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BA4204

OPERATIONS MANAGEMENT

BA4204 OPERATIONS MANAGEMENT

UNIT I INTRODUCTION TO OPERATIONS MANAGEMENT Operations Management – Nature, Importance, historical development, transformation processes, differences between services and goods, a system perspective, functions, challenges, current priorities, recent trends. Operations Strategy – Strategic fit , framework. Productivity; World-class manufacturing practices

UNIT II OPERATIONS AND THE VALUE CHAIN Capacity Planning – Long range, Types, Developing capacity alternatives, tools for capacity planning. Facility Location – Theories, Steps in Selection, Location Models. Sourcing and procurement - Strategic sourcing, make or buy decision, procurement process, managing vendors.

UNIT III DESIGNING OPERATIONS Product Design - Criteria, Approaches. Product development process - stage-gate approach - tools for efficient development. Process - design, strategy, types, analysis. Facility Layout – Principles, Types, Planning tools and techniques.

UNIT IV PLANNING AND CONTROL OF OPERATIONS Demand Forecasting – Need, Types, Objectives and Steps - Overview of Qualitative and Quantitative methods. Operations planning - Resource planning - Inventory Planning and Control. Operations Scheduling - Theory of constraints - bottlenecks, capacity constrained resources, synchronous manufacturing

UNIT V QUALITY MANAGEMENT Definitions of quality, The Quality revolution, quality gurus; TQM philosophies; Quality management tools, certification and awards. Lean Management - philosophy, elements of JIT manufacturing, continuous improvement. Six sigma

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UNIT -1

INTRODUCTION TO OPERATIONS MANAGEMENT

1.1INTRODUCTION

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

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

1.1.1Concept Of Production

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

1.1..2Production system

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

The production system has the following features:

1. Production is a well organised activity with pre-established objectives.
2. The production system converts the various inputs into outputs.
3. Production function is integrated with other activities of the organisation.
4. Feedback system is necessary to control and improve the system performance.
5. 5.It is a continuous process.

1.1.3Operation management

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

1.1.4Definition of Operation Management

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

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

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

1. .1.4.1Alteration

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

1. 1.4.2.Transportation

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

1.1.4.3.Storage

It refers to preserving goods in a protected environment.

1.1.4.4Inspection

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

All the above activities in one way or another are making a product more useful. The

operations managers have the prime responsibility for processing inputs into outputs. They must bring together the materials, capacity and knowledge available for the purpose achieving its production objectives. The definition of the operations Management contains the concepts such as Resources, Systems, transformation and Value addition Activities etc. A brief explanation about such words is given below:

1.1.4.5 Resources

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

1.1.4.6 Systems

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

1.1.4.7Productivity

The objective of combining resources is to transform the inputs into goods and services having a higher value than the original
The productivity refers to the ratio between values of output per work hour to the cost of inputs.

1.1.4.8 Objectives of Operation management

The objectives of the production management are given below:

1.1.4.8.1Right Quality: Quality is the important factor, which should be considered at the time of manufacturing process. All efforts should be taken to ensure the quality of the manufactured goods.

1.1.4.8.2Right Quantity: The manufacturing organisation should produce the goods in right number. If they are produced in excess of demand the capital will block up in the form of inventory. If the quantity is produced in short of demand, it leads to shortage of products.

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

1.1.4.8.4.Low Manufacturing Cost: Manufacturing costs are determined before the product is actually produced.

1.2 NATURE OF OPERATION MANAGEMENT

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

1.2.1. To provide customer service

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

1.2.2 Effective utilisation of resources

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

1.2.3. To reduce cost of production

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

1.2.4. To improve product quality

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

1.2.5. To fix time schedule

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

1.2.6. Proper utilisation of Machinery

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

1.2.7. Material control

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

1.3 IMPORTANCE OF OPERATIONS MANAGEMENT

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

- ✓ Location of facilities.
- ✓ Plant layouts and Material Handling.
- ✓ Product Design.
- ✓ Process Design.
- ✓ Production and Planning Control.
- ✓ Quality Control.
- ✓ Materials Management.

1.3.1 Location facilities

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

1.3.2. Plant layout and material handling

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

1.3.3Material Handling refers to the moving of materials from the store room to the machine and from one machine to the next machine during the production process. It is the art and science of moving, packing and storing of products in any form. Material cost can be reduced by judicious selection of materials and its proper storage. Material handling devices increases the output, improves quality, speeds up the deliveries and decreases the cost of production. Hence, material handling should be a prime task in the designing of new projects.

1.3.4. Product design

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

1.3.5. Process design

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

1.3.6. Production Planning and Control

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

1.3.6.1Planning is deciding in advance what to do, how to do it, when to do it and who is to do it. Planning bridges the gap from where we are and to where we want to go. It makes it possible for things to occur which would not otherwise happen.

1.3.6.2Routing is the process of selection of path, which each part of the product will follow. Routing determines the most advantageous path to be followed for department to department and machine to machine till raw material gets its Final Shape

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

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

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

1.3.6.6.Quality control

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

acceptable quality is manufactured. It is the entire collection of activities, which ensures that the operation will produce the optimum quality products at minimum cost. The main objectives of Quality Control are:

- ✓ To produce qualitative items
- ✓ To reduce companies cost through reduction of losses due to defects.
- ✓ To produce optimal quality at reduced price.
- ✓ To ensure satisfaction of customers with productions or services or high quality level, to build customer good will, confidence and reputation of manufacturer.
- ✓ To make inspection prompt to ensure quality control.
- ✓ To check the variation during manufacturing.

1.3.7.Materials Management

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

- ✓ To minimise material cost.
- ✓ To purchase, receive, transport and store materials efficiently
- ✓ To reduce costs through simplification, standardisation, value analysis etc.
- ✓ To identify new sources of supply and to develop better relations with the suppliers.
- ✓ To reduce investment made in the inventories and to develop high inventory turnover ratios.
- ✓

1.3.8.Maintenance Management

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

1. To reduce breakdown of machineries
2. To keep the machines and other facilities in a good condition.
3. To ensure the availability of the machines, buildings and services required by other sections of the factory also.
4. To keep the plant in good working condition.

1.4.HISTORY DEVELOPMENT OF OPERATIONS MANAGEMENT

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

same time, psychologists, socialists and other social scientists began to study people and human behaviour in the working environment. In addition, economists, mathematicians, and computer socialists contributed newer approaches.

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

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

	Material Requirement Planning (MRP	
1980	Quality and productivity applications from Japan: robotics, CAD-CAM	W.E. Deming & J. Juran

using the 'input-transformation-output' process. In other words, operations are processes that take in a set of input resources which are used to transform something, or are transformed themselves, into outputs of products and services.

There are two categories of inputs in any operation's processes; transformed and transforming resources. Transformed resources are the resources that are treated, transformed or converted in the process. The three main types of transformed resources include

- ✓ **Materials:** involves transforming either physically (e.g. manufacturing), by location (e.g. transportation), by ownership (e.g. retail) or by storage (e.g. warehousing).
- ✓ **Information**: This can be transformed by property (e.g. accountants), by possession (e.g. market research), by storage (e.g. libraries), or by location (e.g. telecommunications).
- ✓ **Customers**: They can be transformed either physically (e.g. hairdressers), by storage (e.g. hotels), by location (e.g. airlines), by physiological state (e.g. hospitals), or by psychologiucal state (e.g. entertainment).

The other set of inputs to any operations process are *transforming resources*. These are the resources which act on or carry out the transformation process. There are two main types of transforming resources:

- ✓ Facilities - the buildings, equipment, plant and process technology of the operation.
- ✓ Staff - includes all the people involved in the operations process.

The exact nature of both facilities and staff will differ between operations. For example, most staff employed in a factory assembling air conditioners may not need a very high level of technical skills. In contrast, most staff employed by an accounting firm will require a higher level skills and qualifications. Similarly, the facilities in both types of work would differ quite significantly.

Although products and services are different, sometimes it can be hard to differentiate between the two. Therefore as a general guideline, products are usually tangible while services are intangible.

1.5.1.Inputs to the transformation process

In order to make products and deliver services, a business needs resources – i.e. inputs. The textbooks often refer to these as "factors of production", which is a slightly boring way of describing real resources such as:

- ✓ **Labour** – the time and effort of people involved in the business: employees, suppliers etc
- ✓ **Land** – think of this as the natural resources that are used by the business – e.g. actual land, energy, and other natural resources
- ✓ **Capital** – capital includes physical assets such as machinery, computers, transport which are used during production. Capital can also include finance – the investment that is required in order for the business activities to take place.

- ✓ **Enterprise** – enterprise is the entrepreneurial "fairy-dust" that brings together or organises the other inputs. The entrepreneur takes the decisions about how much capital, what kind of labour etc and how & when they are needed in the business. You will probably agree that enterprise is the most important input for a successful business.
  Inputs by themselves are rarely enough for a start-up to succeed. They need to be the right kind of inputs, in the right mix. So, for example, a successful entrepreneur will be keen to ensure:
- ✓ **High quality people are employed** (the best the business can afford at each stage of development) and that these people are retained and invested in (training)
- ✓ **Capital investment is focused on efficiency and quality** – use of modern machinery or IT systems of the right kind can have a significant effect whether a small business is able to compete

1.5.2Outputs from the transformation process

The outputs of business activities are reflected in the products and services sold to customers. It is quite useful to think of ways in which similar business activities can be grouped based on those outputs.
Economists and business examiners alike have traditionally categorised the outputs from the transformation process into these three groups:

Sector	Businesses involved in…
Primary	Extraction of natural resources (e.g. oil, gas) and farming activities
Secondary	Production of finished goods and components (e.g. flat-screen TVs, computer memory chips, games consoles, industrial equipment, motor vehicles. The secondary sector is also often referred to as the "manufacturing sector".
Tertiary	Providing a service of some kind. E.g. health, travel, legal, finance, building, security. The list of potential services is endless. Think of this as any business activity that involves people doing things for you! Retail businesses are in the tertiary sector.

In recent years, some textbooks have also suggested that there is a fourth sector – the **Quaternary sector**. The quaternary sector consists of those industries providing information services, such as computing and ICT (information and communication technologies), consultancy (offering advice to businesses) and R&D (research, particular in scientific fields).

In most textbooks you will see the outputs of the Quaternary sector included in the tertiary sector. Don't worry; the distinction isn't important. What is important is that you remember that the Tertiary sector in the UK has grown strongly over recent decades and now accounts for about 75% (three quarters) of all business activity.

A final word about the categorisation of business activities (outputs) into sectors. Remember that is perfectly possible for a single business to be operating in more than one sector.

For example, many farms in Britain (farming = primary sector) also offer holiday accommodation (tertiary sector) and produce processed foods such as cheese and ice-cream from farm supplies (secondary sector).

Here is another example. Morrison's supermarkets (i.e. tertiary sector - one of the four largest supermarkets in the UK) also own and operate its own factories that make many of the food products sold in store (secondary sector).

1.5.2.1 Example of Transformation Process

For example, a hospital transforms ill patients (the input) into healthy patients (the output).

Transformation processes include:

- changes in the physical characteristics of materials or customers
- changes in the location of materials, information or customers
- changes in the ownership of materials or information
- storage or accommodation of materials, information or customers
- changes in the purpose or form of information
- changes in the physiological or psychological state of customers.

Often all three types of input – materials, information and customers – are transformed by the same organisation. For example, withdrawing money from a bank account involves information about the customer's account, materials such as cheques and currency, and the customer. Treating a patient in hospital involves not only the 'customer's' state of health, but also any materials used in treatment and information about the patient.

One useful way of categorising different types of transformation is into:

- manufacture – the physical creation of products (for example cars)
- transport – the movement of materials or customers (for example a taxi service)
- supply – change in ownership of goods (for example in retailing)
- service – the treatment of customers or the storage of materials (for example hospital wards, warehouses).

Several different transformations are usually required to produce a good or service. The overall transformation can be described as the macro operation, and the more detailed transformations within this macro operation as micro operations. For example, the macro operation in a brewery is making beer .The micro operations include:

- milling the malted barley into grist
- mixing the grist with hot water to form wort
- cooling the wort and transferring it to the fermentation vessel
- adding yeast to the wort and fermenting the liquid into beer
- filtering the beer to remove the spent yeast
- decanting the beer into casks or bottles.

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1.5.3 DIFFERENCE BETWEEN SERVICES & GOODS

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

- ✓ Manufacturing organisations
- ✓ Non-manufacturing organisations

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

- ✓ Manufacturing organisation produces the goods that are tangible in nature. On the other hand service organisations render service to the customers instead of tangible products.
- ✓ The products of manufacturing units can be stored in physical form. But the products of non-manufacturing organisation cannot be stored.
- ✓ In manufacturing organisation, mostof the customers have no direct contact with the operations.On the other hand, in the caseservice organisations the customers are present during the creation of the service.

