineer will not have the data required to implement equipment standardization.

8. Consults with maintenance crafts workers on technical problems

The maintenance engineer consults at a technical level with maintenance craft workers concerning equipment or work-related problems. This consultation may be about advanced troubleshooting or even equipment redesigns.

9. Monitors new tools and technology

The maintenance engineer is responsible for staying abreast of all the tools and technology that are available in the maintenance marketplace. This means that the maintenance engineer is responsible for reading books and magazines, attending conferences, and interfacing with other maintenance engineers to gather this data.

10. Monitors shop qualifications and quality standards for outside contractors

The maintenance engineer is responsible for ensuring that all outside contractors are qualified and that the work performed by contractors is of the proper quality. We had to implement a Quality Assurance/Quality Control Procedure with hold-on points to do this after a lot of failures occurred in a matter of 3 days we had about 5 failures of equipment contractors worked on. The maintenance engineer must do a factory inspection where equipment are refurbished at a contractor site.

11. Develops standards for major maintenance overhauls and outages

The engineer is responsible for examining outage and overhaul plans for completeness and accuracy. He or she then makes appropriate recommendations to the planner for adjustments in the plans or schedules.

12. Makes cost-effective benefit review of the maintenance programs

Periodically, the maintenance engineer reviews maintenance programs for his or her areas of responsibility and determines whether the work should be performed by operators, maintenance crafts workers, or outside contractors. In addition, the engineer reviews what work needs to be done, what work can be eliminated, and what new work

needs to be identified and added to the maintenance plan. This is called job plans optimizations.

13. Provides technical guidance for the preventive and predictive maintenance programs

The engineer periodically reviews the preventive and predictive maintenance programs to ensure the proper tools and technologies are being applied. This review is typically in conjunction with the maintenance planner.

14. Perform Benchmarking Studies by monitoring competitor's activities in maintenance management

The engineer is also responsible for gathering information about competitor's maintenance programs. This information may come from conferences, magazines articles, or peer-to-peer interfacing and should be reviewed for ideas for potential improvements in his or her company's maintenance program.

15. Serves as the focal point for monitoring performance indicators for maintenance management

The maintenance engineer is responsible for developing a performance indicators for maintenance and reviewing those with the maintenance manager.

16. Optimizes maintenance strategies

The maintenance engineer is responsible for examining maintenance strategies and ensuring that they all are cost effective. We can't be having a maintenance strategy forever in a plant, conditions change and this must always be reviewed once a year.

17. Responsible for analyzing equipment, operating data

The maintenance engineer ensures that equipment is operating as close to design parameters as possible. Doing this ensures that there is no wasted production from less-than-optimal equipment capacity. So remember if you don't measure you don't know your plant performance.

#### **Check your progress 4**

1. What are the main functions of maintenance management ?
  - a. Analyzing equipment, operating data
  - b. Optimizes maintenance strategies
  - c. Perform Benchmarking Studies
  - d. All of these

---

#### **4.6 Replacement Policies**

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Maintenance is defined as a process in which working condition of plant or machinery is maintained at the optimum level as to give maximum output. Maintenance is done through repair, partial replacement and total replacement. Following is the significance of the maintenance policy:

- Maintenance policy ensures that equipments are always in ready and reliable condition. This ensures company is able respond to any sudden change in demand.
- Maintenance policy ensures that equipments are always calibrated to provide good–quality products and competitive advantage. This ensures that there are no sudden and frequent breakdowns and reduce production of defective products.
- Maintenance policy ensures that there are no major breakdowns. This ensures there is no lose of inventory or market share for companies following JIT philosophy.
- Maintenance policy ensures that costs are always controlled.
- Maintenance policy is particularly important in capital–intensive industries.

If organizations are not able to implement an effective maintenance policy than it can result in the following results:

- Full capacity utilization may not be achieved.
- Increase in maintenance cost as more spare parts are required.
- Reduction in product quality and increase in wastage.
- Safety of workers and operators in jeopardy.

### Check your progress 5

1. What are the advantages of Maintenance policy?
  - a. It ensures that equipments are always in ready and reliable condition.
  - b. It ensures that equipments are always calibrated to provide good–quality products and competitive advantage
  - c. It ensures that costs are always controlled.
  - d. All of these
2. What are the issues generated in absence of Maintenance policy?
  - a. Increase in production cost as fixed labor cost cannot be reduced.
  - b. Costs are always controlled.
  - c. There are no major breakdowns.
  - d. None of these

---

## 4.7 LET US SUM UP

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In this unit we have learnt that Maintenance is primarily concerned with day to day problem of machinery equipment in maintaining good working condition. It is very essential to ensure a continuous production flow by utilizing maximum capacity of plant. Maintenance is defined as a process in which working condition of plant or machinery is maintained at the optimum level as to give maximum output.



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#### 4.8 Answer for Check Your Progress

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##### Check your progress 1

Answers: (1–c)

##### Check your progress 2

Answers: (1–d)

##### Check your progress 3

Answers: (1–b), (2–a)

##### Check your progress 4

Answers: (1–d)

##### Check your progress 5

Answers: (1–d), (2–a)

---

#### 4.9 Glossary

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1. **Maintenance** : servicing of machinery equipment to work for better working condition.
  2. **Machinery** : Machines that are used in factories for production of goods.
- 

#### 4.10 Assignment

---

Write note on maintenance of machinery.

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#### 4.11 Activities

---

Collect information on types of maintenance applied in factories.

---

#### 4.12 Case Study

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With reference to machining, how preventive maintenance is done?

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#### 4.13 Further Readings

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1. Davies, A. (1997). Handbook of condition monitoring: techniques and methodology. London: Chapman & Hall.
2. Det Norske Veritas AS. (2001). Recommended practice DNV–RP–A203 Qualification Procedures for New Technology–Appendix B. Høvik, Norway.
3. Gopalakrishnan, P., and Banerji, A.K. (2004). Maintenance and Spare Parts management. New Dehli: Prentice–Hall of India.

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## **Block Summary**

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This block give detailed information about maintenance of different machinery along with knowledge related to types of maintenance in factories. The block explained more about Quality inspection or Quality Assurance which serves as activities for ensuring quality of products manufactured. The knowledge about working and role of Gap analysis technique in businesses are also detailed.

After studying this block, students understand correctly about manufacturing strategy which should be created alongside of company. The concept of purchasing of correct material with right quality, right quantity at right time with nominal cost from correct source are well detailed.

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**Block Assignment**

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**Short Answer Questions**

1. What is Quality Control?
2. What is Materials Management?
3. State the benefits of Gap analysis technique?
4. How Maintenance plays an important role in industry?
5. Describe about various manufacturing strategy to be followed while setting a product?

**Long Answer Questions**

1. What are Quality inspection?
2. What are the features of Total Quality Management?
3. Compare about inspection and audit in terms of production?

**Enrolment No. :**

1. How many hours did you need for studying the units ?

**Unit No    1    2    3    4**

**Nos of Hrs**

2. Please give your reactions to the following items based on your reading of the block :

Items	Excellent	Very Good	Good	Poor	Give specific example if any
Presentation Quality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Language and Style	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Illustration used (Diagram, tables etc)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Conceptual Clarity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Check your progress Quest	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Feed back to CYP Question	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____

3. Any Other Comments

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**BBAR-404**

# **PRODUCTION AND OPERATION MANAGEMENT**

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**BLOCK-3 INDUSTRIAL ENGINEERING AND SALES  
FORECASTING**

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## **UNIT 1**

PRODUCT DESIGN AND DEVELOPMENT

## **UNIT 2**

INDUSTRIAL ENGINEERING AND WORK STUDY

## **UNIT 3**

SALES FORECASTING

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## **BLOCK-3 INDUSTRIAL ENGINEERING AND SALES FORECASTING**

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### **Block Introduction**

Product development involves creating a new product which can be sold by enterprise to its customers. The design relates to activities that are involved in creating styling, look and feel of product based on product's mechanical architecture, materials and processes with necessary engineering components for making product workable. Sales forecast is an estimation of sales volume that a company can expect to attain within the plan period. A sales forecast is not just a sales predicting.

In this block, students will get knowledge about Product Life Cycle and various aspects of it with knowledge about its constituents and components. The concept and working of Industrial Engineering and related components like Work Study, Method Study, Work Measurement, Productivity are well explained with features and characteristics. The block will detail about features, objectives advantages and limitations of Sales Forecasting. The knowledge about Product Development Techniques is explained.

After studying this block, students will be able to understand correctly about the important concepts of Sale Forecasting. The concept of Product Design and Development and its need will help students to know and compare about various design rules.

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### **Block Objective**

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**After completing this block, students will be able to :**

- Acquire knowledge about Product Life Cycle
- Understand different needs for Product Design and Development
- Study the different techniques of Industrial Engineering
- Understand the concept of Sales Forecasting
- Understanding limitations of Sales Forecasting

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### **Block Structure**

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<b>UNIT 1</b>	<b>PRODUCT DESIGN AND DEVELOPMENT</b>
<b>UNIT 2</b>	<b>INDUSTRIAL ENGINEERING AND WORK STUDY</b>
<b>UNIT 3</b>	<b>SALES FORECASTING</b>



## PRODUCT DESIGN AND DEVELOPMENT

### : UNIT STRUCTURE :

- 1.0 Learning Objectives**
- 1.1 Introduction**
- 1.2 Concept of Product Design and Development**
- 1.3 Need for Product Design and Development**
- 1.4 Characteristics of Good Design**
- 1.5 Product Life Cycle (Plc)**
- 1.6 Product Development Process**
- 1.7 Product Development Techniques**
- 1.8 Process Design**
- 1.9 Relationship between Product Design and Process Design**
- 1.10 Let Us Sum Up**
- 1.11 Answer for Check Your Progress**
- 1.12 Glossary**
- 1.13 Assignment**
- 1.14 Activities**
- 1.15 Case Study**
- 1.16 Further Readings**

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### **1.0 Learning Objectives**

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**After reading this Unit, you will be able to:**

- Understand the concept of Product Life Cycle (PLC)
  - How Product Design is related with Process Design
- 

### **1.1 Introduction**

---

The economic success of most firms depends on their ability to identify the needs of customers and to quickly create products that meet these needs and can be produced at low cost. Achieving these objectives is not just a marketing challenge, or a design problem, or a manufacturing problem; it is a product development problem that encompasses all of these tasks.

A product is something sold by an enterprise to its customers. Product development is the set of activities beginning with the perception of a market opportunity and ending in the production, sale, and delivery of a product.

New product design and development activity is a combined effort of three major functions: Marketing, New product development (Design and Development) and Manufacturing. Marketing provides customer viewpoint, product development links the customer requirements and technical scope into product, manufacturing provides the production view to be captured into product design and process plan. These three functions are supported by Industrial Engineering Function to make the design more efficient economically.

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## 1.2 Concept of Product Design and Development

---

Product development involves creating a new product which can be sold by enterprise to its customers. The design relates to activities that are involved in creating styling, look and feel of product based on product's mechanical architecture, materials and processes with necessary engineering components for making product workable. The development jointly refers to complete process of identifying a market opportunity by creating product which can appeal to identified market and involves testing, modifying and refining of product till it gets ready for production. A product can be any item from a book, musical composition, or information service, to an engineered product such as a computer, hair dryer, or washing machine.

The work of developing extra ordinary new products is difficult and time-consuming which involves more cost. People who have never been involved in a development effort gets shocked by time requirement with amount of money involved in designing of new product. Great products are not simply designed, but instead they evolve over time through countless hours of research, analysis, design studies, engineering and prototyping efforts, and finally, testing, modifying, and re-testing until the design has been perfected.

Few products are developed by a single individual working alone. It is unlikely that one individual will have the necessary skills in marketing, industrial design, mechanical and electronic engineering, manufacturing processes and materials, tool-making, packaging design, graphic art, and project management, just to name the primary areas of expertise. Development is normally done by a project team, and the team leader draws on talent in a variety of disciplines, often from both outside and inside the company. As a general rule, the cost of a development effort is a factor of the number of people involved and the time required to nurture the initial concept into a fully-refined product. Rarely can a production-ready product be developed in less than one year, and some projects can take three to five years to complete.

### Check your progress 1

1. What are the necessary skills required for product design?
  - a. Industrial design
  - b. Mechanical and electronic engineering,
  - c. Graphic art
  - d. All of these

---

## 1.3 Need for Product Design and Development

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Product Design conducts an analysis of the market, technology, and competition, in terms of the user experience and interface design, early in the product lifecycle to determine the user interface (UI) design direction. Partnering with Product Management, the Product Design group conducts surveys, focus groups, reviews, and other activities to better understand the market, customer, and end-user problems that are being solved in terms of the user experience and interface design.

Product Design conceptualizes a solution to the problems identified in the requirements document that Product Management creates. The Product Design team develops storyboards, screen flow diagrams, wireframes, prototypes, and other artefacts to validate the UI workflow solution. UI design prototypes are

iterated with customers and their end-users to ensure the solution continues to solve their business problems.

Product Development builds the solution based on requirements and specification provided by Product Management and Product Design. Product Design partners with Product Development in terms of the UI and presentation layer detailed design. Technology issues require revisions to the presentation layer user interface and UI specification, in which case Product Design and Product Development partner to determine the best approach on a case-by-case basis.

### Check your progress 2

1. What is product design?
  - a. It conceptualizes a solution to the problems identified in the requirements document that Product Management creates
  - b. builds the solution based on requirements and specification provided by Product Management and Product Design
  - c. Both of these
  - d. None of these

### 1.4 Characteristics of Good Design

The essential requirements of a good product design are listed as follows :

- Product must optimally perform its main function (task).
- It must be easy to repair at a low repair cost.
- It must be very reliable to use.
- It must follow principles of aesthetics.
- It must be a durable one.
- It can be easily produced in large numbers at minimum production cost.
- It must be simple to produce and use (handle).
- It must also be compact.

There are essential requirements of a good product design such as :

#### Utility

The product must be designed in such a way that it optimally performs the main task or function for which it is purchased by a buyer. In other words, the product must satisfy the needs and wants of the consumer.

For e.g. The main function of an Air Conditioner (AC) is to provide quick cooling of a room. So, AC must be designed in such a way that it can cool a room as quickly as possible. If it doesn't meet basic expectations, the consumers won't buy it.

#### Repairability

The product must be designed in such a way that it can be easily repaired whenever necessary during a malfunction. The product repairs must be done quickly that too at a low repair cost. Consumers usually don't buy those costly products, which are either very expensive to repair / maintain or those who take a longer time and more money for repairing.



### **Reliability**

Reliability means dependability on a product. Consumers prefer to purchase and use often those products which perform their main function or task optimally for a longer period without any annoying malfunctions, breakdowns or failures. In short, a product must perform quite well and give trouble-free service for a decent amount of time. It must not need constant repairs and/or frequent maintenances. It is so, since repairs often turn costly and are very time consuming. Reliability is crucial for consumer durables and office equipments. A reliable product gains consumers' trust, loyalty and this creates its goodwill in the competitive market. Therefore, reliability is an important factor to be kept in mind while designing a product.

### **Aesthetics**

Aesthetics must be kept in mind while designing a product. It refers to, how the product looks, feels, sounds, tastes or smells. That is, the product must look, feel, sound, taste or smell very good. It must be attractive, compact and convenient to use. Its packaging must also be made graphically appealing and colorful. If this aspect is not considered, product will fail in the market. This factor is very important, especially in case a product is designed for and targeted to the young generation that is emerging with a modern mindset and current trends.

### **Durability**

Durability refers to the life of a product. A durable product performs flawlessly for a longer period. It is a sign of a good-quality product. Consumers want their products to have a longer life. They do not want to replace their products repeatedly. This factor is very crucial for durable and costly products like televisions, refrigerators, cars, so on. Therefore, durability is another important requirement that must be kept in mind while designing a product.

### **Producibility**

The product must be designed in such a way that it can be produced in large quantities with ease at a minimum production cost. The production department must be able to produce the product easily, quickly, in ample quantities and at a low production cost. The production process must not be very complex, and it must not require costly machines to produce the product.

### **Simplicity**

The design of the product must be very simple. The simpler a design, the easier, it is to produce and use (handle). Simple products are also economical and reliable. The product must have the least number of operations without affecting its functionality.