Differences between the goods and the service

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

1.6.A SYSTEM PERSPECTIVE SYSTEM

A system is a group of interrelated items in which no item studied in isolation will act in the same way as it would in the system. A system is divided into a series of parts or subsystems, and any system is a part of a larger system. The system's boundary defines what is inside the system and what is outside. A system's environment is everything outside the system boundary that may have an impact on the behaviour of the system. A system's inputs are the physical objects of information that enter it from the environment and its outputs are the same which leave it for the environment.

The activities in an operations system can be classified as input, transformation process and output. The input activity involves two categories of resources. Transforming resources are the elements that act on, or carry out, the transformation process on other elements. These include such elements as labour, equipment/plant and energy. The nature and mix of these resources will differ between operations. The transformed resources are the elements which give the operations system its purpose or goal. The operations system is concerned with converting the transformed resources from inputs into outputs in the form of goods and services. There are three main types of transformed resource of materials which can be transformed either physically (e.g. manufacturing), by location (e.g. transportation), by ownership (e.g. retail) or by storage (e.g. warehousing), information which can be transformed by property (e.g. accountants), by possession (e.g. market research), by storage (e.g. libraries), or by location (e.g. telecommunications) and customers they can be transformed either physically (hairdresser), by storage (e.g. hotels), by location (e.g. airlines), by physiological state (e.g. hospitals), or by psychological state (e.g. entertainment). Two types of transforming resources are facilities (e.g. building and equipment) and staff (all the people involved in the operations process).

The sub-systems of a firm related to specific business disciplines are termed the functional areas of a business. The three main functional areas in a business are the operations, marketing and finance functions. The marketing function works to find and create demand for the company's goods and services by understanding customer needs and developing new markets. The need for marketing and operations to work closely together is particularly important as the marketing function will provide the forecast of demand from which operations can plan sufficient capacity in order to deliver goods and services on time. The finance function is responsible for the obtaining and controlling of funds and covering decisions such as investment in equipment and price-volume decisions. Other functions which play a supporting role in the organisation include the personnel function which will play a role on the recruitment and labour relations, the research and development function which generates and investigates the potential of new ideas and the information technology department which supplies and co-ordinates the computer-based information needs of the organisation.

The relationship between functions can be seen as a number of sub-systems within the system called the 'organisation'. Thus each function (e.g. marketing) can be treated using the same input/process/output transformation model as the operations function. In other words each function within the organisation can be treated as performing an operations activity, as they are transforming inputs into outputs. This implies every part of the organisation is involved in the operations activity (to an external or internal customer) and thus the theory of operations covered in this book is relevant to them. When operations is cited as a function in itself however it is referring to the part of the organisation which provides goods and services for external customers.

The operations function itself is involved in all parts of the firm and thus has a major impact on the competitive position of the organisation. The traditional view of the operations sub-system is that it is one function within a linear sequence of processes and is thus 'buffered' from the actions of the marketplace. Thus both physical stocks and allocation of responsibility within functions outside of operations are used to protect the operations system from the external environment. For example the R&D function will carry responsibility for the development of new product ideas which are then 'passed on' to the operations function and the purchasing function will take responsibility for the sourcing of materials and bought-in services. Physical buffers include stocks of materials before and after the operations function to ensure stability of supply and ability to meet fluctuating demand respectively.

The idea behind this model is that the operations function can concentrate solely on transforming inputs of raw materials into goods and services without the need to consider the external environment outside of the organisational system. The disadvantage of this model includes the slowness of response to changes in the environment as they are transmitted through various connected functions and the inability of operations to develop in response to the needs of customers. In fact the operations function is critical in meeting customer needs and is deeply involved in the performance of the organisation. For example the parameters under which a product/service can be marketed is directly consequent on inputs from the operations functions such as flexibility affecting the product range available.

Thus instead of being seen as simply a 'black box' which takes raw materials and transforms then into a product/service, the operations function should be seen as critical to the marketing position and competitive advantage of the organisation. The need for operations to improve performance across a number of attributes (e.g. quality, delivery, cost) means that competitive improvements will require long-term commitment and thus a strategic view of operations. The approach requires a commitment to quality improvement and then an improvement in other competitive factors that together will lead to a reduction in cost. This contrasts with the direct approach to cost reduction of cutting the labour force or 'downsizing'. Apart from failing to tackle the underlying problems and increase performance across the competitive factors, this approach is limited by the fact that direct labour costs typically account for a small proportion of overall costs.

1.7.FUNCTIONS OF OPERATION MANAGEMENT

An organisations functions can be broadly divided in to

1. Finance
2. Operation
3. Marketing

Operation as a function of management has relationships with marketing, finance, engineering and other functional areas. Finance department is concerned with securing adequate financial resources for the organisation and its

proper utilisation. Allocation of the financial resources throughout the organisation is the major function of finance department including **operations department**. Marketing department is responsible for identification of needs and

wants of the prospective customers and developing a suitable marketing plan. Inshort, operation is a key activity in an organisation, which is linked with marketing and financial activities. For the successful functioning of the organisation, co-operative actions of all section of the organisation are needed. All functional departments have to work together. Here, operational management is central to the functioning of all other parts of organisation. There should be functional collaboration among different departments. For this purpose information sharing between these departments is essential. In short operation management is the business function that plans, organises, coordinates, and controls the resources needed to produce a company's products and services. For ensuring this, the co-operation and support from all other department of the organisation are essential.

1.7.1Material handling equipment

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

17.1.1. Lifting Equipment

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

1.7.1.2. Storage Equipment

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

1.7.1.3 Automated Handling Equipment

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

1.7.1.4. Robotics

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

1.8.CHALLENGES OF OPERATION MANAGEMENT

Operations management is challenging as a branch of study because it employs highly technical and highly specialized language and approaches. In addition, another challenge emerges in the context of business activities and business environment, especially as both context and environment change to alter the effectiveness of operations techniques and processes for managers and businesses. Moreover, the levels of technical and problem solving or conceptual skills required in understanding and applying the tools and techniques of operations management create the most significant challenge for business owners and managers. Business managers and owners must be able to delve into the deeper sides or aspects of processes that create value by understanding activity flow and interrelationships between productive inputs or variables (the factors of production) and how external and internal environmental factors affect how effectively and efficiently these can be combined to produce goods and create services. Most importantly, the concept of value should be understood in terms of the link between value and processes. Operations managers should understand that it is processes that create value and therefore, strive to manage these processes in relation to the value they envision for the organization and their customers. Operations managers must meet the technical challenge presented by operations management in terms of the required body of knowledge and

understanding they need to possess to carry out their job responsibilities and tasks effectively and efficiently. They must also be able to meet the service challenge of operations management by understanding that the design and creation of services differ from the design of physical products or goods. Finally, operations managers must meet the applications challenge of operations
management by being able to effectively apply its proposed tools, techniques, methods, theories, principles, and processes in solving production problems, adding value, and maximize output for the organization in efficient ways.

1.8.1.The Technical Challenge of Operations Management

The first challenge of operations management for business owners and managers is to fully understand what operations management is all about and its role and function in creating and adding value to business processes and practices for customer satisfaction and business performance. This stems from the highly technical characteristic of this field of management study in terms of the variety of tools, techniques, and their abstract nature and complex interrelationships and connections, as operations management is at best an integrative field of management study which leans more toward the quantitative side of management theory and focusing more predominantly on efficiency practices. It is more than any other field of management study, a highly technical and increasingly quantitatively-oriented subject matter, especially as it becomes more advanced with the application of project management, time, motion, capacity planning and forecasting theories and models, lean systems theory, decision making analysis models, and scheduling techniques that are often rigged with mathematical formulas and techniques, and most recently in its practice, computer applications software systems that require high technical and quantitative skills. For the student of operations management, these can be overwhelming enough, especially for those with mathematics or numbers phobia. Thus, it becomes increasingly unpleasant to think about for business owners and managers who lack formal education and understanding of these techniques, processes, and tools that could potentially add value to their business or change their business models significantly to create more revenue streams, competitive advantage and opportunities. Even the average MBA graduate lacks sufficient knowledge in operations management, especially if he or she never completed more than a course or concentration in the field. Thus, it should be rather daunting for managers in training without such luxury of a college course or education in operations management to be presented with a diversity of operations processes, techniques, and methods engaging complex and highly quantitative ideas and formulas. Corporate trainers in the field of operations management must therefore break down materials to simple practical principles and ideas that can be immediately and easily applied to practice to facilitate usefulness and understanding to practicing managers and business owners.

Operations managers must be especially literate and technically competent by possessing a significant level of knowledge and understanding of operations management. This means understanding its major philosophies, principles, theories, and practices as well as the variety of tools, techniques, and methods used in operations management. This includes understanding value and quality management theories and methods or techniques in a manner sufficient enough to apply them and getting positive results for

the organization in terms of added value and quality, understanding the techniques and processes involved in forecasting, scheduling, capacity and resource planning, supply chain management, facility layout and design, as well as other relevant operational processes and activities as deemed essential in the effective and efficient management of organizational resources.

Operations managers must speak the language of operations most fluently while being able to also speak the language of other functional areas fluently enough to understand what other managers do, as this affects the decisions and policies they make and engage in the production and creation of goods and services. They must understand the importance of finance and marketing in affecting operational processes and how their operations decisions in turn affect these functional areas or activities that organizations use to create a value stream of customer-desired characteristics and features in what the organization does or will do. This essentially means possessing more than surface level knowledge of the field of operations management and related fields; it means being able to understand the interdisciplinary nature of operations management as study and practice devoted to maximizing value creation for competitive advantage and success.

1.8.2.Operations Management and the Service Challenge

Manufacturers produce tangible products while service products are often intangible (Heizer & Render, 2011). Services can be defined as

"economic activities that typically produce an intangible product [such as education, entertainment, lodging, government, financial, and health services] (Heizer & Render, 2011, p. 10). The challenge here is that operations managers are engaged in the creation of a product which they cannot touch or see, but which must be experienced, and as such, is difficult to measure in any objective form and is highly characterized by variations. The Service Challenge is one of the most difficult for business owners and managers when it comes to applying the theories, processes, techniques and tools of operations management in creating value because these tools and techniques were originally the domain of a large manufacturing economy that prevailed until the early 1990s in highly developed countries. Now that over 75 % of GDP stems from the creation of services in the United States, for example, these techniques must now be applied broadly in services businesses and industries in streamlining the processes that create service value and quality for customers.

There are some fundamental differences between goods and services that operations managers should be conscious of as they manage the processes that create services. Services are usually intangible as opposed to physical products which are tangible. This means that it becomes increasingly difficult to gauge the processes that create services because of difficulty in measurements and uniqueness of service providers. According to Heizer and Render (2011) services are often produced and consumed simultaneously thereby constituting no need for storage or inventory. A challenge of service is that we have not developed ways or methods to really inventory services on any recognizable or significant levels. Therefore, we have to constantly repeat and recreate services upon their simultaneous demise. Compared to tangible products, services are often unique

(Heizer & Render, 2011). This means that the combination of resources in terms of mix or amounts can vary significantly when it comes to services provision or creation. Unlike physical products, services require higher levels of customer contact and customer interaction, and hence, they are very difficult to standardize, automate, and make because customers are unique and this affects their different levels of demand for services. Furthermore, services have what Heizer and

Render (2011) describe as "inconsistent product definition" (p. 10). For example, while product definition may be rigorous, inconsistency sets in because of the characteristics, uniqueness, and influence of the service provider or customer.

We are living in an economy where the knowledge worker is emerging as the dominant creator of value, and services are often predominantly knowledge-based because they require and depend on the technical and conceptual, as well as interpersonal skills of the service provider. Finally, Heizer and Render (2011) describe services as being frequently dispersed because they must be brought into contact with consumers in various places. There are several characteristics of services that create a challenge for operations managers: perishability, variability, intangibility, and subjectivity.

Many of the functional activities in organizations are in fact services. For example, accounting, human resources and training, logistics, and marketing are services. These services serve as value enhancing productive or creative activities that create enhanced products by adding value and increasing quality. The service sector is still growing and it is most probable that operational practices must center even more on creating effective service processes in the near future. The service sector represents that segment of economies that include trade, education, lodging, financial, medical, legal, and other professional occupations and services constitute the largest economic sector in postindustrial societies (Heizer & Render, 2011; Krajewski, Ritzman & Malhotra, 2013). Most organizations today are engaged in the creation of services and operations managers must develop effective methods and approaches in making services more efficient and satisfying to their customers. This means having knowledge and keen sight to recognize service improvement opportunities and creating service blueprints or flowcharts of service process that show which steps have high customer contact (Krajewski, Ritzman & Malhotra, 2013). Moreover, operations managers must understand the requirements for service facilities and the number of lines and arrangement of the facilities (service system) as they affect service provision.