### **Compact**

The product must be small; it must occupy less space, and must have lower weight. In other words, it must be very compact. The company must try to make its products as small as possible. Today, everything is turning smaller. Big sized cell phones are now out of fashion. In the 1950s, computers were as huge as spacious rooms. However, today we have laptops and palmtop computers. Most products can be made compact. Still, this cannot be done for all products. In case of

televisions, it is just the opposite. Today people want bigger televisions. Similarly, there is a limit on small size. We cannot have a phone which is so tiny that it requires a microscope to see its keypad.

### Check your progress 3

1. What are the characteristics of good product design
  - a. It must be easy to repair at a low repair cost.
  - b. It must be very reliable to use.
  - c. It must be a durable one
  - d. All of these.
2. What is meant by durability?
  - a. It refers to the life of a product
  - b. It means dependability on a product
  - c. Both A and B
  - d. All of these

### 1.5 Product Life Cycle (Plc)

Product life cycle is a concept of marketing that explains about various stages of a product that moves from raw till existence in the market. We see every new product progresses through sequence of stages right from introduction to growth, maturity and decline. Figure 1.1 shows the description about product revenue and profits as a function of life cycle stages.

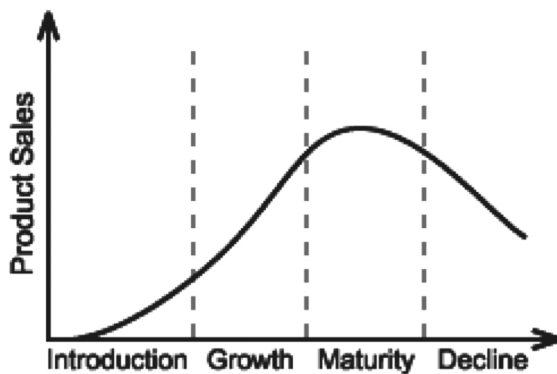


Fig 1.1 Stages of PLC

#### Introduction Stage

Introduction stage allow the firms to create product awareness and to develop a product for the market. During such phase, impact on marketing mix follows :

- Establishment of product branding and level of quality with intellectual property protection such as patents and trademarks.
- Establish low pricing in order to build market share or high skim pricing which helps in recovery of development costs.
- Establishing selective distribute of product till consumers show acceptance of product.

- Promoting of product by marketing communications thereby building product awareness
- Educating potential consumers about the product.

### **Growth Stage**

Growth stage helps the firms in creating brand preference and also allows increase of product market share. In this :

- Product quality is maintained and extra features and services may be added to the product.
- Pricing is maintained because of increasing demand with low competition.
- Distribution channels added as demand increases with acceptance of product by the customers.
- Promotion is aimed at a broader audience.

### **Maturity Stage**

During the maturity stage, strong growth in sales reduces with result of competition in similar products. The main aim at this point is to defend market share though maximizing profit. In this stage:

- Product features gets enhanced which will make the product differentiable from competitors.
- Pricing gets reduced due to new competition.
- Distribution becomes serious and incentives are offered to encourage preference over competing products.
- Promotion emphasizes product differentiation.

### **Decline Stage**

In case of decline in sales, the company results in many options :

- To maintain the product, product need to be revive by adding extra features
- To locate fresh customers for the product.
- To lower the product costs and continue selling of product for loyal niche segment.
- To discontinue the product or liquidating balance inventory to other firm who are willing to take the product.

We see that the decisions in the decline phase depends mostly on selected strategy either by enhancing the product or rejuvenated if it is being harvested or liquidated. The price may be maintained if the product is harvested, or reduced drastically if liquidated.

### **Check your progress 4**

1. How many stages are there in product life cycle?
  - a. Two
  - b. Four
  - c. Six
  - d. None of these

2. What is growth stage in product life cycle?
  - a. Product quality is maintained and extra features and services may be added
  - b. Pricing is maintained because of increasing demand with low competition.
  - c. Promotion is aimed at a broader audience.
  - d. All of these

## 1.6 Product Development Process

Product development processes are steps and tasks involved in designing of product such as :

- Strategy
- Organization
- Concept generation
- Marketing plans
- Evaluation
- Commercialization

Of new product. It is a cycle by means of which an innovative firm routinely converts ideas into commercially viable goods or services. The idea about product development is to cultivate, maintain and increase company's market share by satisfying customers need. Not all products will appeal to all customers, hence defining target market for product is an important element which should be considered early in product development process. For this, quantitative market research need to be done at every phases of design process which can be done either before the product or service is conceived or at the time of product designing and can also at the time of launching of product.

The five elements of fuzzy front end product development are :

### Identification of design criteria

It involves brainstorming possible new products. Once an idea has been identified as a prospective product, a more formal product development strategy can be applied.

### Idea analysis

It involves a closer evaluation of the product concept. Market research and concept studies are undertaken to determine if the idea is feasible or within a relevant business context to the company or to the consumer.

### Concept genesis

It involves turning an identified product opportunity into a tangible concept.

### Prototyping

It involves creating a rapid prototype for a product concept that has been determined to have business relevance and value. Prototyping in this front-end context means a "quick-and-dirty" model is created, rather than the refined product model that will be tested and marketed later on.

### Product development

It involves ensuring the concept has passed muster and has been determined to make business sense and have business value.

### Check your progress 5

1. Product development processes includes.
  - a. Strategy
  - b. Organization
  - c. Concept generation
  - d. All of these
2. What is meant by Concept genesis?
  - a. It involves creating a rapid prototype for a product
  - b. It involves turning an identified product opportunity into a tangible concept.
  - c. It involves brainstorming possible new products
  - d. None of these

---

### 1.7 Product Development Techniques

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Product development remained evolving as fluid process where certain steps alter as per nature of project same as person managing product development. In many firms, there appears a dedicated team which do researches and tests for development of new products.

Until few years ago, process of product design and development focused mainly on certain characteristics which a product should contain to have correct response in response to certain functional specifications thereby defining restrictions by manufacturing processes. Although, design process is considered from wider perspective, though merely referring of products characteristics lead to certain external development factors like:

- Customers requirements
- Quality
- Reduction of manufacturing cost and control
- The assembly and distribution process
- Environmental impact before and after manufacture
- Product disassembly reuse for recycling
- Safety, hygiene, ergonomic factors, etc.

There are certain product development techniques which are considered for designing of products such as :

#### Design techniques

This technique involves :

- Quick product specification
- Conjoint Analysis
- Robust design
- Modular Design
- Rapid design transfer
- Rapid Prototyping and tooling
- Quick Function Deployment
- Design of Excellence
- Design optimization
- Incremental innovation
- Group Technology
- Failure mode effect analysis

### Organizational techniques

This technique involves :

- Concurrent activities management
- Stage–Gate process
- Multifunctional Design teams

### Information technologies

This technique involves :

- Computer Aided Design (CAD)
- Computer Aided Manufacturing (CAM)
- Computer Aided Engineering (CAE)
- Computer Integrated Manufacturing
- Internet and Intranets
- Electronic Data Interchange (EDI)
- Expert systems
- Groupware
- Product Data Management (PDM)

### Manufacturing techniques

This technique involves:

- Manufacturing Resource Planning (MRP)
- Just in Time
- Optimal Product Technology
- Statistical Process Control

### Check your progress 6

1. What does organizational techniques for product development contains?
  - a. Manufacturing Resource Planning (MRP)
  - b. Computer Aided design
  - c. Concurrent Activities Management
  - d. None of these
2. Which of the following are information technologies?
  - a. CAD(Computer Aided Design)
  - b. CAM(Computer Aided Manufacturing)
  - c. EDI(Electronic Data Interchange)
  - d. All of these

## 1.8 Process Design

A successful process design takes into account the correctness of process as an objective on the organization. It requires broader view of complete organization thereby delivering customer values by regular involvement of management at different stages. To have good process design, effective process strategy needs to be followed, which involves singular line items for manufacturing of end product. Effective process strategy should have :

- Raw material procurement
- Customer participation
- Technology investment

There are certain process development steps that are needed for a process to design :

**Process Requirement :**

Initially the information needs to be collected for framing structure with end objectives by writing process requirement document. Such document will list various stages, risk and stakeholders for production which covers:

- Assessment of available technology
- Raw material requirement
- Factory/plant layout
- Demand forecast

**Team Building :**

After writing the process requirements, company will finalised a team as per skill level and experience where each member will get familiarize with whole process.

**Planning and Implementation :**

Once the team has been made, the team will develop module; policies and procedure that are needed for production on prior approvals.

**Audit :**

A regular audit is to be carried out which will make sure that the process created will be implemented in line and that will deliver values to customers.

**Enhancement :**

Once the product is designed and launched in the market, then in due course of time, there may be enhancement in product features otherwise the product may get discontinued from the market.

**Check your progress 7**

1. What is required for effective process strategies?
  - a. Raw material procurement
  - b. Customer participation
  - c. Technology investment
  - d. All of these

---

**1.9 Relationship between Product Design and Process Design**

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Design process for product needs clear understanding of functions and performance of particular product. Whether the product is new, or rebrushed, it is examined how design and style of products changes. The market for a product and its anticipated uses be defined clearly with the help of sales personnel, market analysts and other member in an organization. Product design is important activity in an organisation as it involves more than 70% of cost at initial design stages.

During product design and once a part design is finalized, the production processes must be planned. In process planning, the general characteristics of the part, such as the general part configuration, material, surface finish, and tolerances, and must be determined first. These characteristics will affect part handling, the type of tooling and machines, the sequence of operations, assembly, and rate of production

The effect and efficiency of operations management, Just-in-Time manufacturing, and total quality management depend upon product design and process planning. The product design determines the processes available to make them. The product design and the process determine the quality of the product and the cost. Quality and cost determine the profitability of the company.

In product design, a standard is a carefully established specification covering the product's material, configuration, measurements, and so on. This means that all products made to a given specification will be alike and interchangeable. Light bulbs are a good example of standardization. The sockets and wattage are standardized and the light bulbs are interchangeable.

### Check your progress 8

1. The effect and efficiency of operations management will depend on
  - a. Product design
  - b. Process Planning
  - c. Both A and B
  - d. None of these

### 1.10 Let Us Sum Up

In this unit we have learnt that product development involves in building fresh product that can be sold to customers having activities involved in creating styling, look and feel of product as per product architecture, materials and processes.

We see that product design serves as analysis concerning about market, technology and competition where user experience and interface design shows in product lifecycle for finding user interface design direction.

It is noted that Product life cycle serves as marketing concept which detailed about various stages of product right from raw till existence in market.

Product development remained evolving as fluid process where certain steps alter as per nature of project same as person managing product development. In many firms, there appears a dedicated team which do researches and tests for development of new products.

It is noted that a good process design caters correctness of process as its objective on organization which needs broader view of complete organization in order to deliver customers values through regular involvement of management.

### 1.11 Answer for Check Your Progress

#### Check your progress 1

Answers: (1-d)

#### Check your progress 2

Answers: (1-a)



**Check your progress 3**

Answers: (1-d), (2-a)

**Check your progress 4**

Answers: (1-b), (2-d)

**Check your progress 5**

Answers: (1-d), (2-b)

**Check your progress 6**

Answers: (1-c), (2-d)

**Check your progress 7**

Answers: (1-d)

**Check your progress 8**

Answers: (1-c)

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**1.12 Glossary**

1. **Concept** : It is an early stage design where overall intent or direction is apparent.
2. **Model** : It is the representation of design which can be physical or representation on computer through software.

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**1.13 Assignment**

What is the role of Product development in creating new product?

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**1.14 Activities**

Collect information on factors related to marketing of product through Product life cycle.

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**1.15 Case Study**

Discuss the factors responsible for creating process design.

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**1.16 Further Readings**

1. BRITISH STANDARDS INSTITUTION – BSI. BS 4778 – British Standard Glossary of terms used in Quality assurance (including reliability and maintainability terms). London, 1979.
2. PRADO, D. Gerenciamento de projetos nas organizações. Belo Horizonte: Editora de Desenvolvimento Gerencial, 2000.

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## INDUSTRIAL ENGINEERING WORK STUDY

### UNIT STRUCTURE:

- 2.0 Learning Objectives**
- 2.1 Introduction**
- 2.2 Meaning and Nature of Industrial Engineering**
- 2.3 Applications of Industrial Engineering**
- 2.4 Functions of Industrial Engineers**
- 2.5 Techniques Of Industrial Engineering**
- 2.6 Concept Of Work Study, Method Study, Work Measurement, Productivity**
- 2.7 Measures to Improve Productivity**
- 2.8 Let Us Sum Up**
- 2.9 Answer for Check Your Progress**
- 2.10 Glossary**
- 2.11 Assignment**
- 2.12 Activities**
- 2.13 Case Study**
- 2.14 Further Readings**

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### **2.0 Learning Objectives**

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**After reading this Unit, you will be able to understand :**

- Need of Industrial Engineering
- Applications of Industrial Engineering
- Concept of Work Study
- Improving Productivity

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### **2.1 Introduction**

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To survive in competitive world, it is important for an organization to work continuously and find different ways to enhance the efficiency and productivity of the product. This can be done by locating new, easy and cost-effective ideas of manufacturing or servicing of products.

Work study and industrial engineering plays a vital role which helps in:

- Simplifying job design
- job enrichment
- value analysis
- method analysis
- operational analysis

Work study normally adopted by companies which helps in various job productivity. Industrial engineering being the latest method used to enhance productivity which helps in design, enhancement, setting of engineering systems which encompasses plants, machinery, workers, etc.

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## 2.2 Meaning and Nature of Industrial Engineering

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Industrial engineering is related with development of effective and efficient process to be applied in plant, machinery, materials, etc. It concern with design, improvement and installation of integrated systems involving humans, materials and equipment. It draws specialized knowledge and skills in mathematical, social and physical sciences along with principles and methods of engineering analysis and design for the purpose to specify, predict and evaluating results from certain systems.

Its objectives is :

- To increase productivity without incurring incremental costs.
- To encourage automation by decreasing human intervention.
- To develop efficient and effective operation work cycle.

It is the branch of engineering which involves in making or doing things better. The Industrial engineers helps in reducing production costs, increasing efficiency, improving quality of products and services, ensuring worker health and safety, protecting environment.

### Check your progress 1

1. Industrial Engineering helps in
  - a. Value Analysis
  - b. Method Analysis
  - c. Job enrichment
  - d. All of these
2. What is industrial engineering?
  - a. It is the development of effective and efficient process to be applied in plant, machinery and materials etc.
  - b. It involves turning an identified product opportunity into a tangible concept.
  - c. It involves creating a rapid prototype for a product concept
  - d. All of these

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## 2.3 Applications of Industrial Engineering

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There are certain techniques and tools that are practicing throughout the world in regards to industrial engineering. It deals with designing of new prototypes products which to helps in saving money. It draws upon the principles and methods of engineering analysis and synthesis with mathematical, physical and social sciences along with principles and methods of engineering analysis and design in order to show, predict, and find results from systems. In lean manufacturing systems, industrial engineers work to eliminate wastes of time, money, materials, energy, and other resources. There are certain applications of Industrial Engineering such as :

- To provides support service for workers, supervisors, staff and management.
- It helps the company to be competitive in market place.
- It lead to lower costs for producing quality product.

It gives the feeling of being wanted by providing line supervisor with consistent and fair schedules.

- It serves as an assistance to management in providing manufacturing routings of parts.
- It assist foremen and supervisors by giving exact data in setting of work place.

### Check your progress 2

1. What is the use of Industrial Engineering?
  - a. It helps the company to be competitive in market place.
  - b. It lead to lower costs for producing quality product.
  - c. It serves as an assistance to management in providing manufacturing routings of parts.
  - d. All of these

## 2.4 Functions of Industrial Engineers

An Industrial Engineer is an engineer who works in a factory. His job is to solve any problems which come up when the factory is making a product which has been designed by Desing Engineers. The Design Engineer decides what a product's characteristics should be, builds and tests a prototype (a sample model), and supplies detailed drawings and specifications to Manufacturing (which operates the factory). If the drawings and specs are good enough, Manufacturing will have no problem building hundreds or thousands of products.

Industrial Engineers serve as managers in small and medium sized industries because they understand the management of people and resources, internal and external customer perspectives, effective communication skills, and important business practices and ethics. Most of all, they have the ability to continuously improve the entire system, from working with materials, tools, and technologies to successfully managing staff and human resources.