1.8.3.The Practical Applications Challenge

Despite any understanding of operations management theories, principles, processes, ideas and techniques, the real world is far more complex than we can imagine and the variables of change have become more uncontrollable as unplanned change creates a paradox (Burke, 2005) for organizational leaders and managers who seek to balance strategy and process. Therefore, the context in which application of operations management processes and techniques take place can create as much a challenge as these processes and techniques, and furthermore, the nature and types of business activities and

outputs will also create limitations and challenges in applying what has been established throughout literature and practice as sound operations management principles for increasing quality and performance or adding value to business.

Whether it is Six Sigma, Theory of Constraint (TOC), Total Quality Management (TQM), Lean Six Sigma, Statistical Process Analysis, or any other methods or techniques to managing value and quality through forecasting, scheduling, enterprise resources planning (ERP), materials requirement planning, process strategy, supply chain management, operations managers must be able to fully appreciate and understand these before they can apply them to create the value and quality they seek or desire for their organizations and customers. Operations management is an applied field of study and operations managers must apply its knowledge and principles as practices that set the pace for organizational value creation and quality improvement processes. From statistical processes, tools, and techniques to philosophies and guidelines underlying various methods such as TQM, Six Sigma, JIT, and the like, operations managers must endeavor to understand these for the opportunities they can create in terms of building and sustaining competitive advantage.

1.9 CURRENT PRIORITIES & RECENT TRENDS

Operations traditionally refers to the production of goods and services separately, although the distinction between these two main types of operations is increasingly difficult to make as manufacturers tend to merge product and service offerings. More generally, Operations Management aims to increase the content of value-added activities in any given process. Fundamentally, these value-adding creative activities should be aligned with market opportunity (see Marketing) for optimal enterprise performance To be able produce professional managers capable of fulfilling strategic roles within business and government enterprises the need for the practice of operations management cannot be forgone. Operations management is very important in business operations since it forms the heart of the organisation by controlling the system of operation. Operations management deals with the design, operation, and improvement of the systems that create and deliver a firm's primary products andservices. Like marketing and finance, operations management is a functional fieldof business with clear management responsibilities. Guinness Ghana limited is acompany in which produces alcoholic and nonalcoholic beverages such as Guinnessand Malta Guinness respectively.The effect of the global economic crisis has been profound on the UK businesssector. As a result, a new generation of entrepreneurs and business owners lookset to emerge - and many individuals who found themselves leaving college withinthe last decade will soon be seen to embark on careers which demand a significant degree of managerial skill. Subsequently, operations management has developed as a specialist subject of study on many management courses - but how does it differ from other more well-known aspects of business such as sales management and project management? And what is its importance to business today?. In the simplest terms, operations management is different because its primary concern is usually the efficiency of the

production or delivery of goods or services within a company. Consequently, an operations manager will typically need to manage the amount of resources - for example, materials or labour - needed for the desired output. In more depth, those eager to study operations management on any one of many management courses in the UK and US will quickly learn of the diversity of, and complexities within, the field. The focus on such modules will usually cover: facilities - including the planning and management of their location, analyses of

production methods in order to ensure output is achieved with as little resource aspossible, as well as issues with quality control and the risk of error. The importance of operations management today is therefore quite easy to see, even if not necessarily in reference to the subject as an entire job description, but instead referring to the skills useful to anyone in a managerial position. Indeed, with the growth of smaller companies - especially within the digital and media sectors -the latter is more significant. Increasingly, the trend amongst 21st Century industries is to offer both products and services, such as specialist programmes and tools alongside consultancy, in an effort for businesses to differentiate themselves and to offer more to prospective clients. Those with operations management skills will therefore be more prepared for differentiation between planning, control and delivery of either products or services.

1.9.1Recent Trends In operations management

- ✓ Global Competition
- ✓ Operations Strategy
- ✓ Flexibility Cycle
- ✓ Time Reduction
- ✓ Business Process Re-engineering
- ✓ Supply Chain Management Workers
- ✓ Involvement TQM Lean Manufacturing

Organizations must improve their products as well as productivity to retain theirmarket share. The long-term success of an organization requires investments intechnology because new technologies can improve efficiency and productivity. Inthis chapter, we discussed how organizations can benefit from automation. Some of the recent technological developments in the field of operations management, which include computer-aided design (CAD), direct and indirect computer-aided manufacturing (CAM), flexible manufacturing system (FMS), and computer integrated manufacturing (CIM) were discussed in the chapter.

Automated machines usually perform a variety of operations, depending on the instructions received from the computer with respect to the sequence and operational specifications of a process. FMS is a form of flexible automation in which several machine tools are linked to the materials-handling system. A central computer controls all aspects of the system. CIM

refers to a computer application that connects various computerized systems into a single multi-functional system. Another development in the field of technology is artificial intelligence (AI).
AI enables computers to exhibit some of the characteristics of human intelligence, like the capacity for learning, understanding language, reasoning and problem solving.
EDI is a system, wherein standardized forms of electronic documents are transferred between two computer systems. Customers and suppliers or departments within the same organization can share and transmit information electronically in real time using EDI.

1.10.OPERATIONS STRATEGY

Strategic decisions can be classified as those decisions which make major long term changes to the resource base of the organisation in response to external factors such as markets, customers and competitors. Thus strategic decisions occur as a result of an evaluation of the external and internal environment. The external evaluation may reveal market opportunities or threats from competitors.

The evaluation of the internal environment may reveal limitations in capabilities relative to competitors. Strategy is seen as complex in nature due to a high degree of uncertainty in future consequences arriving from decisions, integration is required of all aspects and functional areas of business and major change may have to be implemented as a consequence of strategic choices made.

1.10.1Levels of Strategy

Strategy can be seen to exist at three main levels within the organisation. At the highest or corporate level the strategy provides very general long-range guidance for the whole organisation, often expressed as a statement of its mission. The mission statement describes in general terms what key decision-makers want the company to accomplish and what kind of company they want it to become. Thus the mission focuses the organisation on specific market areas and the basis on which it must compete.

The second level of strategy is termed a business strategy and may be for the organisation or at the strategic business unit level in larger diversified companies. There the concern is with the products and services that should be offered in the market defined at the corporate level. The third level of strategy is termed the operational or functional strategy were the functions of the business (e.g.

operations, marketing, finance) make long-range plans which support the business strategy. Since the operations function is responsible in large part for the delivery of the product/service it has a major responsibility for business strategy formulation and implementation. This model implies a

'top-down' approach to strategy formulation in which corporate goals are communicated down to business and then functional areas. Although there has always been interaction within this hierarchy in both directions in this model the role of functional areas such as operations in setting the framework for how a company can

compete is being recognised. The increasing importance of operations strategy development is discussed in the following section.

1.10.2 The Role of Operations in Strategy Development

The operations/manufacturing function plays an important role in the formulation and delivery of the organisation's strategy. Market conditions have changed from a mass production era with an emphasis on high volume, low cost production to an environment demanding performance on measures such as quality and speed of delivery as well as cost. In addition the rapid pace of change in markets means the basis of how the organisation will compete may change quickly over time.

The traditional approach to strategy development has been for senior managers to establish corporate objectives, develop a strategy for meeting these objectives and then to acquire resources necessary to implement the chosen strategy. This approach is intended to ensure that resources are directed efficiently at the areas identified as 'strategically' important from the strategic analysis. The approach is based on the firm's ability to forecast future market conditions and thus identify gaps between future market needs and organisational capability. However in dynamic markets the ability to forecast far enough into the future in order to build a competitive advantage will be limited. Also this approach has led to an emphasis on relatively short-term objectives and a lack of emphasis on 'behavioural' factors such as performance evaluation systems and selection and development of the work-force. The idea is that in dynamic market conditions the strategic plan should indicate the general direction that the organisation should follow based on the capabilities and values it possesses.

1.11.STRATERGIC FIT

Operations should focus on specific capabilities that give it a competitive edge which may be termed competitive priorities. Four operations priorities or measures of these capabilities can be termed cost, time, quality and flexibility.

1.11.1 Cost

If an organisation is competing on price then it is essential that it keeps its cost base lower than the competition. Then it will either make more profit than rivals, if price is equal, or gain market share if price is lower. Cost is also important for a strategy of providing a product to a market niche, which competitors cannot provide. Thus cost proximity (i.e. to ensure costs are close to the market average) is important to maximise profits and deter competitors from entering the market.

The major categories of cost are staff, facilities (including overheads) and material with the greatest scope for cost reduction lies with reduction of the cost of materials. A relatively small proportion of costs are usually assigned to direct labour.

1.11.2Time

The time delay or speed of operation can be measured as the time between a customer request for a product/service and then receiving that product/service. Speed is an important factor to the customer in making a choice about which organisation to use. The concept of P:D ratios compares the demand time D (from customer request to receipt of goods/services) to the total throughput time P of the purchase, make and delivery stages. Thus in a make-to-stock system D is basically the delivery time, but for a customer-to-order system the customer demand time is equal to the purchase, make and delivery stages (P). In this case the speed of the internal processes of purchase and make will directly effect the delivery time experienced by the customer. Thus the advantage of speed is that it can either be used to reduce the amount of speculative activity and keep the delivery time constant or for the same amount of speculative activity it can reduce overall delivery lead time. Thus in competitive terms speed can be used to both reduce costs (making to inaccurate forecasts) and reduce delivery time (better customer service).

1.11.3Quality

Quality covers both the quality of the product/service itself and the quality of the process that delivers the product/service. Quality can be measured by the 'cost of quality' model were costs are categorised as either the cost of achieving good quality (the cost of quality assurance) or the cost of poor quality products (the costs of not conforming to specifications). The advantages of good quality on competitiveness include increased dependability, reduced costs and improved customer service.

1.11.4 Flexibility

There are a number of areas in which flexibility can be demonstrated. For example it can mean the ability to offer a wide variety of products/services to the customer and to be able to change these products/services quickly. Flexibility is needed so the organisation can adapt to changing customer needs in terms of product range and varying demand and to cope with capacity shortfalls due to equipment breakdown or component shortage. Types of flexibility include product flexibility which is the ability to be able to quickly act in response to changing customer needs with new product/service designs and volume flexibility which is the ability to be able to decrease or increase output in response to changes in demand. Volume flexibility may be needed for seasonal changes in demand as services may have to react to demand changes minute by minute.

1.12 STRATEGY FRAMEWORK

An operational framework is a guide to a company's policies, goals, standards, procedures and training. The framework sets out the way the company does business and promotes a corporate culture and identity. An operational framework may also include principles of good governance and set out company values and divisions within the firm. Each operational framework contains different elements.

1.12.1Organization

The operational framework generally describes the corporate organization or management structure. This includes how leaders will govern the company and the hierarchy of its divisions or management teams. For example, the framework may set out the levels of management, from the CEO to department heads and ordinary managers. Accompanying this might be a chart illustrating the corporate hierarchy. In smaller firms, this section might simply state the corporate structure, such as owner-operator.

1.12.2.Policies

The operational framework will generally outline company policies. These can include guiding principles on behavior, employment and promotion. It might also contain general guidelines for all employees to follow. These can include directives such as always act with fairness and integrity, support roles must be adequately staffed and responsive, always use good governance and risk management procedures and managers will have an open-door policy. These guidelines are in the operational framework to establish and develop a company ethos and culture. The document might also outline which markets the company will target and where it will focus research and development spending.

1.12.3.Processes and Procedures

Most companies include guidelines for core processes and procedures in their operational frameworks. The framework does not generally list exact instructions for processes, such as how to operate various types of equipment. Instead, it sets guidelines for broader matters, such as how to conduct business planning and when to do an audit. The framework might have procedures for managing workflow, policies for bidding on contracts and for allocating assets to company divisions. It may also include specific information on procedures for hiring, facilities management and customer relations.

1.12.4.Multiple Frameworks

Companies might have more than one operational framework. An organization might develop a framework to achieve a particular goal. For example, in 2011, the private sector arm of the World Bank set out a sustainability framework that established goals and procedures for fostering growth in developing countries by financing private sector investments. The company might design a green framework, stating environmental goals for each section of the business. An innovations framework may outline policies, procedures and management changes the company will use to achieve innovation and growth.

1.12.5.Spilt ups of Operations strategy

The focus of operations strategy in an organization is to understand and achieve the ability to consistently deliver products and services to meet customer needs and the business's overall plans. Objectives typically focus on the areas of quality, cost, flexibility, and speed. Operations strategy corresponds to the overall business strategy, especially as it relates to meeting customer needs and the market direction of procurement, conversion, and delivery of products and services. Operations strategy must

be consistent with the firm's functional strategies, including those of marketing and finance.

Manufacturing, service, and supply chain transformation processes use resources to convert inputs into some desired output. Inputs can be a raw material, a customer, or a finished product from another system. Transformation processes include, but are not limited to, the following categories.

- ✓ **Physical**. Manufacturing processes, for example, are where physical material is converted to finished products.
- ✓ **Location**. Transportation of a product is an example of a location transformation. These are common in supply chains and also in factories and warehouses.
- ✓ **Exchange**. An example is found in retail, where a customer exchanges money for an item.
- ✓ **Storage and redistribution**. These are processes where an item is stored and made available for immediate delivery, for example, in a warehouse or distribution center.
- ✓ **Physiological**. An example of this type of transformation process is a hospital, where sick patients are the inputs and healthy patients are the desired outputs.
- ✓ **Informational**. Informational processes are where data is stored, transferred, analyzed, and made available for various purposes.