However, often the specs are incomplete or inconsistent. Then the Industrial Engineer figures out what's wrong with the specs and corrects them so Manufacturing can proceed. Naturally, he usually must confer with the Design Engineers to get the problem solved. Industrial Engineers work to make things better, be they processes, products or systems which typically focus on:

- Project Management Project Management
- Manufacturing, Production and Distribution
- Supply Chain Management
- Productivity, Methods and Process Engineering
- Quality Measurement and Improvement

INDUSTRIAL  
ENGINEERING AND  
SALES FORECASTING

- Program Management
- Ergonomics/Human Factors
- Technology Development and Transfer
- Strategic Planning
- Management of Change
- Financial Engineering

Industrial engineers determine the most effective ways for an organization to use the basic factors of production - people, machines, materials, information, and energy - to make or process a product or produce a service. They are the bridge between management goals and operational performance. They are more concerned with increasing productivity through the management of people, methods of business organization, and technology than are engineers in other specialties, who generally work more with products or processes.

- To solve organizational, production, and related problems most efficiently, industrial engineers
- Study the product and its requirements
- Use mathematical methods to meet product requirements
- Design manufacturing and information systems
- Develop management control systems for financial planning and cost analysis
- Design production planning and control systems to coordinate activities and control product quality
- Design or improve systems for the physical distribution of goods and services
- Determine which plant location has the best combination of raw materials availability, transportation, and costs
- Develop wage and salary administration systems and job evaluation programs

**Check your progress 3**

1. The main focus of industrial engineers is on –
  - a. Quality Measurement and Improvement
  - b. Program Management
  - c. Technology Development and Transfer
  - d. All of these
2. What are the main functions of industrial engineers?
  - a. Solving problem while development of a product
  - b. To manage people and resources
  - c. Both A and B
  - d. All of these

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## 2.5 Techniques of Industrial Engineering

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Planning and designing manufacturing processes and equipment is a main aspect of being an industrial technologist. An Industrial Technologist is often responsible for implementing certain designs and processes. Industrial Technology involves the management, operation, and maintenance of complex operation systems. Techniques of industrial engineering are-

### **Method study:**

To establish a standard method of performing a job or an operation after thorough analysis of the jobs and to establish the layout of production facilities to have a uniform flow of material without back tracking.

### **Time study:**

This is a technique used to establish a standard time for a job or for an operation.

### **Motion Economy:**

This is used to analyse the motions employed by the operators do the work. The principles of motion economy and motion analysis are very useful in mass production or for short cycle repetitive jobs.

### **Value Analysis:**

It ensures that no unnecessary costs are built into the product and it tries to provide the required functions at the minimum cost. Hence, helps to enhance the worth of the product.

### **Financial and non-financial Incentives:**

These helps to evolve at a rational compensation for the efforts of the workers.

### **Production, Planning and Control:**

This includes the planning for the resources (like men, materials and machine) proper scheduling and controlling production activities to ensure the right quantity, quality of product at predetermined time and pre-established cost.

### **Inventory Control:**

To find the economic lot size and the reorder levels for the items so that the item should be made available to the production at the right time and quantity to avoid stock out situation and with minimum capital lock-up.

### **Job Evaluation:**

This is a technique which is used to determine the relative worth of jobs of the organization to aid in matching jobs and personnel and to arrive at sound wage policy.

### **Material Handling Analysis:**

To scientifically analysis the movement of materials through various departments to eliminate unnecessary movement to enhance the efficiency of material handling.

**Ergonomics:**

It is concerned with study of relationship between man and his working conditions to minimize mental and physical stress. It is concerned with man- machine system.

**Check your progress 4**

1. What is meant by motion economy?
  - a. This is used to analyses the motions employed by the operators do the work.
  - b. This is a technique which is used to determine the relative worth of jobs of the organization
  - c. It is used to scientifically analysis the movement of materials through various departments
  - d. None of these
2. What is meant by Ergonomics?
  - a. It is used to determine the relative worth of jobs of the organization
  - b. These helps to evolve at a rational compensation for the efforts of the workers.
  - c. It is concerned with man-machine system
  - d. None of these

---

**2.6 Concept of Work Study, Method Study, Work Measurement, Productivity**

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**Work Study**

Work Study is systematic study of methods of work in order to improve effective use of its resources and set standards of performance. It can be applied where a set of processes is involved. It introduces most efficient working method and serves as efficient tool in management which improves improve efficiency at every levels of organization. It helps in reducing waste through standardization of element of job.

Work study is done to find the current situation in organization with opportunities of improvement which allows organizations to become more systematic and profitable. The aim of work study is to help management in getting optimum use of human and material resources which are present to organization for performing work for which, it is engaged. Work Study has certain benefits such as:

- Increase in Productivity
- Increase in efficiency
- Improved work flow
- Improved work layout
- Improved standards

It is done in two stages.

Method Study – It involves studying of method and locating improved method.

Work Measurement – It finds standard time needed to complete improved method.

### **Method Study**

Method Study is the scientific way of getting better job design which deals with existing job process and proposed job process in finding correct job process that lead in efficient and cost effective operations. The objectives of method study are :

- To study current work process and proposed work process.
- To find new methods of increased production and lowering of cost.
- To get optimum utilization of resources.

Method study will allow increase in overall productivity and profitability of organization and works with following procedures :

- Study about selection of work.
- Recording current method.
- Critical examination of the facts.
- Development practical, economic and effective method.
- Installation of new method.
- Maintenance of new method and practices checking

### **Work Measurement**

Work measurement is a process of setting up time of given task by qualified worker who works at defined level of performance. There are ways in which work may be measured using certain techniques. The basic procedure consists of three stages;

- An analysis phase in which the job is divided into convenient, discrete components, commonly known as elements;
- A measurement phase in which the specific measurement technique is used to establish the time required (by a qualified worker working at a defined level of performance) to complete each element of work;
- A synthesis phase in which the various elemental times are added, together with appropriate allowances, to construct the standard time for the complete job.

The techniques used to measure work can be classified into those that rely on direct observation of the work, and those that do not. For example, some techniques, such as predetermined motion-time systems and the use of synthetic or standard data can provide times from simulation or even visualisation of the work. However, the data on which such techniques are based were almost certainly based on earlier observation of actual work.

### **Productivity**

Productivity is an objective concept which involves in :

- Measuring ideally against a universal standard.
- Monitoring organizations in terms of productivity for strategic reasons



- Corporate planning, organization improvement or comparison to competitors
- Tactical reasons including project control or controlling performance to budget

Productivity is a measuring concept involving :

- Relative measure of actual output of production in comparison with actual input of resources measured across time or against common entities.
- Increase in output for level of input or decreasing in input for constant level of output by increasing the productivity.

Measuring of productivity describing how well the resources of an organization being used to produce input.

### **Importance of productivity**

The importance of productivity are :

#### **Key to prosperity**

Rise in productivity results in higher production which has direct impact on standard of living. It reduces cost per unit and enables reduction in sale price. It increases wages for workers and increased profit for organisation. Higher demand creates more employment opportunities.

#### **Higher productivity leads to economic growth and social progress**

Higher productivity helps to reduce cost per piece which make product available at cheaper rate. Thus it is beneficial for consumers. Low price increases demand of the product which in turn increases profit of the organisation. Higher profit enables organisation to offer higher dividend for shareholders. It increases export and increases foreign exchange reserves of a country.

#### **High productivity requires elimination of waste in all forms**

It is necessary to eliminate wastage in raw material, wastage of time in case of men and machinery, wastage of space etc. to improve productivity. Several techniques like work study, statistical quality control, inventory control, operation research, value analysis etc. are used to minimise wastage of resources.

Improvement in productivity is important for country like ours because it can minimise level of poverty and unemployment.

#### **Check your progress 5**

1. What are the characteristics of work study?
  - a. Increase in Productivity
  - b. Increase in efficiency
  - c. Improved work flow
  - d. All of these

2. What is work measurement?
  - a. It involves studying of method and locating improved method.
  - b. It finds standard time needed to complete improved method.
  - c. Both of these
  - d. None of these

---

## 2.7 Measures to Improve Productivity

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There are varieties of factors which can affect productivity, both positively and negatively

- capital investment in production
- capital investment in capacity
- capital investment in equipment
- capital investment in facility
- economies of scale
- workforce knowledge
- technological changes
- work methods
- procedures
- systems
- qualities of products
- qualities of processes
- qualities of management
- legislative and regulatory environments
- general levels of education
- social environments
- geographic factors

Productivity is an overall measure of the ability to produce a good or service. More specifically, productivity is the measure of how specified resources are managed to accomplish timely objectives as stated in terms of quantity and quality. Productivity may also be defined as an index that measures output (goods and services) relative to the input (labor, materials, energy, etc., used to produce the output).

Productivity improvement can be achieved in a number of ways. If the level of output is increased faster than that of input, productivity will increase. Conversely, productivity will be increased if the level of input is decreased faster than that of output. Also, an organization may realize a productivity increase from producing more output with the same level of input. Finally, producing more output with a reduced level of input will result in increased productivity.

Any of these scenarios may be realized through improved methods, investment in machinery and technology, improved quality, and improvement techniques and philosophies such as just-in-time, total quality management, lean production, supply chain management principles, and theory of constraints.

A firm or department may undertake a number of key steps toward improving productivity. There are certain steps which help in productivity improvement:

- Develop productivity measures for all operations measurement is the first step in managing and controlling an organization.
- Look at the system as a whole in deciding which operations are most critical; it is over-all productivity that is important.
- Develop methods for achieving productivity improvement, such as soliciting ideas from workers, studying how other firms have increased productivity, and reexamining the way work is done.
- Establish reasonable goals for improvement.
- Make it clear that management supports and encourages productivity improvement.
- Measure improvements and publicize them.

Don't confuse productivity with efficiency. Efficiency is a narrower concept that pertains to getting the most out of a given set of resources; productivity is a broader concept that pertains to use of overall resources. For example, an efficiency perspective on mowing the lawn given a hand mower would focus on the best way to use the hand mower; a productivity perspective would include the possibility of using a power mower.

### **Check your progress 6**

1. Which of the following factors affect productivity?
  - a. capital investments in production
  - b. capital investments in technology
  - c. capital investments in equipment
  - d. All of these
2. What is meant by productivity?
  - a. It is an index that measures output (goods and services) relative to the input
  - b. It involves studying of method and locating improved method.
  - c. It finds standard time needed to complete improved method.
  - d. None of these

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## **2.8 Let Us Sum Up**

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In this unit we have learnt that Industrial engineering is basically development of effective and efficient process for plant, machinery, materials, etc and concerns with designing, improvement and installation of integrated systems with involvement of humans, materials and equipment.

We see that an Industrial Engineer works in a factory where his work is to solve any problems which come at the time of production of goods.

Planning and designing manufacturing processes and equipment are aspects of industrial technologist which is responsible for implementing designs and processes.

It is noted that work study appears as systematic study of methods of work which enhance effective use of resources and set standards of performance. It can be applied where a set of processes is involved.

Productivity is an overall measure of the ability to produce a good or service. More specifically, productivity is the measure of how specified resources are managed to accomplish timely objectives as stated in terms of quantity and quality.

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## 2.9 Answer for Check Your Progress

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Industrial Engineering and Work Study

### Check your progress 1

Answers: (1-d), (2-d)

### Check your progress 2

Answers: (1-d)

### Check your progress 3

Answers: (1-d), (2-c)

### Check your progress 4

Answers: (1-a), (2-c)

### Check your progress 5

Answers: (1-d), (2-b)

### Check your progress 6

Answers: (1-d), (2-a)

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## 2.10 Glossary

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1. **User** - The person who uses design or product.
2. **Vendor** - A company which provides goods or services related to items, typically prototype or production components.

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## 2.11 Assignment

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Write the role of Industrial engineering.

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## 2.12 Activities

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Collect information on steps required in Planning and designing of equipments in factory.

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## 2.13 Case Study

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Prepare a project report about Work Study of process in chemical industry?

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## 2.14 Further Readings

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1. Nichols, R. G., and Stevens, L. A., "Listening to people", Harvard Business Review, September-October, 1957, Boston, Mass.
2. Rennie, H., What Did You Say, Achiever, 1986, Associated Management Institute.
3. Schantz, J. J., Videotape Recording Saves Time for I.E.", Industrial Engineering, Institute of Industrial Engineers Management Press, Norcross, Ga., July, 1981.



**: UNIT STRUCTURE :**

- 3.0 Learning Objectives**
- 3.1 Introduction**
- 3.2 Concept of Sales Forecasting**
- 3.3 Importance of Sales Forecasting**
- 3.4 Objectives of Sales Forecasting**
- 3.5 Techniques of Sales Forecasting**
- 3.6 Limitations of Sales Forecasting**
- 3.7 Approaches to Sales Forecasting**
- 3.8 Let Us Sum Up**
- 3.9 Answer for Check Your Progress**
- 3.10 Glossary**
- 3.11 Assignment**
- 3.12 Activities**
- 3.13 Case Study**
- 3.14 Further Readings**

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**3.0 Learning Objectives**

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After reading this Unit, you will be able to :

- Need of Sales Forecasting
  - Uses of Sales Forecasting
  - Features of Sales Forecasting
- 

**3.1 Introduction**

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Sales forecasting, though crucial, is one of the grey areas of management. It is a grey area in the sense that it is based on a number of assumptions regarding customer and competitor behaviour as well as the market environment, and therefore, its reliability depends upon the extent of culmination of the uncertainty as predicted. The preparation of a sales forecast requires (a) the availability of historical information on the product and industry sales, (b) identification of product sales determinants, (c) prediction regarding the behaviour of market forces for the period under forecast, (d) use of appropriate techniques for forecasting, (e) judgement of executives preparing the sales forecast, and (f) the firm's market share objectives.

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**3.2 Concept of Sales Forecasting**

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Sales forecast is an estimation of sales volume that a company can expect to attain within the plan period. A sales forecast is not just a prediction of sales. It is the act of matching opportunities with the marketing efforts. Sales forecasting is the determination of a firm's share in the market under a specified future. Thus sales forecasting shows the probable volume of sales.

1. **General Economic Condition :** It is essential to consider all economic conditions relating to the firm and the consumers. The forecaster must see the general economic trend-inflation or deflation, which affect the business favourably or adversely. A thorough knowledge of the economic, political and the general trend of the business facilitate to build a forecast more accurately. Past behaviour of market, national income, disposable personal income, consuming habits of the customers etc., affect the estimation to a great extent.
2. **Consumers :** Products like, wearing apparel, luxurious goods, furniture, vehicles; the size of population by its composition-customers by age, sex, type, economic condition etc., have an important role. And trend of fashions, religious habits, social group influences etc., also carry weights.
3. **Industrial Behaviours :** Markets are full of similar products manufactured by different firms, which compete among themselves to increase the sales. As such, the pricing policy, design, advanced technological improvements, promotional activities etc., of similar industries must be carefully observed. A new firm may come up with products to the markets and naturally affect the market share of the existing firms. Unstable conditions—industrial unrest, government control through rules and regulations, improper availability of raw materials etc., directly affect the production, sales and profits.
4. **Changes within Firm :** Future sales are greatly affected by the changes in pricing, advertising policy, quality of products etc. A careful study in relation to the changes on the sales volume may be studied carefully. Sales can be increased by price cut, enhancing advertising policies, increased sales promotions, concessions to customers etc.
5. **Period :** The required information must be collected on the basis of period—short run, medium run or long run forecasts.

### Check your progress 1

1. What is sales forecasting?
  - a. It is an estimation of sales volume that a company can expect to attain within the plan period
  - b. It is the act of matching opportunities with the marketing efforts
  - c. It is the determination of a firm's share in the market under a specified future.
  - d. All of these

---

### 3.3 Importance of Sales Forecasting

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Sales forecast is an estimate of Sales, in monetary or physical units, for a specified future period under a proposed business plan or programme and under an assumed set of economic and other forces outside the unit for which the forecast is made.

1. Supply and demand for the products can easily be adjusted, by overcoming temporary demand, in the light of the anticipated estimate; and regular supply is facilitated.

2. A good inventory control is advantageously benefited by avoiding the weakness of under stocking and overstocking.
3. Allocation and reallocation of sales territories are facilitated.
4. It is a forward planner as all other requirements of raw materials, labour, plant layout, financial needs, warehousing, transport facility etc., depend in accordance with the sales volume expected in advance.
5. Sales opportunities are searched out on the basis of forecast; and thus discovery of selling success is made.
6. It is a gear, by which all other activities are controlled as a basis of forecasting.
7. Advertisement programmes are beneficially adjusted with full advantage to the firm.
8. It is an indicator to the department of finance as to how much and when finance is needed; and it helps to overcome difficult situations.
9. It is a measuring rod by which the efficiency of the sales personnel or the sales department, as a whole, can be measured.
10. Sales personnel and sales quotas are also regularized-increasing or decreasing-by knowing the sales volume, in advance.
11. It regularizes productions through the vision of sales forecast and avoids overtime at high premium rates. It also reduces idle time in manufacturing.
12. As is the sales forecast, so is the progress of the firm. The master plan or budget of a firm is based on forecasts. The act of forecasting is of great benefit to all who take part in the process, and is the best means of ensuring adaptability to changing circumstances. The collaboration of all concerned leads to a unified front, an understanding of the reasons for decisions, and a broadened outlook. 1. Supply and demand for the products can easily be adjusted, by overcoming temporary demand, in the light of the anticipated estimate; and regular supply is facilitated.

### **Check your progress 2**

1. What is the importance of sales forecasting?
  - a. Supply and demand for the products can easily be adjusted,
  - b. Allocation and reallocation of sales territories are facilitated
  - c. Both A and B
  - d. None of these

---

### **3.4 Objectives of Sales Forecasting**

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A sales forecast is an important component of any business plan. For the sales rep, as well as the entire organization, a sales forecast aims to predict future sales and is used as the basis of planning time and resources. A good forecast should have several objectives, all directed at identifying what you will sell, when you will sell it and to whom.

Sales forecasting provides a business with a set of predictions about the kinds of sales it can expect on a month-to-month basis, typically within a one-year timetable. Many sales forecasts use statistical data and techniques, such as regression analysis, to make predictions. Other approaches make educated guesses about how current economic and social trends will play out in the future and the impact of those trends on sales. A sales forecast helps businesses manage several key objectives.

### **Budgeting**

While a sales forecast only offers a prediction, it allows the business owner to make reasoned decisions about how to spend. For example, the owner can use the forecast to set a static budget for each month that covers payroll, rental costs and utilities in order to keep valuable staff during low profit periods. The business owner also can use the forecast to plan implementation of an expensive change initiative right after a peak sales period, because the business can ensure enough working capital to support the project.

### **Staffing**

For seasonal businesses that experience a large upswing in demand only at certain times, the sales forecast can help to determine appropriate staffing levels for those periods. Tax preparation services, for example, see heavy demand in the spring. If the forecast calls for double the sales in the spring, the business might hire one additional person, while a forecast of quadruple the sales might call for two or three additional staff members. In other cases, an anticipated slow period may lead the owner to trim hours across the board, rather than reducing total staff.

### **Production/Purchasing**

Businesses that manufacture a product also can use sales forecasts to make tentative plans for materials purchasing and production levels. For example, if there is a predictable drop-off in demand during summer months and a correlated drop in material costs due to lower demand, the business might reduce production levels and increase material purchasing during those months. Some businesses choose to use predictable downtime to increase available stock as preparation for anticipated upswings in sales.

### **Investors**

A sales forecast also can help business owners secure additional funding. Unlike the present value of a business, typically based on assets, the sales forecast helps to show what kind of return on investment the business is likely to generate for potential investors. A sales forecast that shows projected sales in excess of the present value of the business makes a strong argument for investing, since the investors can anticipate a higher return on investment.

### **Check your progress 3**

1. What are the objectives of sales forecasting?
  - a. Budgeting
  - b. Staffing
  - c. Production/Purchasing
  - d. All of these



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### 3.5 Techniques of Sales Forecasting

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Every company that uses sales forecasts possesses its own technique to approach the forecasting process. Some companies have a dedicated team of forecast professionals while others use the sales staff to generate the forecast. The statistical methods used to generate the sales forecast depend on the demand profile of the product. Statistical forecast methods vary widely and finding the right method often boils down to trial and error.

#### **Decomposition**

Decomposition stands as one of the most common statistical sales forecasting methods. Decomposition belongs to the time series family of forecasting methods. Decomposition looks at each component separately to determine a forecast value for the specified component and then combines the data output into an overall forecasted value. A variety of statistical decomposition methods exist.

#### **Simple Exponential Smoothing**

Unlike decomposition, which uses the entire history of a product as the forecast input, simple exponential smoothing uses a weighted moving average. Because simple exponential smoothing seeks to reduce, or smooth out, the irregular patterns in a product over time, this forecasting method works best with products whose main component exhibits strong cyclical and irregular patterns.

#### **Census X-11**

Census X-11 resembles a standard decomposition method because it uses the same variables trend, seasonality, cyclicity and irregularity as forecast inputs. The difference comes from how it uses these variables. It places more emphasis on the seasonal and cyclical components of the product. Census X-11 also uses a specific number of trading days in the month. Using trading days allows this forecast method to weigh the future forecast by the number of trading days used in the forecast input.

#### **Techniques**

All forecasters use a different technique when performing forecasting activities. Some forecasters prefer to forecast in a vacuum&mdash;not using input from other sources other than the data. This technique rarely works for any extended period of time. In most businesses the best source of data comes from the human elements involved in the business. Forecasting in a vacuum disregards this important source of data. Collaborative forecasting techniques such as collaborative planning, forecasting and replenishment use internal company resources and resources from suppliers to create a mutually agreed upon forecast.

#### **Considerations**

When considering what forecast methods and techniques to use remember this, forecasts are always wrong. The best method and technique is the one that keeps the business running efficiently and at the least cost.

#### **Check your progress 4**

1. Which of the following techniques of sales forecasting uses a weighted moving average?
  - a. Census X-11
  - b. Simple Exponential Smoothing
  - c. Decomposition
  - d. All of these

2. What is census X-11?
  - a. It uses the same variables trend, seasonality, cyclical and irregularity as forecast inputs.
  - b. It uses a weighted moving average
  - c. It belongs to the time series family of forecasting methods
  - d. None of these

---

### **3.6 Limitations of Sales Forecasting**

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Sales forecasting is actually the art and science of predicting the future demands by anticipating how consumers are likely to behave in a given set of circumstances. A company might ask †what will be the demand if real incomes increase by 10% or how would the demand be impacted if a competitor launches a similar product. Other functions in organization – production, purchasing, finance, HR plans – are also affected by the sales forecast.

#### **Lack of Sales History**

Sales forecast are based upon what the company has been able to achieve in the past. Early stage companies do not have significant revenue history to rely on. They may be anticipating rapid growth, but forecasting exactly what the growth rate might be is difficult. Companies expecting high revenue growth also find it difficult to accurately forecast what sales might be without a track record to base projections on.

#### **Difficulty Forecasting the Industry and Competition**

Industry conditions and the competitive environment both affect a company's sales potential. You must forecast how you believe the industry will grow in the next year and whether competition will become more intense. Both of these factors are in flux. For example, the national economy could go into an unexpected slump that negatively affects your industry's growth. New competitors could enter the market and implement their own strategies to try to take sales away from your company. This state of constant change limits your ability to make sales forecasts you can depend on.

#### **Tendency to be Optimistic**

You should always involve the members of your sales staff in the forecasting process. They are in close contact with your customers and have a good feel for how the business environment is now and is likely to be next year. However, salespeople tend to be optimistic. They always believe they can exceed the sales performance they achieved in the past. If you have five equally optimistic salespeople and they each give you sales goals for the upcoming year, you are likely to end up with a total company forecast that is too optimistic. Part of the owner's task is to temper this optimism so the forecast is achievable.

#### **Consumer Behavior is Hard to Predict**

A small-business owner and his marketing staff are never absolutely certain their marketing message will resonate with the target customers, or whether they have chosen the best media to deliver the message. This uncertainty leads to both revenue surprises and disappointments. Ultimately, the customers wield the power.

They may not be convinced by your marketing campaign that your products or services are superior to those offered by your competitors. Also, consumer tastes and preferences may change during the course of the year.

### **Management Inflexibility**

The effectiveness of the sales forecasting process can be limited by the inflexibility of the company owner, if you view the sales targets as set in stone. If significant negative variances to forecast occur, some owners don't adjust them but instead try to motivate the sales staff to work harder. This can result in frustration and a drop in sales staff morale, because sales staff compensation is at least partially based on reaching the targets. A better approach is to use a rolling 12-month forecast that is adjusted each quarter as actual results are posted. This method recognizes that the business environment is constantly changing.

### **Check your progress 5**

1. What are the limitations of sales forecasting?
  - a. Management Inflexibility
  - b. Lack of Sales History
  - c. Difficulty Forecasting the Industry and Competition
  - d. All of these

---

## **3.7 Approaches to Sales Forecasting**

---

Forecasting, rudiment point of planning, from a marketing standpoint, is the tactics of predicting alterations in the marketing environment, so that organizations can contrive strategies to encounter them when they occur.

The sales forecast is an anticipation of sales, in monetary or physical unit for a defined period of time, in a specified marketing circumstances and geographical extent under a particular set of marketing programme.

There are three basic approaches to sales forecasting: the opinion approach which is based on experts judgements; the historical approach, which is based on past experience and knowledge; and the market testing approach, which is based on testing market through survey and research. No one technique of sales forecasting can be applied to all organizations, nor all factors that set a sales forecast be supplied by one individual or statistical department.

Depending upon the type of problem involved, and the degree of accuracy needed a concern selects the approach which may be more suitable to achieve the predetermined goal. In the following lines, an attempt has been made to make a brief study of the various approaches of sales forecasting.

### **I. Opinion approach :**

The opinion approach is based on cogitation of executives, experts and specialists. Experts' opinions, views of sales force composite and survey of buyers' intentions are all used in the opinion approach. Let us analyze them briefly:

#### **(i) Experts opinion :**

In this technique information's are amassed from experts including economists, marketing consultants, suppliers, distributors and trade associations,

inside or outside the concern. One or more experts forecast future sales based on personal cognition, from discussing with other experts, through customer contacts or through reciting resplendent reports related to national economy and industrial state.

The advantages of this method of forecasting are that different points of view are achieved quickly and inexpensively. But the greatest drawback of this method is subjectivity and hence they lack scientific validity and can be deceptive.

**(ii) Sales-force composite :**

The sales force composite is a forecast arrived at by gathering estimates from each salesperson of the organization products. Sales managers presumably know more about their own territory or region than others in the organization.

Salesmen have first hand information because they are indirect contact to buyers. Each and every salesman submits his sales estimation to be hopped in his region. The summation of the estimates of all salespersons is named sales forecasting. The estimates may be submitted annually at the start of the annual forecast or continuously in what marketers call rolling forecasts. Several arguments favour sales-force composites.

First being closest to the customers, salesman may have more knowledge than any other. Second if the sales force is actually involved in forecasting, it has a greater incentive to achieve the desired sales quotas. Finally, this method is easy, economical, consistent and reliable. The weaknesses of sales-force composite method are: First, salesperson has keen interest in sales and they can make hasty estimates which may be disastrous also.

Some salesmen may be over-pessimistic or over-optimistic regarding future sale opportunities. Second after salesperson are unknown about economic fluctuations for that they are unable to predict long term trends. Third if the quota of salesmen is fixed then they will estimate low quoting.

**(iii) Survey of buyers' intention :**

Since sales forecasting is the art of anticipating what buyers are likely to do under a given set of conditions, it is most useful to take a survey of the opinions of potential buyers themselves. Buyers are solicited to communicate their buying intentions in forthcoming period. Here information can also be gathered from governmental agencies, trade associations and educational institutions.

For example, American Airlines conducts regular polls of its passengers and comprising the results with general industry information and government statistics to predict future levels of air traffic. If buyers' purchase estimates are accurate, our sales forecasts may be useful. But experience has shown that a market survey approach is really practical only when concern is selling specialized costly goods.

The market survey approach is of value basically for industrial products and consumer durable products where advanced planning is required and for new products where past data do not exist. Another objection raised to this method is that in the case of consumer convenience goods, it would be prohibitively costly in terms of money and time, to pay a personal call on every customer. But this problem can be solved by statistical sampling.

## II. Historical approach :

Another approach for sales forecast is to employ the quantitative data from past sales results for predicting future. The popular methods of correlating data include time series projections and statistical projections. Let us analyze them briefly.

(i) **Time-series projections :** Under this method forecasts are made on the basis of statistical-mathematical analysis of past data. The logic underlying this approach is that past data are an expression of enduring causal relationships that can be uncovered through quantitative analysis. Changes in a time series are attributable to many components, which can be classified into four major heads, according to the nature of these factors, as

- (a) Secular Trend (T) the result of long term basis developments in population, production, money in circulation and technology;
- (b) Cyclical Variations (C) Oscillatory movements related to change in business cycles (prosperity, recession, depression and recovery) from time to time;
- (c) Seasonal Variations (S) a recurrent pattern of sales within the year, whether it be on a seasonal, quarterly, monthly, weekly or even hourly basis;
- (d) Erratic Variations (E) random nature and arise on account of sporadic factors e.g., strikes, lock-outs, fires, wars, riots etc. All the four components interact with the original sales series (Y) in the following way :

$$Y=f(T, C, S, E)$$

In this case T is stated in absolute values and C, S, E are stated as percentages. Two models are commonly used for the dis-composition of a time series into its components. According to additive model time series can be expressed as  $Y=T+C+S+E$  and according to multiplication model  $Y=T \times C \times S \times E$

E. The multiplication model assume in more realistic way that C, S, and E are proportional to the trend level of sales.

The time series projection does not take into consideration effect of marketing programmes, which must be built into the final forecast, but for most companies the time-series projection in the objective and quantitative method most frequently used. This type of model has gained its greater acceptance is business concerns.

(ii) **Statistical projections :** Time series projection treats past and future sales of any product as a function of period of time, rather than of any authentic demand factors. Various real factors also affect the sale of any product. A statistical projection is a correlation between past sales and various factors relating to market demand.

The concern tries to discover the most important factors affecting the sales of a product and to understand how these factors can be predicted

and related to future sales. This method brings out hidden relationship that the organization had not thought to consider but that may have an important impact on sales.

The factors related to consumer, which are most commonly analyzed are income, population, price-levels and promotion expenditures. The basic formula for statistical demand analysis is as follows:

$$Y=f(X_1, X_2, X_3 \dots X_n)$$

Here the procedure consists of expressing sales (Y) as a dependent variable and trying to explain sales variation as a consequence of variation in a number of independent demand variables  $X_1, X_2 \dots X_3 \dots X_n$ . The demand equations are derived by trying to fit the 'best equation' to historical data. This method is easy, economical, reliable and conspicuous but to find out economic indicators of related sales is much difficult and we cannot apply this method for new products.

### III. Market testing approach :

Under this approach for testing market the product is sold for a definite period of time under actual conditions. The goal of market testing is to validate the results obtained from prototype testing and early consumer research by prolonging these results to a representative sample of the market.

Test marketing is the stage where all the product and marketing plans is tried out for the first time in a small number of well chosen and authentic sales environments. Thus the sales forecast is made for a year on the basis of the result obtained from a real sale in a part of the market.

This method is more suitable for new products and the can sure of the market can also be removed because the real position of the market is known to the executives. We may thus, conclude that sales forecast determines the expected level of sales based on a chosen marketing plan and environmental conditions.

Sales forecast is the core of the arch of structure of modern marketing research. For marketing department accurate and authentic sales forecast is the key to the planning of promotion policies, to management of inputs for reallocation of sales territories and quota for establishing control and incentives to reducing marketing risk, for setting budgetary contrivances and to all other activities of marketing.

Adequate marketing planning will become essential quanon for integrated marketing action. Since the gigantic mansion of market planning is fabricated on the support of sales forecasting, it seems palpable that for developing more adequate and reliable sales forecasts, a growing amount of time and money will be invested by organizations. Sales are forecasted on the basis of historical data and various changing factors. At present in our developing economy it is difficult to forecast the future tendencies. Generally these- forecasting are made by some specialized agencies. From opera•tional point of view permanent staff should be appointed for MR and sales forecasting so that they will be known about each and every factor and authentic results can be expected. On the place of moment research for market measurement continuous information flow is needed.

### Check your progress 6

1. What are the components in Time series Projection?
  - a. Time-series projections
  - b. Secular Trend
  - c. Cyclical Variations
  - d. All of these
2. Which of the following is the type of opinion approach?
  - a. Market testing approach
  - b. Experts opinion
  - c. Secular Trend
  - d. None of these

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### 3.8 Let Us Sum Up

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In this unit we have learnt that sales forecast appears as an estimate of sales volume which a company expect to attain within the plan period.

We see that sales forecast is not just a sales predicting but is also act of matching opportunities with marketing efforts. It shows firm's share in market under specified future. Sales forecast is estimate of Sales in monetary or physical units for future period under proposed business plan or programme with assumed set of economic and other forces outside unit where forecast is made. Sale forecast is important component of business plan and for organization, as it aims to predict future sales and is applied as basis of planning time and resources.