1.12.6.Competitive priorities

Operational competitive priorities often are devised to create advantages in the marketplace. These priorities are driven by business plan objectives and customer preferences of products and services. Typically the top drivers include high quality, low cost, and high customer service through convenience, speed, and flexibility.

1.12.7.Order winners and order qualifiers

These are product or service highlights seen as valuable by the customer. Order qualifiers are screening criteria that must be fulfilled before a firm's products or services can even be considered as possible candidates for purchase. Order winners are unique characteristics or combinations of characteristics that result in a competitive advantage and obtaining (winning) an order from the customer.

1.12.8Activity-system maps

Activity-system maps are diagrams showing how a company's strategy is delivered through a set of tailored activities. They help the major operational processes of the firm align with operational priorities. Competitive advantage stems from the way the firm's activities reinforce one another.

1.12.9Operations alignment with corporate strategy and the supply chain

Execution of operations strategy is critical to the execution of business goals. The business plan typically is focused on financial objectives, market and product objectives,

technology, and growth. Operations must align these goals with processes such as speed, flexibility, cost and quality. Typically, trade-offs must be considered, such as speed of delivery versus cost.

1.12.10Economies of scale/economies of scope

Large companies can take advantage of economies of scale due to their ability to spread significant investments in resources, such as plants and equipment, over larger volumes of finished goods and services, lowering the incremental portion of cost over higher-volume production. When higher volumes are not necessarily the same items but share common resources, combined production creates economies of scope. For example, larger organizations often have more negotiating power with their suppliers, and third-party logistics organizations often have better success negotiating freight costs than smaller manufacturers.

1.12.11Considerations in adding capacity

Important factors to consider when adding capacity include maintaining system balance, frequency of capacity additions, and the use of external capacity. In a perfectly balanced system, the output of each stage matches the input of the next stage, in such areas as movement of material in a plant, flows from suppliers to plants through distribution centers to customers, and service calls processing from a call center. In practice, it often is difficult to maintain this system balance, and sometimes it is even undesirable. Ways of dealing with imbalance include scheduling temporary downtime, scheduling overtime, leasing equipment, and subcontracting.

When dealing with the frequency of capacity additions, it is important to consider the costs of large versus small chunks of capacity, and the cost of excess capacity that is carried as overhead until used.

1.12.12.Understanding constraints

Constraints management centers on understanding the weakest link in the process flow—typically the link with the least capacity or the bottleneck operation. This relates to both internal processes and the supply chain. From a strategy standpoint, constraints often impact the ability to reach customer service goals, pricing targets, and quality expectations.

1.12.13.Sustainability, ethics, and social responsibility

Business requires trust and integrity between partners in the supply chain. Sustainability relates to the degree of concern for the environment, including use of renewable resources and minimization of harmful waste.

Ethics relates to alignment with legal and moral codes of conduct in all activities of the firm. This can be particularly challenging in a global company, as legal and moral codes may differ significantly across cultures and geographies. In some cases there may be

prescribed processes to help ensure ethical dealings, such as those embodied in the Sarbanes-Oxley act of 2002 in the United States.

Social responsibility relates to the areas of sustainability and ethics as they pertain to the communities where the organization does business. It further extends into how the organization supports its communities and encourages its workers to follow suit. (See section 2.3.)

1.12.14.Operations metrics

Operations metrics are a quantitative indicator for process change, showing improving, maintaining, or declining performance. There are two levels of measures within operations functions: top-level key performance indicators that indicate if a process is starting to get out of control; and diagnostic measures used for problem solving, process improvement, and data analysis.

1.12.14.Balanced scorecard

The balanced scorecard theory drives action from strategy by developing specific areas of focus and feedback. Operations controls the flow of inputs and outputs of an organization and is involved in the scorecard through its impact on financial, customer, and internal business processes. Specific aspects of the balanced scorecard theory include the following.

- ✓ **Revenue growth and mix**. Operations management has a major impact on the growth of the firm through capacity considerations and new product and service introduction.
- ✓ **Cost reduction and productivity**. Operations often owns the biggest share of cost reduction in the business. Cost of sales—made up of material, labor, and overhead—typically represents a large component of costs in the organization.
- ✓ **Asset utilization and investment strategy**. Operations typically controls the major capital investments in the organization, including plants, equipment, and inventory.

1.12.15.Benchmarking

Benchmarking is the act of comparing one operation or process with another. This can be performed against similar operations but can be especially effective if done against best-in-class operations, regardless of the market. For example, benchmarking quality at a tool manufacturer against aerospace standards, or benchmarking product introduction against the electronics market.

1.12.16.Best practices

Best practices are techniques, methods, processes, activities, or other actions in conducting business that are most effective at delivering a particular outcome. By seeking out relevant best practices and driving improvements against these examples, gains typically can be made more quickly.

1.13 SUPPLY CHAIN MANAGEMENT

A supply chain is the series of activities that delivers a product or service to a customer.

Activities in the supply chain include sourcing materials and components, manufacturing products, storing products in warehousing facilities and distributing products to customers. The management of the supply chain involves the coordination of the products through this process which will include the sharing of information between interested parties such as suppliers, distributors and customers.

1.13.1Fluctuations in the Supply Chain

The behaviour of supply chains that are subject to demand fluctuations has been described as the bullwhip effect and occurs when there is a lack of synchronisation is supply chain members, when even a slight change in consumer sales will ripple backwards in the form of magnified oscillations in demand upstream. The bullwhip effect occurs because each tier in the supply chain, increases demand by the current amount, but also assumes that demand is now at this new level, so increases demand to cover the next week also. Thus each member in the supply chain updates their demand forecast with every inventory review.

There are other factors which increase variability in the supply chain. These include a time lag between ordering materials and getting them delivered, leading to over-ordering in advance to ensure sufficient stock are available to meet customer demand. Also the use of order batching (when orders are not placed until they reach a predetermined batch size) can cause a mismatch between demand and the order quantity. Price fluctuations such as price cuts and quantity discounts also lead to more demand variability in the supply chain as companies buy products before they need them.

In order to limit the bullwhip effect certain actions can be taken. The major aspect that can limit supply chain variability is to share information amongst members of the supply chain. In particular it is useful for members to have access to the product demand to the final seller, so that all members in the chain are aware of the true customer demand. Information Technology such as Electronic point-of-sale (EPOS) systems can be used by retailers to collect customer demand information at cash registers which can be transmitted to warehouses and suppliers further down the supply chain. If information is available to all parts of the supply chain it will also help to reduce lead times between ordering and delivery by using a system of coordinated or synchronised material movement.

Using smaller batch sizes will also smooth the demand pattern. Often batch sizes are large because of the relative high cost of each order. Technologies such as e-procurement and Electronic Data Interchange (EDI) can reduce the cost of placing an order and so help eliminate the need for large batch orders. Finally the use of a stable pricing policy can also help limit demand fluctuations.

An important aspect of supply chain activities is the role of procurement in not only acquiring the materials needed by an organisation but also undertaking activities such as selecting suppliers, approving orders and receiving goods from suppliers. The term procurement is often associated with the term purchasing but this is taken to refer to the actual act of buying the raw materials, parts, equipment and all the other goods and services used in operations systems. There has recently been an enhanced focus on the procurement activity due to the increased use of process technology, both in terms of materials and information processing. In terms of materials processing the use of process technology such as flexible manufacturing systems has meant a reduction in labour costs and thus a further increase in the relative cost of materials associated with a manufactured product. This means that the control of material costs becomes a major focus in the control of overall manufacturing costs for a product. Another issue that has increased the importance of procurement is that the efficient use of automated systems requires a high quality and reliable source of materials to be available. This is also the case with the adoption of production planning systems such as JIT which require the delivery of materials of perfect quality, at the right time and the right quantity.

1.13.2.Choosing Suppliers

Before choosing a supplier, the organisation must decide whether it is feasible and desirable to produce the good or service in-house. Buyers in purchasing departments, with assistance from operations, will regularly perform a make-or-buy analysis to determine the source of supply.

Often goods can be sourced internally at a lower cost, with higher quality or faster delivery than from a supplier. On the other hand suppliers who focus on delivering a good or service can specialise their expertise and resources and thus provide better performance. Strategic issues may also need to be considered when contemplating the outsourcing of supplies. For instance internal skills required to offer a distinctive competence may be lost if certain activities are outsourced. It may also mean that distinctive competencies can be offered to competitors by the supplier.

If a decision is made to use an external supplier, the next decision relates to the choice of that supplier. Criteria for choosing suppliers for quotation and approval include the following: *Price* – As stated in the introduction, the cost of goods and services from suppliers is forming an increasingly large percentage of the cost of goods and services which are delivered to customers.

Thus minimising the price of purchased goods and services can provide a significant cost advantage to the organisation.

Quality – To be considered as a supplier, it is expected that a company will provide an assured level of quality of product or service. This is because poor quality goods and services can have a significant disruptive effect on the performance of the operations function. For example resources may have to be deployed checking for quality before products can be used, poor quality products that get into the production system

may be processed at expense before faults are found and poor quality goods and services that reach the customer will lead to returns and loss of goodwill.

Delivery – In terms of delivery, suppliers who can deliver on-time, every time, in other words show reliability, are required. The ability to deliver with a short lead time and respond quickly once an order has been placed, can also be an important aspect of performance.

The process of locating a supplier will depend on the nature of the good or service and its importance to the organisation. If there are few suppliers capable of providing the service then they will most likely be well known to the organisation. If there are a number of potential suppliers and the goods are important to the organisation then a relatively lengthy process of searching for suppliers and the evaluation of quotations may take place. Most organisations have a list of approved suppliers they have used in the past, or are otherwise known to be reliable.

However it is important to monitor suppliers in order to ensure that they continue to provide a satisfactory service. A system of supplier rating, or vendor rating is used to undertake this. One form of vendor rating is a checklist which provides feedback to the supplier on their performance and suggestions for improvement. Another approach is to identify the important performance criteria required of the supplier, for example delivery reliability, product quality and price.

The supplier can then be rated on each of these performance measures against historical performance and competitor performance. When choosing suppliers a decision is made whether to source each good or service from an individual supplier, termed single sourcing or whether to use a number of suppliers, termed multi-sourcing.

1.13.3.Supply Chain Distribution

Supply chain distribution refers to the movement of materials through the supply chain to the customer. Two main areas of physical distribution management are materials handling and warehousing.

1.13.3.1Materials Handling

There are three types of materials handling systems available can be categorised as manual, mechanised and automated. A manual handling system uses people to move material. This provides a flexible system, but is only feasible when materials are movable using people with little assistance. An example is a supermarket where trolleys are used to assist with movement, but the presence of customers and the nature of the items make the use of mechanisation or automation not feasible. Mechanised warehouses use equipment such as forklift trucks, cranes and conveyor systems to provide a more efficient handling system, which can also handle items too heavy for people. Automated

warehouses use technology such as Automated Guided Vehicles (AGVs) and loading/unloading machines to process high volumes of material efficiently.

1.13.3.2 Warehousing

Warehouses serve an obvious function as a long-term storage area for goods but also provide a useful staging post for activities within the supply chain such as sorting, consolidating and packing goods for distribution. Consolidation occurs by merging products from multiple suppliers over time, for transportation in a single load to the operations site. Finished goods sourced from a number of suppliers may also be grouped together for delivery to a customer in order to reduce the number of communication and transportation links between suppliers and customers. The opposite of consolidation is break-bulk where a supplier sends all the demand for a particular geographical area to a local warehouse. The warehouse then processes the goods and delivers the separate orders to the customers.

One of the major issues in warehouse management is the level of decentralisation and thus the number and size of the warehouses required in inventory distribution. Decentralised facilities offer a service closer to the customer and thus should provide a better service level in terms of knowledge of customer needs and speed of service. Centralisation however offers the potential for less handling of goods between service points, less control costs and less overall inventory levels due to lower overall buffer levels required. The overall demand pattern for a centralised facility will be an aggregation of a number of variable demand patterns from customer outlets and so will be a smoother overall demand pattern thus requiring lower buffer stocks.
It is a trade-off between the customer service levels or effectiveness offered by a decentralised system and the lower costs or efficiency offered by a centralised system. One way of combining the advantages of a centralised facility with a high level of customer service is to reduce the delivery lead time between the centralised distribution centre and the customer outlet. This can be accomplished by using the facility of Electronic Data Interchange (EDI) or e-procurement systems discussed in the procurement section.