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### 3.9 Answer for Check Your Progress

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#### Check your progress 1

Answers: (1-d)

#### Check your progress 2

Answers: (1-c)

#### Check your progress 3

Answers: (1-d)

#### Check your progress 4

Answers: (1-b), (2-a)

#### Check your progress 5

Answers: (1-d)

#### Check your progress 6

Answers: (1-d), (2-b)

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### 3.10 Glossary

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Sales forecast: it is a way to predict the sale of products.

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### 3.11 Assignment

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Write note on forecasting of products in an Industry.

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### 3.12 Activities

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Collect information about how a manager will predict his sales target based on sales forecasting.

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### 3.13 Case Study

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With reference to products in a Company, suggest the required steps to Product Manager for his products based on sales prediction?

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### 3.14 Further Readings

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1. Bateson, John E. G. and K. Douglas Hoffman (1999), Managing Services

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## **Block Summary**

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This block give detailed information about concept of Work Study, Method Study, Work Measurement, Productivity related to Industrial Engineering. The block explained more about the features and characteristics of a Good Design. The knowledge about Product Design and Process Design are also detailed.

After studying this block, students understand correctly about features and concepts related to Sales Forecasting of products with its role and usage with depth illustrations. The concept of various applications of Industrial Engineering will give students about detailed understanding of aspects of Industrial experience.



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**Block Assignment**

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**Short Answer Questions**

1. List few Product Design and Development?
2. What is Product Development Process?
3. State the benefits of Sales Forecasting?
4. How Industrial Engineers plays important role in company?
5. Is Productivity required to be increased for Work flow?

**Long Answer Questions**

1. What is Process Design?
2. What are the applications of Industrial Engineering?
3. Concept of Work Measurement.

**Enrolment No. :**

1. How many hours did you need for studying the units?

Unit No    1    2    3

Nos of Hrs

2. Please give your reactions to the following items based on your reading of the block :

Items	Excellent	Very Good	Good	Poor	Give specific example if any
Presentation Quality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Language and Style	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Illustration used (Diagram, tables etc)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Conceptual Clarity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Check your progress Quest	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Feed back to CYP Question	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____

3. Any Other Comments

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**Dr. Babasaheb  
Ambedkar  
Open University**

**BBAR-404**

# **MANAGEMENT AND OPERATION MANAGEMENT**

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**BLOCK-4 OPERATION RESEARCH, BREAK EVEN ANALYSIS  
AND CONTEMPORARY ISSUES**

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## **UNIT 1**

USE OF OPERATION RESEARCH IN SOLVING PRODUCTION  
PROBLEM

## **UNIT 2**

VALUE BREAK EVEN ANALYSIS

## **UNIT 3**

LEAN MANUFACTURING

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**BLOCK-4 OPERATION RESEARCH, BREAK EVEN ANALYSIS  
AND CONTEMPORARY ISSUES**

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**Block Introduction**

Operations research deals in research on operations which is normally applicable to problems involved in how to conduct and coordinate operations inside an organization. Operations research applies sophisticated statistical analysis and mathematical modelling to solve an array of business and organizational problems, as well as improve decision-making. As the business environment grows more complex, companies and government agencies rely on analysis to inform decisions that were once based largely on management intuition. In this block, students will get knowledge about the concept of Operations research and its applications in research and operations and ways to solve problems associated with it. The concept and working of various operational research models will be explained to the students along with comparison of simple model and complex model detailed. The block will detail about the study of verbal models and its calculations involved which will help the students to represent some objects for further understanding.

After studying this block, students will be able to understand correctly about the steps involved in calculating break-even point for volume of production of goods. The concept of studying Break-Even charts by respective staff along with the use will help student to know better about the usability of Break-Even charts.

**Block Objective**

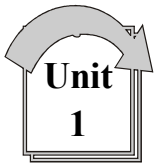
- After completing this block, students will be able to :
- Acquire knowledge about Operation Research
- Understand the different Operation research models
- Understand the Value Break Even Analysis
- Know about Value Break Even Chart
- Understand different techniques of Operations Research
- Assumptions and Limitations of Value Break Even Analysis

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**Block Structure**

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<b>UNIT 1</b>	<b>USE OF OPERATION RESEARCH IN SOLVING PRODUCTION PROBLEM</b>
<b>UNIT 2</b>	<b>VALUE BREAK EVEN ANALYSIS</b>
<b>UNIT 3</b>	<b>LEAN MANUFACTURING</b>



USE OF OPERATION RESEARCH IN SOLVING  
PRODUCTION PROBLEM

**: UNIT STRUCTURE :**

- 1.0 Learning Objectives**
- 1.1 Introduction**
- 1.2 Evaluation of Operation Research**
- 1.3 Nature of Operation Research**
- 1.4 Characteristics of Operation Research**
- 1.5 Phases of Operation Research**
- 1.6 Scope of Operation Research**
- 1.7 Methodology of Operations Research**
- 1.8 Models in Operations Research**
- 1.9 Classification of Operation Research Model**
- 1.10 Characteristics of a Good Model**
- 1.11 Operations Research and Managerial Decisions Making**
- 1.12 Advantages of Operations Research**
- 1.13 Techniques of Operations Research**
- 1.14 Limitations of Operations Research**
- 1.15 Let Us Sum Up**
- 1.16 Answer for Check Your Progress**
- 1.17 Glossary**
- 1.18 Assignment**
- 1.19 Activities**
- 1.20 Case Study**
- 1.21 Further Readings**

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**1.0 Learning Objectives**

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After reading this Unit, students will be able to :

- Understand the concept of Operation Research
- Understand characteristics of a Good Model.
- Know about Operations Research and Managerial Decisions Making
- Understand different techniques of Operation Research
- Know about the advantages and limitations of Operation Research

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## 1.1 Introduction

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Operations Research is a science involved in decision making which provides systematic and scientific approach to every government, military, manufacturing, and service operations. Operations Research is a good area for mathematical graduates where they can use their knowledge and skills in solving complex problems. Steps in Operations Research needed for effective decision– making are :

- Problem Formulation
- Data Collection
- Validation and Analysis
- Interpretation and Implementation
- Mathematical Modelling
- Solution Methods

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## 1.2 Evaluation of Operation Research

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Operations Research is an approach which is applied to enhance service delivery or can strengthen several different aspects of a program. It is included as diagnostic or evaluative studies and are applied for following intervention study steps :

- Locating problems related to service delivery;
- Locating possible strategies to address such problems;
- Test of certain strategies under quasi experimental conditions;
- Disseminating findings to program managers and policymakers
- Enhancing the service delivery programs using the required information.

The technique is especially connected for testing of new and possibly disputable methodologies which are identified with administration conveyance. In this, the association who wishes to actualize such system will try different things with new approach on constrained scale, without really receiving such technique. On the off chance that the procedure comes about ineffectual or makes undesirable political reaction, under such circumstance, the association need to choose whether to suspend with such technique and seek after option approaches or to receive other innovation including little cost. If there should be an occurrence of mediation bringing about adequacy and is adequate to the association, then in such circumstance, the association will make utilization of results to legitimize selection/ development of intercession in an association. It is noticed that the consequences of fruitful Operations Research venture prompts different associations to receive comparable intercession in their projects.

### Check your progress 1

1. What is operation research?
  - a. Operations Research is a science involved in decision making which provides systematic and scientific approach.
  - b. Operations Research is an approach which is applied to enhance service delivery

- c. Both A and B
  - d. None of these
2. Operation research can be applied for
- a. Locating possible strategies to address service delivery problems
  - b. Test of certain strategies under quasi experimental conditions
  - c. Disseminating findings to program managers and policymakers
  - d. All of these

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### 1.3 Nature of Operation Research

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Operations research deals in examination on operations which is ordinarily relevant to issues required in how to lead and arrange operations inside an association. The way of association is for the most part insignificant, and with use of Operations examination, numerous assorted territories identified with assembling, transportation, development, broadcast communications, budgetary arranging, social insurance, military and open administrations turns out to be abnormally wide.

In the exploration piece of name, operations research utilizes a methodology which is like the way research is done in built up experimental fields. To an extraordinary level, the logical technique is connected keeping in mind the end goal to discover the issue of concern especially where process began via precisely watching and defining the issue utilizing required information. After this, an investigative model was developed where edited compositions are quintessence with genuine issue. It is then expect that such model is an adequately exact representation of required elements of circumstance where we get conclusion from the model that is legitimate for genuine issue. Further, appropriate examinations are done to test such theory which gets modified according to the requirements and gets in the long run checked certain types of speculation. Along these lines, in certain sense, operations research takes think about innovative investigative exploration which gets encircled into essential properties of operations. Nonetheless, there is a whole other world to it than this. In particular, Operations examination is likewise worried with the functional administration of the association. Consequently, to be fruitful, Operations research should likewise give positive, justifiable conclusions to the choice maker(s) when they are required. Still another normal for Operations examination is its expansive perspective. As suggested in the previous segment, Operations research receives an authoritative perspective. Subsequently, it endeavors to determine the irreconcilable situations among the parts of the association in a way that is best for the association all in all. This doesn't suggest that the investigation of every issue must give express thought to all parts of the association; rather, the destinations being looked for must be reliable with those of the general association.

Aside from above, Operations scrutinize as often as possible endeavours to find the best answer for specific issues. In spite of just enhancing business as usual, the thought behind Operational examination is to locate the most ideal game-plan. In spite of the fact that it must be translated precisely as far as the viable needs of administration, this "quest for optimality" is a critical subject in Operations

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research. Every one of these qualities lead actually to even now another. It is apparent that no single individual ought to be relied upon to be a specialist on all the numerous parts of Operations exploration work or the issues ordinarily considered; this would require a gathering of people having various foundations and abilities. In this manner, when a complete Operations research investigation of certain issue is embraced, it is ordinarily required to utilize group approach that commonly needs to incorporate people those are prepared in arithmetic, insights and likelihood hypothesis, financial matters, business organization, software engineering, building and physical sciences, with exceptional strategies that can be connected in Operations research. The group additionally needs the fundamental experience and assortment of abilities to give proper thought to the numerous consequences of the issue all through the association.

**Check your progress 2**

1. Operation research used in the field of
  - a. Manufacturing
  - b. Transportation
  - c. Construction
  - d. All of these

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**1.4 Characteristics of Operation Research**

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There are certain characteristics features of Operational Research such as :

- (a) Inter–disciplinary Team approach featured that an individual can be an expert on all aspects of problem where a team confronted with new problem finds a solution of the problem with such approach. With this, every member in a team will use his experience and expertise and will suggest suitable approach for solving other problems
- (b) It is a regular process which cannot stop on application of model to one problem whereby creating new problems in other sectors while taking a decision. It shows organizational changes which is needed to implement decisions and control the results.
- (c) It attempts to locate superior or optimal solution to problem under consideration by defining effective measure which takes into account the objectives of an organization. Being a scientific study of large systems, it identifies problem areas and provide managers with quantitative decisions that upgrades the effectiveness in getting required objectives.
- (d) It enhances the creative ability of decision maker.
- (e) It is a decision making science which will open new problems for study methods.
- (f) It examines functional relationships from a systems overview.
- (g) It shows bad answers to problems in scenario of worst situation, hence it is study which improves only quality of solution.
- (h) It uses scientific method where the process started with careful observation and formulation of problem by framing scientific model for getting observations that will attempt to abstract the essence of required problem.
- (i) It replaces management by personality.

- (j) It is normally for operation economy where confects uncertainty and complexity appearing in a situation will help thereby reducing costs and enhancing the profits and effect substantial operations Economy.

### Check your progress 3

1. What are the main characteristics features of Operational Research?
  - a. It examines functional relationships from a systems overview
  - b. It enhances the creative ability of decision maker
  - c. It replaces management by personality
  - d. All of these

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## 1.5 Phases of Operation Research

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There are different phases of Operational Research such as :

- Observe the Problem Environment
- Analyse and define the problem
- Develop a model
- Selection of data input
- Solution and testing
- Implementation of the solution

### Observe the Problem Environment

This is the first phase of Operational Research study where initially Problem environment was observed where problem exists. In this, certain activities like visits, conferences, observations, research etc will take place where analyst will these activities gets required information and support to proceed and is better prepared to formulate the problem.

### Analyse and Define the Problem

This is the second phase of Operational Research study where not only problem is defined but it takes care about uses, objectives and limitations of study for the required problem. In this, the output appears as clear grasp of requirement for particular solution and understanding of its nature.

### Develop a Model

This is the third phase of Operational Research study where we have to create a model that shows real or abstract situation which are mathematical models describing about systems, process or environment through equations, relationships or formulae. Here the interrelationships among variables, formulating equations, are defined with Operational Research models.

### Selection of Data Input

This is the fourth phase of Operational Research study where fact are established without authentic and appropriate data with untrusted results of models. Here getting correct data is important step where activities involved related to analysing internal–external data and facts, collecting opinions and applications of computer data banks occurs. The idea of this phase is to have sufficient input to operate and test the model.



### **Solution and Testing**

This is the fifth phase of Operational Research study where solution of problems is obtained using model and data input. In this, solution is not implemented immediately and is applied in order to test the model for obtaining limitations if any. In case of not reasonable result, updating and modification of model is considered where output appear as a solution which is desirable and supports present organisational objectives.

### **Implementation of the Solution**

This is the sixth phase of Operational Research study where decision making results as scientific and implementation of decision uses certain behavioural issues. With this, the implementing authority needs to solve behavioural issues which cover workers and supervisors in order to avoid conflicts. In this, a properly implemented solution by Operational Research techniques results in improved working conditions and wins management support

### **Check your progress 4**

1. Which of the following are the phases of operation research?
  - a. Observe the problem environment
  - b. Analyse and define the problem
  - c. Develop a model
  - d. All of these
2. In which of the following phase activities like visits, conferences, observations, and research will take place?
  - a. Analyze and define the problem
  - b. Observe the Problem Environment
  - c. Solution and Testing
  - d. None of these

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## **1.6 Scope of Operation Research**

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It is noted that in present years of organized development, Operational Research enters in many different areas of research such as:

### **In agriculture**

With sudden increase of population and shortage of food, all countries are facing problem related to:

- Favorable allocation of land to many crops based on certain climatic conditions
- Favorable distribution of water from many resources like canal for purpose of irrigation

With this there appear needs of finding suitable policies with such limitations by providing good quantity of work in such domain.

### **In finance**

In present days, it is essential for all government to plan carefully for economic progress of country. Hence the Operational Research techniques can be productively applied in order to:

- Find profit plan for company
- Maximize per capita income with low amount of resources
- Decide on best replacement policies

### **In industry**

We see that when industry manager frames the policies based on past experience then in his absence, a serious loss could encounter ahead of industry which can be compensated by recruiting specialist which by applications of Operational Research, will make the industry to decide upon optimum distribution of limited resources such as manpower, machines, material, in order to reach at optimum decision.

### **In marketing**

By using, Operational Research techniques, marketing administrator will decide upon

- Location of products for sale to lower the transportation cost
- Minimum per unit sale price
- Size of stock which come across with future requirements
- Selecting best advertising media in terms of cost, time etc
- Procurement of goods at minimum cost

### **In personnel management**

The personnel manager will make use of Operational Research techniques in order to :

- Appoint highly suitable person on minimum salary
- Know best age of retirement for employees
- Locate number of persons appointed as full time in case of seasonal workload

### **In production management**

A production manager will make use of Operational Research techniques so as to :

- Find number and size of items to be produced
- Schedule and sequence production machines
- Compute optimum product mix
- Select, locate and design sites as per production plans

### **In Decision–Making**

Operation Research techniques are considered as good tool that helps in increasing the efficiency of management decisions. Its objectives are complement to subjective feeling of administrator while its scientific method are applied to comprehend and explain phenomena of operating system.

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- There are certain advantages of Operational Research study in business and management which helps in taking appropriate decision and can help in following activities as :
- The management of big companies finds it expensive in order to give continuous executive supervisions over routine decisions. This approach directs the executives to plan their concentration to more pressing matters. Many times it is noticed that Operational Research results as helpful tool in saving law and order situation. This planning model serves as a vehicle that coordinates marketing decisions with restrictions forced on manufacturing capabilities.
- The study of Operational Research initiates to examine problem of decision making as this approach develops into system to be employed frequently.
- With study of Operational Research models, it helps in enhancing intuitive decisions. In case of complex situations, human mind never expect to assimilate all significant factors without Operational Research and computer analysis.