The warehouse or distribution system can be itself outsourced and this will often be the only feasible option for small firms. The choice is between a single-user or private warehouse which is owned or leased by the organisation for its own use and a multi-user or public warehouse which is run as an independent business. The choice of single-user or multi-user warehouse may be seen as a break-even analysis with a comparison of the lower fixed costs, but higher operating costs of a multi-user warehouse, against the high fixed costs and lower operating cost of a single-user warehouse.

UNIT-2

FORECASTING, CAPACITY & FACILITY DESIGN

2.1.DEMAND FORECASTING

Demand forecasting is the activity of estimating the quantity of a product or service that consumers will purchase. Demand forecasts

- Predict the future demand for a company's products or services.

Demand forecasting may be used in making pricing decisions, in assessing future capacity requirements, or in making decisions on whether to enter a new market.
Forecast

Positive forecast :Prediction about the future based on assumption

Active forecast: Forecasting is done

2.1.1NEED OF DEMAND FORECAST

- Distribution of resources
- Helps in avoiding wastages of resources
- Serves as a direction to production & Pricing
- Helps in devising sales policy
- Decrease of business risk
- Inventory management

2.1.2TYPES

Qualitative methods: These types of forecasting methods are based on judgments, opinions, intuition, emotions, or personal experiences and are subjective in nature. They do not rely on any rigorous mathematical computations.

Quantitative methods: These types of forecasting methods are based on mathematical (quantitative) models, and are objective in nature. They rely heavily on mathematical computations.

2.1.3 Tools Of Forecasting Techniques

Qualitative model

2.1.3.1.Delphi Technique

A systematic forecasting method that involves structured interaction among a group of experts on a subject. The Delphi Technique typically includes at least two rounds of experts answering questions and giving justification for their answers, providing the opportunity between rounds for changes and revisions.

2.1.3.2. Nominal group technique

The **nominal group technique** (NGT) is a group process involving problem identification, solution generation, and decision making.

2.1.3.3. Marketing research method

The process or set of processes that links the consumers, customers, and end users to the marketer through information — information used to identify and define marketing opportunities and problems and improve understanding of marketing as a process.

2.1.3.4Sales force composite method

A technique used by production managers to project the future demand for a good or service based on the total amount that each salesperson anticipates being able to sell in their region.

Quanitative model

I. **Time Series Models**

a. **Last period Method**

Uses last period's actual value as a forecast

Ft= At – 1

Ft = Forecast demand for period t

At-1= Actual demand in previous period

2.1.3.5.Simple Average Method

$$Ft = \frac{\sum_{t=1}^{n} At}{n} \quad \textbf{(OR)}$$

$$Ft = \frac{A1+A2+A3+A3+A4+\ldots.+An}{n}$$

Ft =Forecasted demand for period t

At= Actual demand for period t

n= Total no of periods

2.1.3.6 Moving average method

Uses an average of a specified number of the most recent observations, with each observation receiving a different emphasis (weight)

$$ft = \frac{At\text{-}1 + At\text{-}2 + At\text{-}3 + At\text{-}4 + At\text{-}5 + \ldots.Atn}{n}$$

Where

Ft- Forecasted demand for period t

At- Actual demand for period t

n- Total no of periods

.2.1.3.7.Exponential smoothing method

A weighted average procedure with weights declining exponentially as data become older.

$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$$

Where

F_t – Forecasted demand for period t

F_{t-1} –forecasted demand for previous method

α- Smoothening constant

A_{t-1}- Actual demand for previous demand

e. Trend Project(Past data/ Predicting the future)

This method is a version of the linear regression technique.

Y = a + bX

Where
X represents the values on the horizontal axis (time)
Y represents the values on the vertical axis (demand).

2.1.3.8.Cause and Effect Model

Correlation and Regression method

Linear regression is a mathematical technique that relates one variable, called an *independent variable,* to another, the *dependent variable,*

$Y = a + bX$

Y- independent variable

X- Dependent variable

a- the intercept

B- slope of the line

2.1.3.9.Econometric Method

It includes endogenous –determined within the model (controlled variables) and exogenous variable-determined outside the model(uncontrolled variables)

eg., Money

2.1.3.10.Input and output method

It helps to determine Or forecast the demand of a particular product or services.

End use method

It has theoretical and practical method or value. It is influenced by the technological , structural and other changes.

2.1.3.11.Factors affecting demand forecast

- ✓ Business cycle
- ✓ Customer plan
- ✓ Product life cycle
- ✓ Competitor's effort
- ✓ Credit policy
- ✓ Sales effort
- ✓ Advertising

2.1.3.12.OBJECTIVES OF DEMAND FORECASTING

Project Revenues

One of the basic reasons for demand forecasting is to help you project sales revenues so you can create your annual budget. Your projected revenues will determine how much you can spend and still make a profit. Creating several demand scenarios will help you create a flexible budget that triggers spending changes as your revenues increase and decrease. Knowing your revenue also helps you project tax liabilities and your ability to service your debt.

Better Production Scheduling

Demand forecasting helps you determine how many of each product you'll sell and when you'll sell them, helping you improve your production scheduling. This will help you ensure you have the materials, supplies and labor you need during busy times. You might increase your inventory during slow periods or well before forecast peak demand times. If you need to service equipment and machinery, demand forecasting can help you identify the best times to buy them. Knowing your production needs will also help you optimize your labor spending by avoiding a need for overtime or contract help.

Adequate Cash Flow

Knowing the timing of your demand will help you determine when you'll have more bills to pay and when you'll have slow income. This allows you to take steps to have adequate cash and credit available to pay your bills and keep your operations running. Even if your total sales volumes remain steady throughout the year, forecasting the demand for specific products will help you meet the terms of different suppliers and prepare for specific slow-paying customers throughout the year.

Logistics Planning

From the time you take an order to the time you deliver it, you create a supply chain that must work together to prevent logjams. Demand forecasting helps you coordinate your production, warehousing and distribution. If your production department stalls, your warehouse might not have enough staff on hand when a rush of catch-up product begins to arrive. If your demand increases and you haven't scheduled enough trucks to deliver it, you delay or lose sales and can lose customers who need to find product elsewhere.

STEPS IN DEMAND FORECSTING

- ✓ Gathering Information
- ✓ Determine previous demand
- ✓ Focus on future
- ✓ Look at the market plan
- ✓ Use tools for measurement
- ✓ Review key Indicators

- ✓ Compile the result

2.2.CAPACITY PLANNING

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

✓ 2.2.1.Capacity requirement planning

- o A capacity requirement planning is a part of manufacturing resource planning .Capacity resource planning is carried out after a manufacturing resource planning program has been run. The important elements of the capacity requirement planning process are of establishing, measuring and adjusting the limits or levels of the production capacity based on the process of determining the amount of labour and machine resources required to accomplish the tasks of production.
- o Capacity requirements can be evaluated from two perspectives—long-term capacity strategies and short-term capacity strategies.

✓ 2.2.2. Long-term capacity strategies

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

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

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

- ✓ Phasing out capacity: The out-dated manufacturing facilities cause excessive plant closures. The impact of the closure will be huge in the case of industries. The phasing out

also affects the employability of employees and which in turn affect the standard lining of the society. The phasing out options makes alternative arrangements for men like shifting them to other jobs or to other locations, compensating the employees etc.

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

- o Fundamental capacity is fixed for short period. Major facilities will not be changed. Many short-term adjustments for increasing or decreasing capacity are possible. The adjustments to be required depend upon the conversion process like whether it is capital intensive or labour intensive or whether product can be stored as inventory. Capital-intensive processes depend on physical facilities,
  plant and equipment. Short-term capacity can be modified by operating these facilities more or less intensively than normal.

2.2.4.Long-term Capacity Decisions

Although every business will have different needs when it comes to capacity, the following four-step procedure can be used as a general guide to plan for long-term capacity decisions:[1]

1. Estimate future capacity requirements
2. Identify gaps by comparing requirements with available capacity
3. Develop alternative plans for reducing the gaps
4. Evaluate each alternative, both qualitatively and quantitatively, and make a final choice.

Step 1: Estimate capacity requirements

A process's capacity requirement is what its capacity should be for a future period to meet the organisation's demand, taking into account the desired capacity cushion.[2] Capacity requirements can be expressed in one of two ways: with an output measure or with an input measure.

Step 2: Identify gaps

A capacity gap refers to the difference between projected capacity requirements and current capacity, whether it is negative or positive.[3] If multiple operations and several resource inputs are involved, making long-term capacity decision can become a very complex task.

For example, if you decide to only expand the capacity of certain operations, your overall capacity may be increased. On the other hand, if one of your operations is constrained, then your overall process capacity will only increase if the constrained operation is also increased.

Step 3: Develop alternatives

Once you have estimated your organisation's capacity requirements and identify gaps, you should develop alternative plans to cope with projected gaps. One alternative, known as the base case, is to do nothing and simply lose orders from any demand that exceeds current capacity or incur costs because capacity is too large. Other alternatives may include the various timing and sizing options such as the expansionist and wait-and-see strategies. Some alternatives for reducing capacity include the closing of facilities, laying off employees, or reducing the days or hours of operation.

Step 4: Evaluate the alternatives

The final step involves evaluating each alternative both qualitatively and quantitatively. Qualitatively, you must look at how each alternative fits the overall capacity strategy.. Some of the more important issues to consider include the uncertainties of demand, competitive reaction, technological change, and cost estimates. Having good knowledge and experience will certainly help in this process. You can also use the 'what-if' analysis to further assess each alternative's implications before making a final choice.

Quantitatively, you must estimate the change in cash flow for each alternative over the forecast time horizon compared to the base case. When undertaking this task you should only be concerned with calculating the cash flows attributable to the project.

2.2.5The short-term capacity strategies

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

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

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

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

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

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

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

2.2.6TYPES OF CAPACITY

2.2.6.1 Maximum capacity

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

2.2.6.2Effective capacity

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

2.2.6.3Demonstrated capacity

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

2.3.DEVELOPING CAPACITY ALTERNATIVES

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

1. The first step is to describe the general flow of activities with in the process.
2. Establish the time period.
3. Establish a common unit of measurement for the entire process
4. Identify the maximum capacity for the overall process
5. Identify the effective capacity for the overall process
6. Determine the demonstrated capacity
7. Compare the demonstrated, effective and maximum capacities and take appropriate actions.

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

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

2. Capacity affects the cost efficiency of production.

3. Capacity affects the scheduling system.

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

2.3.1The process involved in capacity planning is as follows:

Demand forecasting

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

Capacity decisions

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

Facilities planning

Capacity decisions automatically lead to the setting up of necessary facilities in order to produce goods and services as determined the previous steps. Facility planning

can be done either by the expansion or contraction of existing facilities or by setting up of additional new facilities.

Decisions and implementation

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

2.3.2Importance of capacity planning

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

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

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

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

5. Capacity decisions can affect competitiveness.

6. Capacity planning reduces the complexity in manufacturing operation. Principles of capacity planning

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

2.3.3Agree on a common definition of capacity planning

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

2.3.4Select a capacity planning process owner

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

2.3.5.Identify the key resources to be measured

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

2.3.6.Compare current utilisation to maximum capacities

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

2.4.OVERVIEW OF SALES & OPERATIONS PLANNING

S&OP is a dynamic process. It is senior executive-led and requires well-defined workflows, schedules, disciplines, reporting, analyses, measurement, and information feedback, as well as documentation of decisions and assumptions.

Additionally, a dedication to controlled continuous improvement is essential. While some time needs to be allocated to recent performance and short-term issues, the process focuses primarily on mid- to long-term analyses, planning and decision making.

S&OP incorporates demand planning (sales planning and forecasting); supply/operations and resource planning; the integration of new product development (NPD) and innovation plans; mapping and reconciliation of those plans to financial plans and objectives; the evaluation of various plan scenarios; and agreement by cross-functional management of the best plans/scenarios.

The cycle is completed with a thorough review, discussion and approval by the senior management team of those plans, associated risks and opportunities. Once plans are approved, execution, monitoring and control of the agreed-upon plans and schedules become the focus.

2.4.1.Six Interdependent Elements Of Sales & Operations Planning Capability

S&OP process capability elements to consider:

1) ***Business Strategies and Policies***: By strategy, we mean a strategic plan to develop the desired level of capability for the S&OP process. The strategy must include a vision and objectives for that process. These must be supported by specific plans and investments to put S&OP capabilities in place. Policies must be developed to enable the strategic goals of S&OP.

2) ***Business Processes***: This includes practices and procedures for demand planning; supply planning; reconciliation and integration of demand, supply, financial and new product plans; and senior executive review and approval of scenarios and plans.

3) ***Organization and People***: Addresses corporate culture as it relates to successful S&OP, the executive-level leadership and teamwork required, and the specific skills, qualifications, training, education, team structures and responsibilities and other organizational considerations to meet the vision and objectives for S&OP.

4) ***Management Reports***: The reports and other information required by management and the organization for decision making, scenario evaluation, measurement, management and control of the S&OP process.

5) ***Models and Methodologies***: The models and tools used for scenario development, "what-if" and plan analyses, performance measurement, reporting and so forth.