**Check your progress 5**

1. How operational research technique does help in finance field?
  - a. By finding the number and size of items to be produced
  - b. By selecting Location of products for sale to lower the transportation cost
  - c. By Finding profit plan for company
  - d. None of these
2. Operation Research can be used in
  - a. Production Management
  - b. Industry
  - c. Agriculture
  - d. All Of These

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**1.7 Methodology of Operations Research**

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The systematic methodology developed for Operational Research study problems involving conflicting among multiple objectives policies and alternatives. In final analysis, Operational Research serves as scientific methodology that applies to the study of operations of big organizations or activities thereby assessing overall implications of alternative actions and providing improved management decisions. Solving Operations Research problem is not a linear process where process breaks down into steps as :

- Describing the problem;
- Formulating Operations Research model;
- Solving Operations Research model;
- Performing analysis of solution;
- Presenting solution and analysis

We see that in every process, there appears feedback loops as after modelling and solving problem, the need for validity of solution should be considered. In case of an invalid solution, there are provisions to alter or update formulation in order to integrate new understanding of the problem. Let's consider the five steps of Operations Research methodology :

### **Describing the Problem**

The idea behind this step is to come with formal, rigorous model description by optimising the project with abstract description of a problem along with data. After having the problem, consider data available with more rigorous model description for formulation. Many times, the data received will not be of full use or sometimes the limitations of data significantly changes model description and subsequent formulation.

### **Formulating the OR Model**

This will translate problem details into required Operational Research model where implementation is quite different. In case of linear programming are to be used to solve problem, then formulating Operational Research model will involve translating of problem into linear programme. In case of simulation are used for solving the problem, then formulating Operational Research model involves break down of the behaviour of system which are simulated in sequence of events there finding random variables which drives the simulation.

### **Solving the OR Model**

The idea of this phase is to solve Operational research model as per the formulation step depending on model used. Normally in this, there are more than one solution method for particular Operational Research model.

### **Performing analysis of the solution**

Often there is uncertainty in the problem description (either with the accuracy of the data provided or with the value(s) of data in the future). In this situation the robustness of our solution to the OR model can be examined using analysis. Analysis involves identifying how the solution would change under various changes to the problem data. This sort of analysis can also be useful for making tactical or strategic decisions.

### **Presenting the solution and analysis**

A crucial step in the optimisation process is the presentation of the solution and any analysis. The translation from an OR model's solution back into a concise and comprehensible summary is as important as the translation from the problem description into the OR model. The presentation serves as important step in implementing decisions generated by Operational Research model.

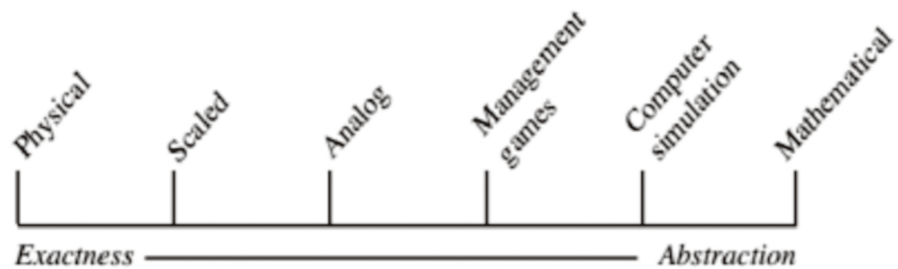
### **Check your progress 6**

1. What are the process breakdown steps in Operations Research problem?
  - a. Describing the problem;
  - b. Formulating Operations Research model;
  - c. Solving Operations Research model
  - d. All of these

## 1.8 Models in Operations Research

It is seen that many operations research studies engaged in framing of mathematical model. These models serve as collection of logical and mathematical relationships which shows aspects of situation under study. It shows important relationships among variables with constraints that restrict solutions to feasible values.

These models are tractable which can be solved and carries required representation of original situation. The model spectrum is abstract mathematical models as shown in figure 1.1. We see that Operational research professionals often use mathematical models to make simplified representations of complex systems.



**Fig 1.1 Different OR models**

Many OR models are replicas of physical properties of object while others behave as physical models with different physical appearance as their object representation. There are four main categories of OR models namely:

- Physical models
- Schematic models
- Verbal models
- Mathematical models

### Physical Models

Such kind of models is done items which are to a great degree comparable of article being displayed, for example, model of planes, autos, ships and so forth. Scale models of metropolitan structures, strip malls, and property improvements looks precisely as genuine when assembled. The model client will say precisely in regards to look and feel of proposed article before making a speculation.

Scale models of planes are tried in wind passages to know its streamlined properties and impacts of air turbulence on external surfaces. Model of a car for testing gets presented to locate its related components. Numerous physical models may not look precisely like object of representation but rather are sufficiently close to give some utility.

### Schematic Models

Such kind of models is theoretical as contrasted and physical models having certain visual correspondence with reality. Diagrams and outlines are schematic models as they have pictorial representations of scientific connections where line plotting on chart portrays a numerical direct relationship among two variables.

Charts, drawings, and plans are sort of schematic models which are pictorial representations of reasonable connections. It demonstrates idea like order or grouping like stream outline. The priority graphs utilized as a part of venture administration or in mechanical production system adjusting demonstrate the

arrangement of exercises that must be kept up keeping in mind the end goal to accomplish a sought result.

### Verbal Models

Verbal models use words to speak to some article or circumstance that exists, or could exist, as a general rule. These models range from straightforward word presentation as in a book to complex business choice issue. These models give indicates required issue and gives applicable and important data to fathom it through suggestions or deciding the achievable options. Verbal models give enough data which can be later on speaking to issue through scientific structure thusly models are changed over into numerical models for appropriate utilitarian arrangements.

### Mathematical Models

Mathematical models are a unique kind of models which is not quite the same as genuine partners and are made utilizing numbers and images which can be changed into capacities, conditions and equations. Such models are required to construct more mind boggling models like frameworks or straight programming models where client with such model can comprehend for numerical arrangements by utilizing straightforward strategies of augmentation and expansion. These models are easy to control, are suitable for use in adding machines and PC programs. These models are grouped in light of use, level of haphazardness and level of specificity.

### Check your progress 7

1. Which of the following operation research model uses words to represent some object or situation that exists?
  - a. Mathematical Model
  - b. Verbal Models
  - c. Physical Model
  - d. None of these
2. Which of the following are the categories of operation research model?
  - a. physical models
  - b. schematic models
  - c. verbal models
  - d. All of these

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## 1.9 Classification of Operation Research Model

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The various classifications of operation Research models are :

### Classification by degree of abstraction

The language models are far more abstract as compared to concrete model or model planes which are placed in wind tunnels as they are suggestive of shape or properties after modelled entity.

### Classification according to Structure

- (a) **Physical Model :** This model is physical representation of item either in idealized form or different scale having similar properties of their representation. It is a scaled model as it is bigger than real, structure may be depicted by enlarged model.
- (b) **Analogue (schematic) Model :** It shows system or object of inquiry by using set of properties that are different from original system. On solving such model, the solution gets reinterpreted in terms of original system.

- (c) **Symbolic Models** : Such models employ set of symbols and functions to show decision variables and its relationships in order to describe the behaviour with mathematical or logical symbols. A symbolic or mathematical model carry set of equations defined and specified by relationship and interactions among different elements of decision problem.

#### **Classification by purpose**

Models can be classified by purpose where purpose of model gets predicted or prescribe such as :

- (a) **Descriptive models** : This model describes several aspects of situation based on observation results or other data present with opinion poll showing by descriptive model. It explains and predict facts and relationships among variables of problem and observe and study the performance of complex system.
- (b) **Normative or prescriptive models** : The idea of this model is to explain objective decision rules or criteria for optimal solutions.

#### **Classification by Nature of the Environment**

- (a) **Deterministic Models** : The models has parameters which are completely defined and outcomes in terms of course of action. It shows completely closed systems and results of models assume single values only where for a given set of input variables, similar output variables result.
- (b) **Probabilities Models** : Such models will take care of situations where consequence or payoff of managerial actions cannot be seen with certainty. In this, the input or output variables takes the form of probability distributions having more than single values.

This models reflects the complexity of real world and uncertainty surrounding it.

#### **Classification according to behaviour characteristics**

- (a) **Static Models** : These models have no impact of changes which takes place at the time of planning where only single decision is required for duration of given time period. In this, the cause and effect are immediate without any time lag.
- (b) **Dynamic models** : These models consider time as one of the important variables and admit the impact of change generated by time. Also in dynamic models, not one, but a series of interdependent decision, is required during the planning horizon. The time dimensions has a definite impact on the model so solution, and on the interpretation of the results.

#### **Classification according to procedure of solution**

- (a) **Analytical models** : Such type of models specifies mathematical structure which can be solved by analytical or mathematical techniques.
- (b) **Simulation and heuristic Models** : Simulation model are more flexible as compared to mathematical model which are used to show complex systems that cannot be formulated mathematically. Heuristic model employs sensitive

rules or guidelines in anticipation of generating new strategies that gives improved solutions.

### Check your progress 8

1. Operation Research are classified on the basis of
  - a. degree of abstraction
  - b. Nature of the Environment
  - c. Both A and B
  - d. None of these
2. Which of the following model consider time as one of the important variables and admit the impact of change generated by time?
  - a. Dynamic models.
  - b. Static model
  - c. Both of these
  - d. None of these

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### 1.10 Characteristics of a Good Model

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In operational research, simple model is better than complex model since it should be easily understood and can perform its intended function. It's important to use the most relevant operational research tool when constructing a model.

In case of complicated systems, users need to remember as models are simplified representations. A good model should be easy to modify and update. New information from the real system can be incorporated easily into a well planned model. It is noted that a model does not always have characteristic of being explanatory rather than descriptive. There are many chief characteristics that a good operational research model should have like :

1. A good number should be capable of taking into account new formulations without having any significant change in its frame.
2. The number of assumptions made should be as small as possible.
3. It should be simple and coherent, i.e. number of variables used should be small.
4. It should be open to a parametric type of treatment. Such situations are often forced when response to an advertising campaign or the customer acceptance of a new product is studied.
5. A model should not take much time in its construction for any problem.
6. It should express the relations and interrelations of action and reaction of cause and effect in operational situations.

### Advantages of a Model

1. It provides some logical and systematic approach to the problem.
2. It incorporates useful tools which help in eliminating duplication of methods applied to solve specific situations.
3. Models help in finding avenues for new research and improvements in a system.
4. It indicates the nature of measurable quantities in a problem.
5. They provide economic descriptions and explanations of the operations of the system they represent.



### **Disadvantages of a Model**

1. They are only an attempt in understanding operation and should never be considered as absolute in any sense.
2. Validity of any model with regard to corresponding operation can only be verified by carrying the experiment and relevant data characteristic.

### **Check your progress 9**

1. Which of the following is the disadvantage of operational research model?
  - a. They are only an attempt in understanding operation and should never be considered as absolute in any sense
  - b. It provides some logical approach to the problem.
  - c. It indicates the nature of measurable quantities in a problem.
  - d. None of these
2. What are the characteristics of model?
  - a. The number of assumption should be made small as possible.
  - b. It should be simple and coherent
  - c. A model should not take much time in construction
  - d. All of these

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### **1.11 Operations Research and Managerial Decisions Making**

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Operations research applies modern measurable investigation and numerical displaying to fathom a variety of business and authoritative issues, and in addition enhance basic leadership. As the business environment develops more mind boggling, organizations and government offices depend on examination to advice choices that were once construct to a great extent with respect to administration instinct.

Operations Research concerns the utilization of logical, regularly numerical, strategies for arranging issues. Initially created by the military amid the second world, it has since spread to extensive organizations and government associations and been connected there with extraordinary achievement. Amid the last 20–30 years numerous propelled sorts of programming has been produced taking into account Operations Research techniques.

Operations Research has been connected in expansive scope of various businesses, e.g. generation, transport, media transmission, delivery, social insurance and instruction. Today it is difficult to run a focused carrier without utilizing Operations Research to streamline the utilization of assets. A decent Operations Researcher have great aptitudes in science, specifically discrete arithmetic. Programming knowledge is an extremely significant expertise for an Operations Researcher. Since Linear Programming (LP) is the establishment for a large portion of the OR techniques, a great comprehension of LP is significant.

### Check your progress 10

1. To solve any type of business and organizational problem, operation research make use of .
  - a. statistical analysis
  - b. mathematical modeling
  - c. Both A and B
  - d. None of these

### 1.12 Advantages of Operations Research

There certain advantages of Operational research such as :

#### Effective Decisions

Operations Research helps the managers to take better and quicker decisions. It increases the number of alternatives. It helps the managers to evaluate the risk and results of all the alternative decisions. So, Operations research makes the decisions more effective.

#### Better Coordination

Operations Research helps to coordinate all the decisions of the organisation. It coordinates all the decisions taken by the different levels of management and the various departments of the organisation. For e.g. It coordinates the decisions taken by the production department with the decisions taken by the marketing department.

#### Facilitates Control

Operations Research helps the manager to control his subordinates. It helps the manager to decide which work is most important. The manager does the most important work himself, and he delegates the less important work to his subordinates.

Operations Research helps a manager to fix standards for all the work. It helps him to measure the performance of the subordinates. It helps the manager to find out and correct the deviations in performance, hence Operations Research facilitates control.

#### Improves Productivity

Operations Research helps to improve the productivity of the organisation. It helps to decide about the selection, location and size of the factories, warehouses, etc. It helps in inventory control. It helps in production planning and control. It also helps in manpower planning. Operations Research is used in expansion, modernisation, installation of technology, etc. Operations Research uses many different mathematical and statistical techniques to improve productivity. Simulation is used by many organisations to improve their productivity. That is, they try out many productions improvement techniques on a small scale. If these techniques are successful then they are used on a large scale.

### Check your progress 11

1. What are the advantages of operation research?
  - a. Better Coordination
  - b. Facilitates Control
  - c. Both A and B
  - d. All of these

2. How do Operation research techniques help the managers to take effective decisions ?
  - a. It help managers to take better and quicker decisions
  - b. It increases the number of alternatives
  - c. It helps managers to evaluate the risk and results of all the alternative decisions
  - d. All of these

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### **1.13 Techniques of Operations Research**

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The operations research expert has a wide array of techniques available for solving problems such as :

#### **Linear Programming**

Linear Programming serves as mathematical technique of taking idea about fixed amount of resources required to satisfy demands with optimised objectives and defined conditions.

#### **Transportation Problem**

It is a special type of linear programming problem in which the objective is to lower the cost of distributing product from several sources to many places.

#### **Assignment Problem**

Briefly, when problem involves allocation of various facilities to various tasks, then such phenomena is termed as assignment problem.

#### **Queuing Theory**

The queuing problem finds the presence of many customers who appears randomly to get some service. Such theory will help in calculating required number of people in queue, expected waiting time in the queue, expected idle time for the server, etc.

#### **Game Theory**

It is used for decision making under conflicting situations where there are one or more opponents. It provides solutions to games where each players wants to maximize his profits and minimize his losses.

#### **Inventory Control Models**

It is related with acquisition, storage, handling of inventories to make sure that the availability of inventory when required gets minimize with wastage and losses. This is required by managers to decide reordering time, reordering level and optimal ordering quantity.

#### **Goal Programming**

It is a powerful tool to tackle multiple and incompatible goals of an enterprise.

#### **Simulation**

It is a technique that involves setting up a model of real situation and then performing experiments. Simulation is used where it is very risky, cumbersome, or time consuming to conduct real study or experiment to know more about a situation.

### **Nonlinear Programming**

It is required when either objective function or constraints are not linear in nature which gets introduced due to certain factors like discount on price of purchase of large quantities.

### **Integer Programming**

Such methods are applied when one or more of variables takes integral values like number of trucks in a fleet.

### **Dynamic Programming**

Dynamic programming is a methodology useful for solving problems that involve taking decisions over several stages in a sequence. One thing common to all problems in this category is that current decisions influence both present & future periods.

### **Sequencing Theory**

It is related to Waiting Line Theory which is applicable when facilities are fixed, but service ordering is controlled.

### **Replacement Models**

These models are concerned with the problem of replacement of machines, individuals, capital assets, etc. due to their deteriorating efficiency, failure, or breakdown.

### **Markov Process**

This process is used in situations where various states are defined and the system moves from one state to another on a probability basis. The probability of going from one state to another is known.

### **Network Scheduling—PERT and CPM**

Network scheduling is a technique used for planning, scheduling and monitoring large projects. Such large projects are very common in the field of construction, maintenance, computer system installation, research and development design, etc.

It deals with substituting symbols for words, classes of things, or functional systems. It incorporates rules, algebra of logic, and propositions.

### **Information Theory**

It is an analytical process transferred from the electrical communications field to operations research. It seeks to evaluate the effectiveness of information flow within a given system and helps in improving the communication flow.

### **Check your progress 12**

1. What is symbolic logic?
  - a. It is a technique used for planning, scheduling and monitoring large projects.
  - b. It deals with substituting symbols for words, classes of things, or functional systems

OPERATION  
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- c. These models are concerned with the problem of replacement of machines.
  - d. None of these
2. What is Simulation?
- a. It is a technique that involves setting up a model of real situation and then performing experiments
  - b. It is a technique used for planning, scheduling and monitoring large projects.
  - c. It is an analytical process transferred from the electrical communications field to operations research.
  - d. None of these

---

### 1.14 Limitations of Operations Research

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There are certain limitations of Operations Research like :

#### **Dependence on an Electronic Computer :**

Operations Research techniques try to find out an optimal solution taking into account all factors. In the modern society, these factors are enormous and expressing them in quantity and establishing relationships among these require voluminous calculations that can only be handled by computers.

#### **Non-Quantifiable Factors :**

Operations Research techniques provide a solution only when all the elements related to a problem can be quantified. All relevant variables do not lend themselves to quantification. Factors that cannot be quantified find no place in Operations Research models.

#### **Distance between Manager and Operations Researcher :**

Operations Research being specialist's job requires a mathematician or a statistician, who might not be aware of the business problems. Similarly, a manager fails to understand the complex working of Operations Research. Thus, there is a gap between the two.

#### **Money and Time Costs :**

When the basic data are subjected to frequent changes, incorporating them into the Operations Research models is a costly affair. Moreover, a fairly good solution at present may be more desirable than a perfect Operations Research solution available after sometime.

#### **Implementation :**

Implementation of decisions is a delicate task. It must take into account the complexities of human relations and behaviour.

#### **Check your progress 13**

- 1. What are the limitations of operation research?
  - a. Money and Time Costs
  - b. Non-Quantifiable Factors

- c. Distance between Manager and Operations Researcher
  - d. All of these
2. Does operation research factors provide solution for Non–Quantifiable Factors?
- a. Yes
  - b. No
  - c. None of these

### 1.15 Let Us Sum Up

In this unit we have learnt that Operations research involves in research and operations for problems involving in conduct and coordinate operations inside an organization.

We see that the systematic methodology developed for Operational Research study problems caters conflict of multiple objectives policies and alternatives.

It is seen that many operations research studies engaged in framing of mathematical model which are collection of logical and mathematical relationships showing aspects of situation under study.

We see that verbal models use words to show object or situation which exists and has a range from simple word presentation to complex business decision problem.

The mathematical models are abstract models that are different from real–life counterparts which are framed with numbers and symbols that transforms into functions, equations and formulas

In operational research, simple model is better than complex model as it is easily understood and can perform its intended function.

Operations research applies sophisticated statistical analysis and mathematical modeling to solve an array of business and organizational problems, as well as improve decision–making.

### 1.16 Answer for Check Your Progress

#### Check your progress 1

Answers: (1–c), (2–d)

#### Check your progress 2

Answers: (1–d)

#### Check your progress 3

Answers: (1–d)

#### Check your progress 4

Answers: (1–d), (2–b)

#### Check your progress 5

Answers: (1–c), (2–d)

**Check your progress 6**

Answers: (1–d)

**Check your progress 7**

Answers: (1–b), (2–d)

**Check your progress 8**

Answers: (1–c), (2–a)

**Check your progress 9**

Answers: (1–a), (2–d)

**Check your progress 10**

Answers: (1–c)

**Check your progress 11**

Answers: (1–c), (2–d)

**Check your progress 12**

Answers: (1–b), (2–a)

**Check your progress 13**

Answers: (1–d), (2–b)

---

**1.17 Glossary**

1. **Scheduling** : it is an act of assigning new future event to present entity.
2. **Random Variate** : It is an artificially generated random variable.
3. **Distribution** : It is a mathematical law that governs probabilistic features of a random variable.

---

**1.18 Assignment**

List some Characteristics Of Operation Research.

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**1.19 Activities**

Collect information on features of Operational Research.

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**1.20 Case Study**

Discuss about the consequences of Operational research.

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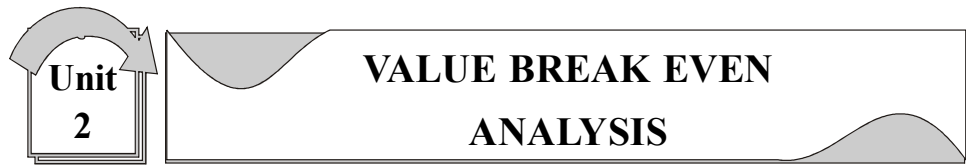
**1.21 Further Readings**

1. Anderson, M., J. Cosby, B. Swan, H. Moore, and M. Broekhoven. 1999. "The Use of Research in Local Health Service Agencies." *Social Science and Medicine* 49: 1007–1019.
2. Bertrand, J.T. and L. Brown. 1997. The Working Group on the Evaluation of Family Planning Operations Research. Final Report. The EVALUATION Project. University of North Carolina, Chapel Hill: Carolina Population Center.

3. Fisher, A., J. Laing, J. Stoeckel, and J. Townsend. 1991. Handbook for Family Planning Operations Research Design. New York, NY: The Population Council.
  4. Iskandar, M. and S. Indrawati. 1996. Indonesia: Utilization of Completed Operations Research Studies. Final report. Jakarta: The Population Council.
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USE OF OPERATION  
RESEARCH IN  
SOLVING  
PRODUCTION  
PROBLEM





**: UNIT STRUCTURE :**

- 2.0 Learning Objectives**
- 2.1 Introduction**
- 2.2 Concept of Value Break Even Analysis**
- 2.3 Uses of Value Break Even Analysis**
- 2.4 Assumptions and Limitations of Value Break Even Analysis**
- 2.5 Value Break Even Point**
- 2.6 Value Break Even Chart**
- 2.7 Let Us Sum Up**
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**2.0 Learning Objectives**

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After reading this Unit, you will be able to understand :

- Need of Value Break Even Chart
- Uses Of Value Break Even Analysis

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**2.1 Introduction**

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Break–even analysis the original investment analysis is helpful in the assurance of the level of generation or in a focused on sought deals blend. The analysis is for administration's utilization just as the metric and computations are frequently not required to be unveiled to outer sources, for example, speculators, controllers or money related organizations. Break–even analysis takes a gander at the level of altered costs in respect to the benefit earned by each extra unit delivered and sold. All in all, an organization with lower altered expenses will have a lower equal the initial investment purpose of offer. For instance, an organization with \$0 of settled expenses will consequently have equalled the initial investment upon the offer of the primary item expecting variable expenses don't surpass deals income. In any case, the amassing of variable expenses will confine the influence of the organization as these costs are brought about for everything sold.

## 2.2 Concept of Value Break Even Analysis

Break–even analysis involves calculation and examination of margin of safety for entity based on revenues that gets collected along with associate costs. With studying various price levels in terms of demand, an entity uses break–even analysis which finds the type of level of sales required to cover total fixed costs. A demandside analysis would give a seller greater insight regarding selling capabilities. Break–even analysis is importance in finding practical application of cost functions having factors such as :

- Sales Volume
- Profit
- Cost

It classify dynamic relationship which occurs among total cost and sale volume of a company, so it is also called as cost–volume–profit analysis which gives an idea about operating condition that occurs during company breaks–even. The break–even point is a level of sales where total revenues is equal to total costs where net income results zero. Such case is often known as no–profit no–loss point. This concept has been proved highly useful to the company executives in profit forecasting and planning and also in examining the effect of alternative business management decisions.

### With the help of the formula :

$$\text{Break–even Point} = \text{Fixed Costs} / (\text{Unit Selling Price} - \text{Variable Costs})$$

The business will find the units required to produce to have break–even point. Once the business reached to break even point, in sales or units sold, all costs gets recovered. Beyond BEP point, all extra unit sold will result in increasing profit for the business. The increase in profit can be calculated by amount of unit contribution margin that is amount of extra revenues which goes towards covering the fixed costs and profit. It can be calculated as follow :

$$\text{Unit Contribution Margin} = \text{Sales Price} - \text{Variable Costs}$$

### Costs

There are two distinct natures of costs that a business has to incur in its normal operational activities :

#### Fixed Costs

It is the same costs which is present for units the company will produce which covers :

- Start–Up Costs
- Rent
- Utility Bills
- Variable costs
- Capital Expenses
- Insurance
- Repairs

Such type of costs are linked with number of units produced which are recurring in nature as they have to be paid periodically. With the production of extra goods and services, such costs increase proportional. These costs normally cover :

- Material
- Labour

- Direct sales and promotion
- Storage

### Revenue

Revenue is the money received from business from customers against selling of goods and services. Discounts and deductions have already been adjusted, which means it is the gross income from which various costs are later deducted in order to calculate profit or loss. Total revenue can be calculated by multiplying the price at which goods or services are sold by number units sold.

### Calculation of Break–even point in units

Break–even point is usually calculated in units, which gives the company the number of units it must produce in order to break–even. It can be calculated by dividing contribution margin by total fixed costs :

$$\text{Break–even point (Units)} = \text{Fixed Costs} / \text{Contribution margin per unit.}$$

### Check your progress 1

1. Break–even analysis helps in finding practical application of cost functions having factors such as :
  - a. Sales Volume
  - b. Cost
  - c. Profit
  - d. All Of These
2. Which of the following is the example of fixed cost ?
  - a. Capital Expenses
  - b. Material
  - c. Labour
  - d. None Of These

---

### 2.3 Uses of Value Break Even Analysis

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There are many uses of Break Even Analysis for companies who are into manufacturing of products. This method tells you how many units of a product must be sold to cover the fixed and variable costs of production. The use of value break even analysis will help in :

- determining selling price which will give the desired profits.
- fixing sales volume to cover a given return on capital employed.
- forecasting costs and profit as a result of change in volume.
- suggestions for shift in sales mix.
- studying the relation between the variable cost, fixed cost and revenue.
- determining costs and revenue at various levels of output.
- managing decision, forecasting, planning and maintaining profitability.
- revealing business strength and profit earning capacity without difficulty and effort.

### Check your progress 2

1. What are the advantages of break even analysis ?
  - a. Makin inter–firm comparison of profitability.
  - b. Determining costs and revenue at various levels of output
  - c. Suggestions for shift in sales mix
  - d. All of these

---

## 2.4 Assumptions and Limitations of Value Break Even Analysis

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## VALUE BREAK EVEN ANALYSIS

Break–even analysis is a practical and popular tool for many businesses, including start–ups. Strengths of breakeven analysis are :

- Focuses entrepreneur on how long it will take before a start–up reaches profitability.
- Helps entrepreneur understand the viability of a business proposition, and also those who will lend money to, or invest in the business.
- Margin of safety calculation shows how much a sales forecast can prove over–optimistic before losses are incurred.
- Helps entrepreneur understand the level of risk involved in a start–up
- Shows the importance of a start–up keeping fixed costs down to a minimum
- Calculations are quick and easy and shows quick estimates.

### Limitations of breakeven analysis

- Unrealistic assumptions where products are not sold at same price at different levels of output.
- Sales are unlikely to be same as output as there appears build up of stocks or wasted output.
- Variable cost varies as output rises, business may benefit from being able to buy inputs at lower prices which reduces variable cost per unit.
- Most business sell more products, so break–even for business becomes hard to find.
- Break even analysis be noticed as planning aid rather instead of decision making tool.

### Check your progress 3

1. Which of the following is the strength of break even analysis?
  - a. It helps entrepreneur in understanding the viability of business proposition.
  - b. Unrealistic assumptions
  - c. Variable cost varies as output rises.
  - d. None of these
2. What are the limitations of breakeven analysis?
  - a. Unrealistic assumptions
  - b. Variable cost varies as output rises
  - c. Both A and B
  - d. None of these

## 2.5 Value Break Even Point

Break-even point describes about the volume of production of goods where total costs will be equal to total sales revenue that results in no-profit and no-loss situation. We see that when the output of any product falls below BEP, then it shows loss, while when the output exceeds BEP, then it shows profit. We can find out the breakeven point for a company either by determining its physical units as volume of output or by finding its money value as value of sales.

So we see that the minimum point of production where total costs are recovered can be at break-even point as :

$$\text{Sales Revenue} - \text{Total Cost}$$

Or

$$\text{Sales} - \text{Variable Cost} = \text{Contribution} = \text{Fixed Cost}$$

We see that at break-even point, contribution earned will cover fixed cost and at point below BEP, contribution earned will not be enough to match fixed cost while at points above BEP, contribution earned more than recovers fixed cost.

**Break-even point can be calculated using the formula :**

$$\text{Break-even point (units)} = \frac{\text{Fixed Cost}}{\text{Contribution per unit}}$$

$$\text{Break-even point (even value)} = \frac{\text{Fixed Cost}}{P/V \text{ ratio}}$$

**BEP in terms of Physical Units :**

It is a good method for companies who are into production of goods where a company will easily find BEP for particular units of product that are sold to earn revenue which will cover their expenses of production that are both fixed and variable. The firm does not earn any profit, nor does it incur any loss. It is the meeting point of total revenue and total cost curve of the firm. The table 1.1 shows the Total Revenue and Total Cost and BEP

Output In Unit	Total Revenue	Total Fixed Cost	Total Total Variable Cost	Cost
0	0	150	0	150
50	200	150	150	300
100	400	150	300	450
1150	600	150	450	600 BEP
200	800	150	600	750
250	1000	150	750	900
300	1200	150	900	1050

While assuming, price of goods be kept fixed at Rs.4 per unit, so total revenue will increasing proportionate to output. Here units of output are sold and total fixed cost to remained at Rs. 150 for every levels of output.

Now the total variable cost is assumed to be increasing by given amount, so from the table, we see that when output is 0, the company will earn only fixed cost. When output is 50, total cost will be Rs. 300, so total revenue will be Rs. 200, that makes loss of Rs. 100 to the company.

Also when output is 100, company gains a loss of Rs. 50. At output 150 units, the total revenue will be equal to total cost, where the company will work at a point where no profit or loss occurs. From the level of output of 200, the firm is making profit.

#### Check your progress 4

1. The formula for Breakeven point(units )is equal to
  - a. Fixed cost / contribution per unit
  - b. Contribution per unit / total cost
  - c. Contribution per unit / fixed cost
  - d. None of these

### 2.6 Value Break Even Chart

Break–Even charts as shown in figure 2.1, are used by managerial economists, company executives and government agencies, which helps in finding out the break–even point. The break–even charts describes about total fixed cost, total variable cost, total cost and total revenue separately. It shows the extent of profit or loss to company at various stages of activity. The following Fig. 2.1 illustrates the typical break–even chart.

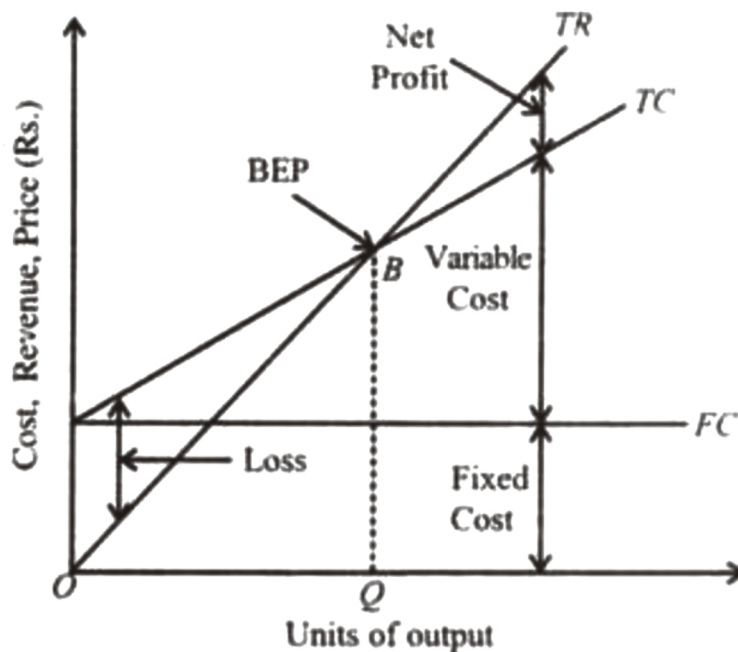


Fig 2.1 break–even chart

In this diagram output is shown on the horizontal axis and costs and revenue on vertical axis. Total revenue curve is shown as linear, as it is assumed that the price is constant, irrespective of the output. This assumption is appropriate only if the firm is operating under perfectly competitive conditions. Linearity of the total cost curve results from the assumption of constant variable cost.