6) ***Systems and Data***: The internal and external systems and data supporting the process, and the integrity and availability of the data required for effective and efficient S&OP.

2.4.2Survey Results Overview

The six areas of S&OP process capability assessed directly in the survey include:

1. Strategy and Policy for S&OP Processes
2. S&OP Process and Practice Design
3. S&OP Organization Culture, Teamwork and Skills
4. S&OP Information for Decision Making
5. S&OP Information Methodologies and Tools
6. S&OP-Related Technology/Systems and Data

Material Requirements Planning (MRP) is a mode of planning that plans requirements in order by the lowest level in which the item appears in a bill of material. That is, it plans all end items first, then all items at the next level, and so on, backward planning each requirement from the requirement's needed date to the item's lead time and batching together requirements needed at the same period of time.

Unlike APS, MRP does not consider routing times, resource capacity, or shifts. The responsibility rests with you, the planner, to make sure your shop floor has the available capacity to work the plan. MRP generates planned orders and exception messages to help you implement an accurate plan.

2.5.OVERVIEW OF MRP

2.5.1Low-level Codes and Bills of Material

Each item has a low-level code that represents the lowest level at which the item appears in all current, job, and production schedule bills of material (BOMs). An end item always has a low-level code of 0. Items in the next level of the BOM have a low-level code of 1, the next level is 2, and so on. MRP processes items in order by low-level code, and processes an item only at its lowest-level code. You should update the low-level codes by running the Current Bill of Material Processor and the Job and PS Bill of Material Processor before you run MRP. See the Low-level Code field help topic for more information.

2.5.2.Routings

MRP does not directly factor operation duration times into its planning logic. However, when planning released jobs, it does use the start date of each operation to backward plan the materials required at the operation if the Plan Materials at Operation Start field is selected on the Planning Parameters form.

Also, if you use the Lead Time Processor to generate lead times for manufactured items, the operation's Run Duration, Move, Queue, Setup, and Finish times will be used in calculating lead time. Therefore, accurate information in your routings is important for successful MRP planning.

2.5.2.Item Lead Times

MRP uses the item lead time to determine the due dates on planned orders it creates to satisfy requirements, planning backward in time from the date the item is needed. Typically, you use the Lead Time Processor to generate the lead time for manufactured items automatically from information including the item routing's move, queue, setup, duration, and finish times and the average hours in a work day.

2.5.3On-hand Inventory and Receipts

MRP calculates the on-hand inventory quantity at the beginning of the process as the total on-hand quantity (that is, on-hand - Qty Reserved for customer orders) at all nettable stockroom locations across all NON dedicated-inventory warehouses at the site. A dedicated-inventory warehouse has the Dedicated Inventory field selected on the Warehouses form.

Receipts (also called "planned supplies") include expected incoming quantities from jobs, production schedule releases, MPS receipts, purchase orders, and transfer orders. If the planning parameter Check PO Requisitions is selected, purchase requisitions are also considered as receipts.

The system considers on-hand inventory and receipts in determining the net requirements for an item.

2.5.4.Independent Requirements

An independent requirement is a demand for an item that does not originate from another requirement. Forecasts, customer orders, and demand transfer orders are independent requirements. MRP starts by planning independent requirements and generates "dependent requirements" for the next levels in the item's BOM.

2.5.5.Master Production Schedule

The master production schedule (MPS) allows you to control production of key end items to help you protect your schedule from fluctuations in order-based demand (forecasts, customer orders, parent job orders, etc.). MPS is a manually created, anticipated build schedule for an item. You create it based on your expectations of demand and your estimation of resource capacity.

When you run the MPS Processor, planned orders are created for MPS item requirements that are due outside the MPS plan fence, but not for the components in the MPS item's bill of material. When you run MRP after running MPS, MRP does not create planned orders for the MPS end item, but does pass those requirements down to the components in the MPS item BOM, creating PLNs for the components.

2.5.6.Information MRP Generates

The output of an MRP process includes planned orders and exception messages.

2.5.7.Planned Orders

When you run an MRP process, the system generates planned orders (PLNs), as illustrated in the example below. PLNs represent MRP's suggestions of how you can manufacture or purchase the item to satisfy the requirements. A PLN is not tied to a particular requirement.

You must examine each PLN and firm it into a real job order, purchase order, transfer order, etc., as you deem appropriate. The item's Source field (as defined on the Items form) determines what type of receipt the PLN will firm into (Manufactured=job order; Purchased=PO; Transferred=transfer order). You can firm PLNs on the Planning Detail form or on the Material Planner Workbench.

2.5.8.Exception Messages

When certain situations occur within the MRP process, such as when the on-hand quantity drops below safety stock, or when a planned receipt is no longer needed (or needs to be moved in or out in time), the system generates a warning/informational alert called an exception message. You must review these messages and take the appropriate action. You can review exception messages on the Planning Detail form or on the

Material Planner Workbench. See About Exception Messages for a description of each message that may be generated.

2.5.9.Reports

After running MRP, you can use the Material Planner Workbench or the Order Action Report to determine the job orders and purchase orders you must generate and release for a given item to be available when needed. Use the Exceptions Report to print a list of all items for which MRP generated exceptions. This is basically the same information you can view on the Planning Detail or Material Planner Workbench forms, but may be easier to use as a tool for responding to the exceptions.

2.5.10.Multi-Site MRP Planning

The system can replicate MRP planned transfer orders to the supply sites in your multi-site environment.

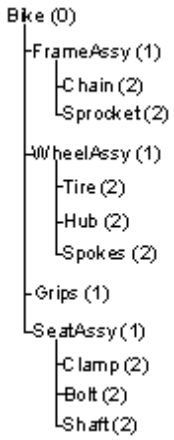
You must set up replication rules to allow a supply site to "see" any demands coming from the site that initiated the MRP process.

2.5.11.Comparison with APS

APS is an alternative planning mode also available in SyteLine. Unlike MRP, APS considers resource capacity and shifts when planning a demand. Also, APS plans demands by order priority, completely planning a single demand through its entire BOM before determining whether capacity is available to plan the next demand. APS is a more accurate and realistic planning method than MRP; however, it may require more thought about how to set a variety of additional planning parameters. APS also requires you to provide accurate routing information to achieve an accurate plan. See APS Overview for more information about the APS planning mode.

2.5.12.Example MRP Plan of a Bicycle End Item

To understand the planning process MRP uses to satisfy requirements for an item, consider a simple BOM for manufacturing a bicycle. In this example, we have an end item Bike that is made from a Frame subassembly, a Wheel subassembly (2-per), Grips (2-per), and a Seat subassembly. In the graphical representation below, the number in parentheses represents the low-level code for each level in the BOM.



2.5.13Example MRP Input Data

For this example, assume this starting data:

- Fixed Lead Time for Bike: 3 days
- Current date is 4/5
- On-hand inventory for Bike: 50
- Safety stock for Bike: 20
- Forecast for Bike: 500, due 4/11 (for this example, we will assume this date is within the Forecast Look Behind/Look Ahead window)
- Customer order: 200, due 4/20
- Purchase order for Grips: 500, due 4/6

When you run MRP Planning, the system performs the entire process for one end item (and all other end items) before moving on to the next level in the BOM. The system plans all items with low-level code 0, in order by due date, and then plans items with low-level code 1, and then low-level code 2, and so on, until all levels of low-level coding are planned. For simplicity in this example, we will observe the process only for low-level codes 0 and 1.

2.5.14.Processing Low-level Code 0 (End Item)

1. Compare forecasts for the item to customer orders to determine the true net requirements. In this example, the forecast has an original quantity of 500. The single customer order in this example (quantity of 200) "consumes" that requirement down to 300. MRP will use this quantity as one of the independent requirements to plan.

2. Create independent requirements for the end item:
   - Forecast: 300

   - Customer Order: 200

NOTE: This example includes only a single customer order and a forecast; however, other demands, such as job orders, transfer orders, and project resources, would be considered as well.

3. Calculate beginning balance on-hand. For this example, on hand is 50.

4. If beginning on-hand is below safety stock (for this example, it is not):
   - Generate On Hand Below Safety Stock exception message.
   - Search for planned receipts (jobs, POs, etc.), within the Job Reschedule time fence or PO Reschedule time fence, to cover the safety stock and generate the appropriate exception message (Move In Rcpt/Move Out Rcpt as appropriate). If planned receipts do not cover safety stock, generate a PLN due on the date the on-hand went below safety stock.

5. Process all requirements for the item. For each requirement, deduct the order quantity from balance on-hand. If the requirement is a forecast, and the Use CO or Forecast parameter is set to Forecast, deduct the full forecast quantity from balance on-hand. If the parameter is set to Both, deduct only the Outstanding Quantity (that is, the quantity not consumed by customer orders) from balance on-hand.

   After deducting the requirement quantity from on-hand, if on-hand is below safety stock:

   - Generate On Hand Below Safety Stock exception message.

   - Search for planned receipts (jobs, POs, etc.) within the reschedule time fence to cover safety stock. If necessary, generate the appropriate exception message. If existing receipts do not cover safety stock, generate a PLN to cover safety stock and the unsatisfied requirement. The system considers the PLN as a placeholder receipt that you will later "firm" into a job, purchase order, etc. In this example, there are no existing receipts to use, so the system creates two PLNs: one to represent the quantity of the forecast (plus the quantity needed to cover safety stock) and one to satisfy the customer order:
   - PLN 1: 270 (net of 300 forecasted quantity - 50 on hand + 20 to cover safety stock), due 4/11

   - PLN 2: 200 (to cover customer order), due 4/20

   On the Planning Detail form, the plan for the Bike item would look something like this:

	Item	Date	Projected On Hand	Outstanding Receipt	Outstanding Requirement	Exception Message	Reference	Parent Item
1 >>	Bike		50.000	0.000	0.000		BALANCE ON HAND	
2	Bike	4/11/2005	320.000	270.000	0.000		PLN 1	
3	Bike	4/11/2005	20.000	0.000	300.000		FCST 2005-04-10	
4	Bike	4/20/2005	220.000	200.000	0.000		PLN 2	
5	Bike	4/20/2005	20.000	0.000	200.000		CO 1601	

NOTE: Depending on the due dates of the demands and the setting of the Days Supply field for the item, these PLNs may be consolidated into a single PLN with a quantity of 470.

6. Pass PLNs for this item down to the component materials in the next level of the BOM. This step "explodes" the requirements for this item down to the next level of the BOM to create the "dependent requirements" for the components.
   - Pass any PLNs created/updated in the previous step to the current BOM, creating "parent planned orders" (PPLN requirements) for the appropriate components. In this example, the system creates these PPLN requirements:

Component	Requirements	Due Date
FrameAssy	PPLN 1: 270	4/7
	PPLN 2: 200	4/15
WheelAssy	PPLN 1: 540	4/7
	PPLN 2: 400	4/15
Grips	PPLN 1: 540	4/7
	PPLN 2: 400	4/15
SeatAssy	PPLN 1: 270	4/7
	PPLN 2: 200	4/15

   - **NOTE:** The component requirements' due dates reflect the parent requirement's due date minus the end item's lead time, counting only manufacturing days as defined by the MDAY calendar.
   - Pass any job receipts identified in step 5 to the job BOM (if it exists; otherwise pass to the current BOM), creating parent job requirements (PJOB requirements) for the appropriate components. In this example, there were no job receipts for the end item.
   - Pass any production schedule receipts to the production schedule BOM (if it exists; otherwise pass to the current BOM), creating parent production schedule requirements (PPS records) for the appropriate components. In this example, there were no PS receipts for the end item.
7. Repeat the above steps to plan the next item. If this is the last item with low-level code 0, move on to planning the items with low-level code 1.

2.5.15.Processing Low-level Code 1 Items

For simplicity, the following process is summarized for all low-level code 1 items; in the system, the steps would be repeated for each low-level code 1 item individually.

1. Compare forecasts for the item to customer orders to determine the true net requirements. In this example, there are no forecasts for any of the low-level code 1 items.

2. Create requirements for the item. Requirements for items in the bill of material were passed down from the end item. For this example, the following requirements were passed:

Component	Requirements	Due Date
FrameAssy	PPLN 1: 270	4/7
	PPLN 2: 200	4/15
WheelAssy	PPLN 1: 540	4/7
	PPLN 2: 400	4/15
Grips	PPLN 1: 540	4/7
	PPLN 2: 400	4/15
SeatAssy	PPLN 1: 270	4/7
	PPLN 2: 200	4/15

3. Calculate beginning balance on-hand. For this example, there is no available on-hand inventory for any of the components.
4. If beginning on hand is below safety stock, generate exception messages and safety stock PLNs as described above in the *Processing Low Level Code 0* section.

5. Process requirements for the item, as described above in the *Processing Low Level Code 0* section. Create PLNs to satisfy each unsatisfied requirement:

Component	Requirements	Resulting PLN
FrameAssy	PPLN 1: 270	PLN 3: 270
	PPLN 2: 200	PLN 4: 200
WheelAssy	PPLN 1: 540	PLN 5: 540
	PPLN 2: 400	PLN 6: 400
Grips	PPLN 1: 540	PLN 7: 40
	PPLN 2: 400	PLN 8: 400
SeatAssy	PPLN 1: 270	PLN 9: 270
	PPLN 2: 200	PLN 10: 200

6. **NOTE:** For the Grips component, PLN 7 is only for 40 because the purchase order for 500 satisfies 500 of the PPLN requirement.

7. On the Planning Detail form, the plan for the FrameAssy item would look something like this:

	Item	Date	Projected On Hand	Outstanding Receipt	Outstanding Requirement	Exception Message	Reference	Parent Item
1 >>	FrameAssy		0.000	0.000	0.000		BALANCE ON HAND	
2	FrameAssy	4/7/2005	270.000	270.000	0.000		PLN 3	
3	FrameAssy	4/7/2005	0.000	0.000	270.000		PPLN 1	Bike
4	FrameAssy	4/15/2005	200.000	200.000	0.000		PLN 4	
5	FrameAssy	4/15/2005	0.000	0.000	200.000		PPLN 2	Bike

8. The plan for the Grips component would look something like this:

9.

	Item	Date	Projected On Hand	Outstanding Receipt	Outstanding Requirement	Exception Message	Reference	Parent Item
1 >>	Grips		0.000	0.000	0.000		BALANCE ON HAND	
2	Grips	4/6/2005	500.000	500.000	0.000		PO 6 2	
3	Grips	4/7/2005	540.000	40.000	0.000		PLN 7	
4	Grips	4/7/2005	0.000	0.000	540.000		PPLN 1	Bike
5	Grips	4/15/2005	400.000	400.000	0.000		PLN 8	
6	Grips	4/15/2005	0.000	0.000	400.000		PPLN 2	Bike

10. Pass PLNs for this item down to the component materials in the next level of the BOM. This step "explodes" the requirements for this item down through the BOM to create the "dependent requirements" for the components.
    - Pass any PLNs created/updated in the previous step to the current BOM, creating "parent planned orders" (PPLN requirements) for the appropriate components. In this example, the system passes PPLN requirements down to the low-level code 2 components.
    - Pass any job receipts identified in the previous step to the job BOM (if it exists; otherwise pass to the current BOM), creating parent job requirements (PJOB requirements) for the appropriate components. In this example, there were no job receipts for any components.
    - Pass any production schedule receipts to the production schedule BOM (if it exists; otherwise pass to the current BOM), creating parent production schedule requirements (PPS records) for the appropriate components. In this example, there was a production schedule for the Grips item, but the Grips item has no components.
11. Repeat the above steps to plan the next item. If this is the last item with low-level code 1, move on to planning the items with low-level code 2.

2.6.MRPII

Manufacturing resource planning (**MRP II**) is defined as a method for the effective planning of all resources of a manufacturing company. Ideally, it addresses operational planning in units, financial planning, and has a simulation capability to answer "what-if" questions and extension of closed-loop MRP.

This is not exclusively a software function, but the management of people skills, requiring a dedication to database accuracy, and sufficient computer resources. It is a total company management concept for using human and company resources more productively.

2.6.1.Key functions and features

MRP II is not a proprietary software system and can thus take many forms. It is almost impossible to visualize an MRP II system that does not use a computer, but an MRP II system can be based on either purchased–licensed or in-house software.

Almost every MRP II system is modular in construction. Characteristic basic modules in an MRP II system are:

- Master production schedule (MPS)
- Item master data (technical data)
- Bill of materials (BOM) (technical data)
- Production resources data (manufacturing technical data)
- Inventories and orders (inventory control)
- Purchasing management
- Material requirements planning (MRP)
- Shop floor control (SFC)
- Capacity planning or capacity requirements planning (CRP)
- Standard costing (cost control)
- Cost reporting / management (cost control)

Together with auxiliary systems such as:

- Business planning
- Lot traceability
- Contract management
- Tool management
- Engineering change control
- Configuration management
- Shop floor data collection
- Sales analysis and forecasting
- Finite capacity scheduling (FCS)

and related systems such as:

- General ledger
- Accounts payable (purchase ledger)
- Accounts receivable (sales ledger)
- Sales order management
- (Distribution requirements planning) (DRP)
- Automated warehouse management
- Project management
- Technical records
- Estimating
- Computer-aided design/computer-aided manufacturing (CAD/CAM)
- CAPP

The MRP II system integrates these modules together so that they use common data and freely exchange information, in a model of how a manufacturing enterprise should and can operate. The MRP II approach is therefore very different from the "point solution" approach, where individual systems are deployed to help a company plan, control or manage a specific activity. MRP II is by definition fully integrated or at least fully interfaced.

2.6.2.Industry specifics

MRP II systems have been implemented in most manufacturing industries. Some industries need specialised functions e.g. lot traceability in regulated manufacturing such as pharmaceuticals or food. Other industries can afford to disregard facilities required by others e.g. the tableware industry has few starting materials – mainly clay – and does not need complex materials planning. Capacity planning is the key to success in this as in many industries, and it is in those that MRP II is less appropriate.

2.6.3.MRP and MRPII: History and evolution

Material requirements planning (MRP) and manufacturing resource planning (MRPII) are predecessors of enterprise resource planning (ERP), a business information integration system. The development of these manufacturing coordination and integration methods and tools made today's ERP systems possible. Both MRP and MRPII are still widely used, independently and as modules of more comprehensive ERP systems, but the original vision of integrated information systems as we know them today began with the development of MRP and MRPII in manufacturing.

MRP (and MRPII) evolved from the earliest commercial database management package developed by Gene Thomas at IBM in the 1960s. The original structure was called BOMP (bill-of-materials processor), which evolved in the next generation into a more generalized tool called DBOMP (Database Organization and Maintenance Program). These were run on mainframes, such as IBM/360.

The vision for MRP and MRPII was to centralize and integrate business information in a way that would facilitate decision making for production line managers and increase the efficiency of the production line overall. In the 1980s, manufacturers developed systems for calculating the resource requirements of a production run based on sales forecasts. In order to calculate the raw materials needed to produce products and to schedule the purchase of those materials along with the machine and labor time needed, production managers recognized that they would need to use computer and software technology to manage the information. Originally, manufacturing operations built custom software programs that ran on mainframes.

Material requirements planning (MRP) was an early iteration of the integrated information systems vision. MRP information systems helped managers determine the quantity and timing of raw materials purchases. Information systems that would assist

managers with other parts of the manufacturing process, MRPII, followed. While MRP was primarily concerned with materials, MRPII was concerned with the integration of all aspects of the manufacturing process, including materials, finance and human relations.

Like today's ERP systems, MRPII was designed to tell us about a lot of information by way of a centralized database. However, the hardware, software, and relational database technology of the 1980s was not advanced enough to provide the speed and capacity to run these systems in real-time,[2] and the cost of these systems was prohibitive for most businesses. Nonetheless, the vision had been established, and shifts in the underlying business processes along with rapid advances in technology led to the more affordable enterprise and application integration systems that big businesses and many medium and smaller businesses use today (Monk and Wagner).

2.6.4.MRP and MRPII: General concepts

Material requirements planning (MRP) and manufacturing resource planning (MRPII) are both incremental information integration business process strategies that are implemented using hardware and modular software applications linked to a central database that stores and delivers business data and information.

MRP is concerned primarily with manufacturing materials while MRPII is concerned with the coordination of the entire manufacturing production, including materials, finance, and human relations. The goal of MRPII is to provide consistent data to all players in the manufacturing process as the product moves through the production line.

Paper-based information systems and non-integrated computer systems that provide paper or disk outputs result in many information errors, including missing data, redundant data, numerical errors that result from being incorrectly keyed into the system, incorrect calculations based on numerical errors, and bad decisions based on incorrect or old data. In addition, some data is unreliable in non-integrated systems because the same data is categorized differently in the individual databases used by different functional areas.

MRPII systems begin with MRP, material requirements planning. MRP allows for the input of sales forecasts from sales and marketing. These forecasts determine the raw materials demand. MRP and MRPII systems draw on a master production schedule, the breakdown of specific plans for each product on a line. While MRP allows for the coordination of raw materials purchasing, MRPII facilitates the development of a detailed production schedule that accounts for machine and labor capacity, scheduling the production runs according to the arrival of materials. An MRPII output is a final labor and machine schedule. Data about the cost of production, including machine time, labor time and materials used, as well as final production numbers, is provided from the MRPII system to accounting and finance (Monk and Wagner).

2.6.5.Benefits

MRP II systems can provide:

- Better control of inventories
- Improved scheduling
- Productive relationships with suppliers

For design / engineering:

- Improved design control
- Better quality and quality control

For financial and costing:

- Reduced working capital for inventory
- Improved cash flow through quicker deliveries
- Accurate inventory records

2.7.ERP

ERP- DEFINITION

An Enterprise resource planning system is a fully integrated business management system covering functional areas of an enterprise like Logistics, Production, Finance, Accounting and Human Resources. It organizes and integrates operation processes and information flows to make optimum use of resources such as men, material, money and machine.

Enterprise resource planning promises one database,

one application, one user interface

for the entire enterprise, where once disparate systems ruled manufacturing, distribution, finance and sales.

Evolution of ERP:

In the ever-growing business environment, the following demands are placed on the industry:

2.7.1.Aggressive cost control initiatives

Need to analyse costs/revenues on a product or customer basis Flexibility to respond to changing business requirements

More informed management decision making Changes in ways of doing business.

One or more applications and planning systems have been introduced into the business

world for crossing Some of hurdles and achieving growth. They are:

Management Information Systems (MIS) Integrated Information Systems (IIS)

Executive Information Systems (EIS) Corporate Information Systems (CIS) Enterprise Wide Systems (EWS) Material Resource Planning (MRP)

Manufacturing Resource Planning (MRP Money Resource Planning (MRP III)

2.7.2.ERP Characteristics :

Any system has to possess few key characteristics to qualify for a true ERP solution. These features are:

2.7.2.1Flexibility : An ERP system should be flexible to respond to the changing needs of an enterprise. The client server technology enables ERP to run across various database back ends through Open Database Connectivity (ODBC).

2.7.2.2.Modular & Open : ERP system has to have open system architecture. This means that any module can be interfaced or detached whenever required without affecting the other modules.

It should support multiple hardware platforms for the companies having heterogeneous collection of systems. It must support some third party add-ons also.

2.7.2.3.Comprehensive : It should be able to support variety of organizational functions and must be suitable for a wide range of business organizations.

2.7.2.4.Beyond The Company : It should not be confined to the organizational boundaries, rather support the on-line connectivity to the other business entities of the organization.

2.7.2.5.Best Business Practices : It must have a collection of the best business processes applicable worldwide. An ERP package imposes its own logic on a company's strategy, culture and organization
Features of ERP : Some of the major features of ERP and what ERP can do for the business system are :

ERP provides multi-platform, multi-facility, multi-mode manufacturing, multi-currency, multi-lingual facilities.

It supports strategic and business planning activities, operational planning and execution activities, creation of Materials and Resources..

ERP covering all functional areas like manufacturing, selling and distribution, payables, receivables, inventory, accounts, human resources, purchases etc.

ERP performs core activities and increases customer service, thereby augmenting the corporate image.

ERP bridges the information gap across organisations.

ERP provides complete integration of systems not only across departments but also across companies under the same management.

ERP is the solution for better project management.

ERP allows automatic introduction of the latest technologies like Electronic Fund

Transfer (EFT), Electronic Data Interchange (EDI), Internet, Intranet, Video conferencing, E-Commerce etc.

ERP eliminates most business problems like material shortages, productivity enhancements, customer service, cash management, inventory problems, quality problems, prompt delivery etc.

ERP provides intelligent business tools like decision support system, Executive information system, Data mining and easy working systems to enable better decisions.

2.8.FACILITY LOCATION

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

general procedures for facility location

Location of a plant or an organization can be seen as a two step decision. First, one has to select a **region**, and second a choice of a **site** has to be made within the region. The first step depends on the plant's long-term strategies like technological, marketing, resource mobilization, and financial strategies. However, the choice of a site within a region can be decided by comparing the relative availability and costs of required resources like: power, transport, labor, water, land, raw materials, in alternative sites. While comparing various sites, one has to take into account both tangible and intangible costs (climate, labor relations, community support, recreational facility, and presence of good schools, etc.) related to the sites. These are all discussed subsequently under the headings: *preliminary screening*, and *selection of exact site*.

Preliminary Screening

It consists of decision about: *(a) zone to which the plant should belong, (b) region in which it should be placed,* and (*c*) *the exact site* where the plant be erected. A preliminary screening to identify feasible sites begins the planning process. For some kinds of facilities, particular environmental or labor con-siderations are crucial. Breweries, for example, need an adequate supply of clear water. Aircraft manu-facturers must be located near a variety of subcontractors; and basic aluminum producers need electri-cal power and aluminum ores.