It should also be noted that the TR curve is drawn as a straight line through the origin, while TC curve is a straight line starting from vertical axis as total cost carries constant / fixed cost plus variable cost that rises linearly. In the figure, B is the break-even point at OQ level of output.

Factors which needs to be taken care while preparing break-even chart such as :

- |                             |                       |
|-----------------------------|-----------------------|
| - Selection of the approach | - Output measurement  |
| - Total cost curve          | - Total revenue curve |
| - Break-even point          | - Margin of safety    |

### Check your progress 5

1. Which of the following factors should be considered preparing break-even chart?
  - a. Selection of the approach
  - b. Output measurement
  - c. Total cost curve
  - d. All of these
2. Breakeven point helps in finding
  - a. total variable cost,
  - b. Profit or loss to company at various stages of activity
  - c. Both A and B
  - d. None of these

---

### 2.7 Let Us Sum Up

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In this unit we have learnt that break-even analysis helps in finding the level of production which is mostly for management's use in order to have metric and calculations to disclose external sources.

We see that break-even analysis uses calculation and examination of margin of safety for entity based on revenues which collects along associate costs.

Break-even point shows volume of production of goods where total costs will be equal to total sales revenue that results in no-profit and no-loss situation.

Break-Even charts are used by managers, economists, executives and government agencies for finding break-even point as the charts describes about total fixed cost, total variable cost, total cost and total revenue separately.

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### 2.8 Answer for Check Your Progress

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#### Check your progress 1

Answers: (1-d), (2-a)

**Check your progress 2**

Answers: (1-d)

**Check your progress 3**

Answers: (1-a) , (2-c)

**Check your progress 4**

Answers: (1-a)

**Check your progress 5**

Answers: (1-d), (2-c)

**2.9 Glossary**

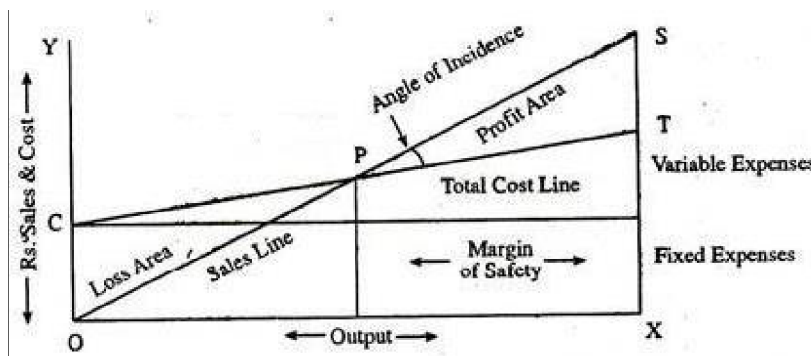
1. Breakeven point : It is the volume of sales needed for company to reach profitability.
2. Break-even analysis : It is the financial analysis which finds the point at which expenses will be equal to gross revenue for zero net difference.

**2.10 Assignment**

Write note on Value Break Even Point.

**2.11 Activities**

Identify break even point in the figure shown



**2.12 Case Study**

Study about fixed expense and variable expense in terms of Value Break Even Point

**2.13 Further Readings**

1. Bateson, John E. G. and K. Douglas Hoffman (1999), Managing Services





**: UNIT STRUCTURE :**

- 3.0 Learning Objectives**
- 3.1 Introduction**
- 3.2 Concept of Lean Manufacturing**
- 3.3 Japanese 5s Model**
- 3.4 Kanban System**
- 3.5 PDCA Cycle**
- 3.6 Kaizen**
- 3.7 Let Us Sum Up**
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**3.0 Learning Objectives**

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After reading this Unit, you will be able to understand :

- Need of Lean concepts
- Different Techniques of Lean production
- Execution of different techniques

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**3.1 Introduction**

---

Lean production is a systematic method of removing “Muda” (Waste) from the manufacturing process. It does not only removes waste but also adds value to the production process. Most of the techniques which are part of lean production are originated in Japan. Center of lean production techniques is consumer. If any process is not important or not adding value to the end consumer then it must be removed slowly and gradually from the production process.

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**3.2 Concept of Lean Manufacturing**

---

Lean Manufacturing essentially is a method that is used in the elimination of waste (or, Muda) along the value stream of a particular manufacturing workflow. A peculiar feature in Lean Manufacturing is the fact that it takes into account the overburdening on resources and also the unevenness of the workload through the value stream.

Lean manufacturing is all about cutting waste while assuring quality. Different techniques and methods are evolved which are now part of lean concepts like Japanese 5s model, Kanban System, Kaizen and PDCA cycle etc.

### Lean Manufacturing principles

- (1) **Value Identification** : It can be anything which customer finds absolutely essential or important.
- (2) **Value Stream Mapping** : Once value is determined, then it is time to turn to value stream mapping (VSM). This process includes identifying every aspect of the process, from the very beginning where raw materials are assembled to delivering the product.
- (3) **Creating Flow** : Once the plan is enacted to eliminate the waste, the next step is overseeing the remaining steps within the operation. This is to ensure that there are no bottlenecks, interruptions, or any other issue within the process.
- (4) **Establishing a Pull** : After the kinks within the process are figured out, production flow becomes much more faster and efficient. This is due to the elimination of the invaluable steps. This makes it much easier for consumers to “pull” products from you whenever needed.
- (5) **Seeking Perfection** : Incorporating these steps alone will greatly improve your production facility, but lean manufacturing requires substantial effort and a change in mindset. Instead of looking at it as just a manufacturing method, it is important to view it as a culture, requiring everyone to be on board.

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### 3.3 Japanese 5s Model

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5S is a systematic form of visual management utilizing everything from floor tape to operations manuals. It is not just about cleanliness or organization; it is also about maximizing efficiency and profit. 5S is a framework that emphasizes the use of a specific mindset and tools to create efficiency and value. It involves observing, analyzing, collaborating, and searching for waste and also involves the practice of removing waste.

For an organization implementing 5S, this tool becomes the foundation stone for all the other Lean Manufacturing tools to be used and organized effectively. The 5S tool works methodically in 5 phases. These 5 phases are termed in Japanese and are transliterated in English to form 5 “S” terms. They are as follows :

- (1) **Seiri or Sort** – is the first step of the 5S and involves sorting of the all the mess and clutter within the workplace while keeping only the important and extremely useful items within the work area.
- (2) **Seiton or Straighten** – is the next step that dictates the process of arranging the decluttered items in an efficient manner so as to be used using the principles of ergonomics. This step ensures that every single item has its place and those items go back to their place.
- (3) **Seiso or Sweep** – is the step that involves a thorough cleaning of the work area, the tools to be used, all the systems, machines and equipment to be used in the manufacturing unit of the company. This will ensure that all the apparatus used during production and assembly are as good as new to eliminate any non–conformity that may arise due to technical difficulties.

- (4) **Seiketsu or Standardize** – ensures that whatever work was conducted in the first 3 steps are now standardized accordingly. This builds in the common standards and how we need to work among the team. Standardization is a key component within Lean Manufacturing, thus, this becomes a crucial phase.
- (5) **Shitsuke or Sustain** – is the final stage that ensures that the company keeps up to the standards adhered and conformed to. This stage involves housekeeping and auditing of the processes and tools and equipment. It is during this stage that the work routine becomes a culture.

---

### 3.4 Kanban System

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Kanban is a visual system for managing work as it moves through a process. Kanban visualizes both the process (the workflow) and the actual work passing through that process. The goal of Kanban is to identify potential bottlenecks in your process and fix them so work can flow through it cost-effectively at an optimal speed or throughput.

Kanban is a concept related to lean and just-in-time (JIT) production, where it is used as a scheduling system that tells you what to produce, when to produce it, and how much to produce.

The first Kanban system was developed by Taiichi Ohno (Industrial Engineer and Businessman) for Toyota automotive in Japan. It was created as a simple planning system, the aim of which was to control and manage work and inventory at every stage of production optimally.

A key reason for the development of Kanban was the inadequate productivity and efficiency of Toyota compared to its American automotive rivals. With Kanban, Toyota achieved a flexible and efficient just-in-time production control system that increased productivity while reducing cost-intensive inventory of raw materials, semi-finished materials, and finished products.

#### **Kanban Principles and Practices**

The Kanban Method follows a set of principles and practices for managing and improving the flow of work. It is an evolutionary, non-disruptive method that promotes gradual improvements to an organization's processes.

- (1) **Start with what you are doing now** : The Kanban Method (hereafter referred to as just Kanban) strongly emphasizes not making any change to your existing setup/ process right away. Kanban must be applied directly to current workflow. Any changes needed can occur gradually over a period of time at a pace the team is comfortable with.
- (2) **Agree to pursue incremental, evolutionary change** : Kanban encourages you to make small incremental changes rather than making radical changes that might lead to resistance within the team and organization.
- (3) **Respect current roles, responsibilities and job-titles** : Unlike other methods, Kanban does not impose any organizational changes by itself. So, it is not necessary to make changes to your existing roles and functions

which may be performing well. The team will collaboratively identify and implement any changes needed. These three principles help the organizations overcome the typical emotional resistance and the fear of change that usually accompany any change initiatives in an organization.

- (4) **Encourage acts of leadership at all levels** : Kanban encourages continuous improvement at all the levels of the organization and it says that leadership acts don't have to originate from senior managers only. People at all levels can provide ideas and show leadership to implement changes to continually improve the way they deliver their products and services.

### **Classic Kanban Board Model**

In a classic Kanban board model, there are three columns, To Do, Doing, Done.

- (1) **To Do** : This column lists the tasks that are not yet started. (aka "backlog")
- (2) **Doing** : Consists of the tasks that are in progress.
- (3) **Done** : Consists of the tasks that are completed.

### **" Example of Kanban System "**

The project manager can visualize the complete workflow management in one application with the help of Kanban software. You can see who is assigned what, what is the duration of the individual tasks, what is the sequence and set priority, how many items are there in the backlog, and the WIP. Set WIP–Limits to stabilize the workflow and also see what the status is of progress overall for the projects.

### **" Effect of implementing Kanban "**

The workflow visualization helps the project manager to control, manage, track, and monitor the workflow. This helps the project manager to share files and documents, communicate the meetings and status with the team members, and effectively collaborate between the teams.

---

## **3.5 PDCA Cycle**

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Continuous Improvement follows the proceeding quality cycle, called the Deming Cycle, or PDCA cycle, which comprises of 4 phases that the product or process needs to go through. It is also known as the Shewhart cycle or Deming cycle. They are as follows:

- (1) **Plan** – In this phase an opportunity for change is identified and the planning is carried out to bring about this change within the system.
- (2) **Do** – Once the planning is completed and verified, the plan is then executed for the change to be implemented within the system.
- (3) **Check**– In this stage, data is collected and viewed to check the success of the change, which was implemented. The results are analyzed with a view to determine whether the change brought about was successful.

- (4) **Act** – Once the change is determined to be successful, the plan is implemented on a much wider scale and continuous assessment takes place. Again, the check stage is followed after large-scale implementation.

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### 3.6 Kaizen

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Kaizen is an approach to creating continuous improvement based on the idea that small, ongoing positive changes can reap major improvements. Typically, it is based on cooperation and commitment and stands in contrast to approaches that use radical changes or top-down edicts to achieve transformation. Kaizen is core to lean manufacturing, or The Toyota Way. It was developed in the manufacturing sector to lower defects, eliminate waste, boost productivity, encourage worker purpose and accountability, and promote innovation.

Kaizen is a compound of two Japanese words that together translate as "good change" or "improvement," but Kaizen has come to mean "continuous improvement" through its association with lean methodology. Kaizen has its origins in post-World War II Japanese quality circles. These circles or groups of workers focused on preventing defects at Toyota and were developed partly in response to American management and productivity consultants who visited the country, especially W. Edwards Deming, who argued that quality control should be put more directly in the hands of line workers. Kaizen was brought to the West and popularized by Masaaki Imai via his book *Kaizen: The Key to Japan's Competitive Success* in 1986.

#### Ten principles of Kaizen

Because executing Kaizen requires enabling the right mindset throughout the company, 10 principles that address the Kaizen mindset are commonly referenced as core to the philosophy. They are :

1. Let go of assumptions.
2. Be proactive about solving problems.
3. Don't accept the status quo.
4. Let go of perfectionism and take an attitude of iterative, adaptive change.
5. Look for solutions as you find mistakes.
6. Create an environment in which everyone feels empowered to contribute.
7. Don't accept the obvious issue; instead, ask "why" five times to get to the root cause.
8. Cull information and opinions from multiple people.
9. Use creativity to find low-cost, small improvements.
10. Never stop improving.

Kaizen is based on the belief that everything can be improved and nothing is status quo. It also rests on a Respect for People principle. Kaizen involves identifying issues and opportunities, creating solutions and rolling them out — and then cycling through the process again for other issues or problems that were inadequately addressed. These following seven steps create a cycle for continuous improvement and give a systematic method for executing this process.



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2. Which of the following best suits Kaizen ?  
(A) List of to do, doing and done (B) Good change  
(C) Improvement (D) Continuous improvement
3. PDCA cycle comprises how many different phases ?  
(A) 2 (B) 3  
(C) 4 (D) 6
4. Which of the following best describes the concept of Lean Manufacturing ?  
(A) Managing waste (B) Keeping waste  
(C) Cutting waste (D) All of the given
5. Which of the following involves sorting of the all the mess and clutter within the workplace ?  
(A) Seiri (B) Seiton  
(C) Seiketsu (D) Seiso

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### 3.7 Let Us Sum Up

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In this unit we have learnt different lean manufacturing techniques. Customer is the central object in all the techniques. How value can be added and waste can be eliminated is the only goal of each and every lean manufacturing techniques in different areas of manufacturing. Principles of Kaizen, some of the real life Kaizen examples, PDCA cycle, Japanese 5s models and kanban system are covered in this unit.

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### 3.8 Answers to Check Your Progress

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- (1 - B)
- (2 - D)
- (3 - C)
- (4 - C)
- (5 - A)

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### 3.9 Glossary

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Lean Manufacturing – systematic methodology for minimization of waste.

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### 3.10 Assignment

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Find out 5 Indian companies following Lean Manufacturing techniques.

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### 3.11 Activities

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Find out Ahmedabad based Lean Manufacturing Consulting service provider and collect information how they execute lean manufacturing process.

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### 3.12 Case Study

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Lean Manufacturing in Practice Lean Manufacturing in Practice A Case Study of Toyota Motors Company Study of Toyota Motors Company

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### 3.13 Further Readings

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Jeffrey K. Liker, The Toyota Way – 14 Management principles from the world's greatest manufacturer, 2004

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## **Block Summary**

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This block give detailed information about Break–even analysis which is helpful in determining level of production or targeted sales mix. The block explained more about calculation and examination of margin of safety which can be applied for future use. The knowledge about finding and locating of Break– even point are also detailed for students.

After studying this block, students understand correctly about Mathematical models along with various other models that will help them in comparison for future understanding. The concept of systematic methodology developed for Operational Research study gives knowledge to student which will help them know to compare about various Operation Research tools.



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**Block Assignment**

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**Short Answer Questions :**

1. List few characteristics of Operation Research?
2. Classification of Operation Research Model?
3. State the benefits of Value Break Even Point?
4. How to prepare Value Break Even Chart?
5. State the advantages of advantages of Operations Research?

**Long Answer Questions :**

1. What are Limitations of Operations Research?
2. What are the Scope of Operation Research?
3. Compare Assumptions and Limitations of Value Break Even Analysis?

**Enrolment No. :**

1. How many hours did you need for studying the units?

Unit No    1       2       3       4

Nos of Hrs

2. Please give your reactions to the following items based on your reading of the block :

Items	Excellent	Very Good	Good	Poor	Give specific example if any
Presentation Quality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Language and Style	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Illustration used (Diagram, tables etc)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Conceptual Clarity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Check your progress Quest	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Feed back to CYP Question	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____

3. Any Other Comments

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