Sources of Information

After identifying several key location requirements (outlined in Section 2.2), management starts looking for alternative locations that are consistent with these requirements. The possible sources of information could be: *local chambers of commerce and industries, local communities, relevant ministries, Government agencies, and trade journals*. The data available with these wings could be geographic breakdowns of labor availability, population, transportation facilities, types of commerce, and similar information.

Detailed Analysis

Once the preliminary screening narrows down the alternative sites to just a few, more detailed analysis begins. At each potential site a labor survey may be conducted to assess the local skills. Community response can be obtained by survey. Community response is important, for example, in deciding where to locate a nuclear reactor, recreation area, commercial bank, state prison, or restaurant. Among the many considerations, each company must identify which ones are most pertinent for their location strategies.

2.8.1.SELECTION OF EXACT SITE

Different sites should be compared on the basis of various factors by asking relevant questions on each issues. Some of them are discussed below:

Transportation facilities

- Is the location easily accessible by vehicles from the main highways?
- Are the railroad facilities sufficient for quick receipt and shipment of goods?
- Can a railroad siding be made available?

Availability of water, power, gas and sewerage

Ⓨ Is water available in sufficient quantity and of required quality?

- Is adequate power available or not?
- Is gas and sewer system adequate to the plant's needs?

Soil characteristics

- Is the bearing capacity of soil suitable to support the building and equipment?
- Will the soil provide adequate drainage?

Drainage

- Will the area drain away all surface water so that the buildings or work area will not be flooded?

Parking space

- Is adequate space available to provide for employees and visitors' vehicles parking?

Space for expansion

- Is enough space available for future expansion of the plant?

Accessibility by workers

- Can the sites be reached by public transport ?
- Is the road and street network suitable for speedy entrance and exit of employees during rush hours or emergency?

Cost of land

- Does the cost of land justify the selected site for the intended product?
- Can the location be shifted to some cheaper site with similar facilities?

Existing buildings

- Are the existing buildings suitable for company's operation on rent or final purchase basis?

Factors Ratings

Factor ratings are used to evaluate location alternatives because (*i*) their simplicity helps decide why one site is better than another; (*ii*) they enable managers to bring diverse locational considerations into the evaluation process; and (*iii*) they foster consistency of judgment about location alternatives. The following **steps** are involved in factor rating:

1. Develop a list of relevant factors.
2. Assign a *weight to each factor* to indicate its relative importance (weights may total 1.00).
3. Assign a common scale to each factor (*e.g*., 0 to 100 points), and designate any minimums.
4. Score each potential location according to the designated scale, and multiply the scores by the weights.
5. Total the points for each location, and choose the location with the maximum points.

Example. A glass company is evaluating four locations *A*, *B*, *C*, and *D* for a new plant and has weighted the relevant factors as shown in Table 2.2. Scores have been assigned with higher values indicative of preferred conditions. Using these scores, develop a qualitative factor comparison for the four locations.

Table

		A		*B*		*C*		*D*	
Relevant Factor	*Assigned weight*	*Score*	*Weighted score*	*Score*	*Weighted score*	*Score*	*Weighted score*	*Score score*	*Weighted*
Production cost	0.33	50	16.5	40	13.2	35	11.55	30	9.9
Raw material supply	0.25	70	17.5	80	20.0	75	18.75	80	20.0
Labor availability	0.20	55	11.0	70	14.0	60	12.00	45	9.0
Cost of living	0.05	80	4.0	70	3.5	40	2.00	50	2.5
Environment	0.02	60	1.2	60	1.2	60	1.20	90	1.8
Markets	0.15	80	12.0	90	13.5	85	12.75	50	7.5
Totals	1.00		62.2		65.4		58.25		50.7

Weighted scores are computed by multiplying the scores with the assigned weight (for example, 50 ×.33 = 16.50) and the totals are scored by summing those products. On the basis of this data, B is the best location, and thus selected.

Cost Analysis

Estimates should also be made for all the costs entering into the operation of the plant in each of the locations. This cost will include: initial cost, cost of raw materials, cost of manufacturing, cost of distribution. Revenues and costs are both affected by facility location. A technique called break-even analysis can be used to relate the costs and revenue to facility location. This is discussed later in section 2.4.5.

2.8.2.THEORIES & LOCATION MODELS

Various quantitative models are used to help determine the best location of facilities. Sometimes, models are tailor-made to meet the specific circumstances of a unique problem. In New York City, for example, a mathematical model was developed to find the best locations of fire companies.

There are some general models that can be adapted to the needs of a variety of systems. In the next section, we briefly introduce three types of models that have been applied to the location problem. They are *(a) simple median model, (b) center of gravity model, (c) linear programming, and (d) simulation*. All these models focus on

transportation costs, although each considers a different version of the basic problem.

2.8.2.1Simple Median Model

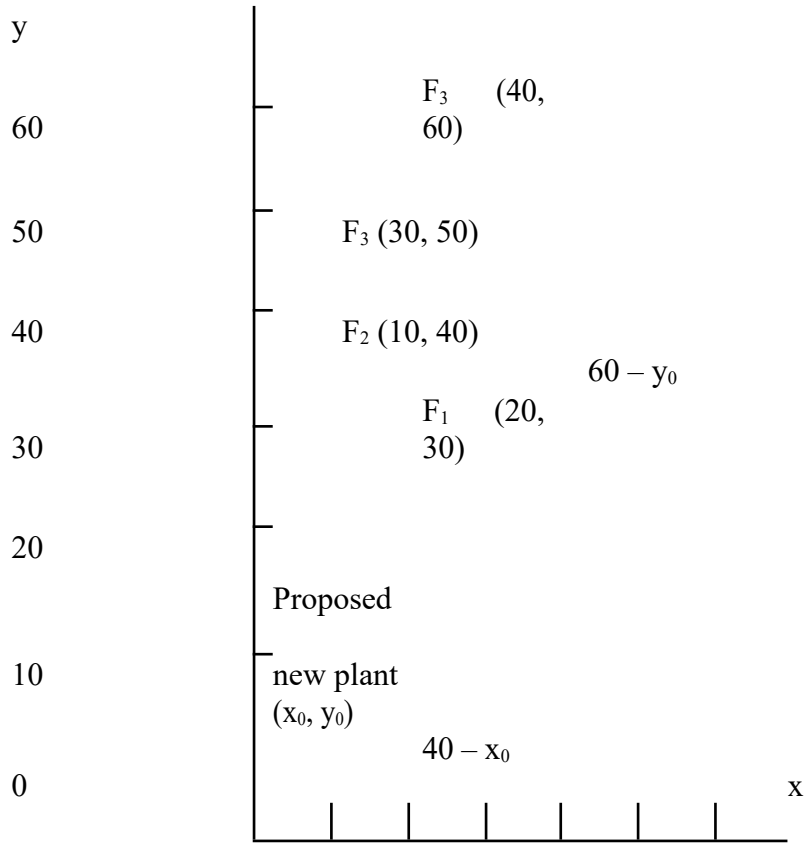
Suppose we want to locate a new plant that will annually receive shipments of raw materials from two sources: F_1 and F_2. The plant will create finished goods that must be shipped to two distribution
warehouses, F_3 and F_4. Given these four facilities (Figure 2.1), where should we locate the new plant to minimize annual transportation costs for this network of facilities?

The *simple median model* (SMM) can help answer this question. This model considers the volume of loads transported on *rectangular* paths. All movements are made in east-west or north-south directions; diagonal moves are not considered. The SMM provides an optimal solution. This is discussed with the help of Figure 2.1 and the Table 2.3.

Let L_i = Loads to be shipped annually between each existing facility F_i, and C_i = Cost to move a load one distance unit to or from F_i.

D_i = Distance units between facility F_i and the new plant. Then, the total transit cost is the sum of the products $C_iL_iD_i$ for all *i*.

$$\text{Total cost of transportation} = \sum_{i=1}^{n} C_iL_iD_i \qquad (2.1)$$



10 20 30 40 50 60

Figure 2.8.2.1. Sources of raw materials and distribution warehouses.

Table 2.8.2.1. Data related to C_i, L_i and D_i

F_i	L_i	C_i	(X_i, Y_i) of F_i
F1	755	$1	(20, 30)
F2	900	1	(10, 40)
F_3	450	1	(30, 50)
F_4	500	1	(40, 60)
Total	2605		

Since all loads must be on rectangular paths, distance between each existing facility and the new plant will be measured by the difference in the *x*-coordinates and the difference in the *y*-coordinates (Figure 2.1). If we let (x_0, y_0) be the coordinates of a proposed new plant, then

$$D_i = | x_0 - x_i | + | y_0 - y_i | \qquad (2.2)$$

Notice that we calculate the absolute value of the differences, because distance is always positive. We could have written Eqn.(2.2) as

$$D_i = | x_i - x_0 | + | y_i - y_0 | \qquad (2.3)$$

Our goal is to find values for x_0 and y_0 for the *new plant* that result in minimum transportation costs. We follow three steps:

1. Identify the median value of the loads Li moved.

2. Find the *x*-coordinate of the existing facility that sends (or receives) the median load.

3. Find the *y*-coordinate value of the existing facility that sends or receives) the median load The *x* and *y* coordinates found in steps 2 and 3 define the new plant's best location.

Example. (*Application of the SMM Model)*

Let us apply the three steps to the data in Table 2.3.

1. *Identify the median load*. The total number of loads moved to and from the new plant will be 2,605. If we think of each load individually and number them from 1 to 2,605, then the median load number is the 'middle' number—that is, the number for which the same number of loads fall above and below. For 2,605 loads, the median load number is 1,303, since 1302 loads fall above and below load number 1,303. If the total number of loads were even we would consider both 'middle' numbers.

2. *Find the x-coordinate of the median load.* First we consider movement of loads in the *x*-direction.

   Beginning at the origin of Figure 2.1 and moving to the right along the *x*-axis, observe the number of loads moved to or from existing facilities. Loads 1-900 are shipped by F_2 from location $x = 10$. Loads 901-1,655 are shipped by F_1 from $x = 20$. *Since the median load falls in the interval 901-1,655, x = 20 is the desired x-coordinate location for the new plant.*

3. *Find y-coordinate of the median load*. Now consider the *y*-direction of load movements. Begin at

   the origin of Figure 2.1 and move upward along the *y*-axis. Movements in the *y* direction begin with loads 1-755 being shipped by F_1 from location $y = 30$. Loads 756-1,655 are shipped by F_2 from location $y = 40$. *Since the median load falls, in the interval 756-1,655, y = 40 is the desired y-coordinate for the new plant.*

Table 2.8.2.2. Calculation of total cost for optimal plant location (x = 20, y = 40)

F_i	x_i of F_i	y_i of F_i	$\mid 20 - x_i \mid$	$\mid 40 - y_i \mid$	$D_i = \mid x_0 - x_i \mid + \mid y_0 - y_i \mid$	L_i	C_i	$C_i L_i D_i$
F_1	20	30	0	10	10	755	\$1	7,550
F_2	10	40	10	0	10	900	1	9,000
F_3	30	50	10	10	20	450	1	9,000
F_4	40	60	20	20	40	500	1	20,000
			Total transportation cost = $\Sigma C_i L_i D_i$, where (i = 1 to 4) =					\$45,550

Center Of Gravity (Grid) Model

This method assumes that the distribution cost is a function of the volumes shipped and the rectilinear distances (*i.e.*, X and Y coordinates). The distances in each of the X and Y coordinates are averaged, using the volumes as weights. The resultant coordinates then constitute the center of gravity for that grid.

If X_c = X coordinate of the center of gravity
Y_c = Y coordinate of the center of gravity
V_i = volume of goods transported to or from each of i destination
X_i = distances traveled by the goods in X direction
Y_i = distances traveled by the goods in Y direction

Then, $X_c = \Sigma V_i X_i / \Sigma V_i$ (2.4)

and $Y_c = \Sigma V_i Y_i / \Sigma V_i$ (2.5)

Once determined, the X_c, Y_c coordinates constitute a starting point for a new site. Locations in that vicinity may then be evaluated, changes suggested, and perhaps some recalculations done before the final choice is made.

Example Table 2.5 shows eight market locations to which a manufacturer of wooden windows expects to ship its products. The shipment volumes, X and Y coordinates of the locations are shown in Table 2.5. Using the center of gravity method, (*a*) find the X_c and Y_c coordinates, and (*b*) suggest a possible warehouse location.

Table 2.8.2.3

Market Area	*Vi (tonne)*	*Xi (km)*	*Yi (km)*
A	8	2.5	10
B	20	3	5
C	12	6.5	8
D	10	11	10
E	30	11	8
F	20	10	4
G	40	13	3.5
H	30	12	2
	170		

Table 2.8.2.4.

Market Area	V_i *(ton)*	X_i *(km)*	*Yi (km)*	$V_i X_i$ *(t-km)*	$V_i Y_i$ *(t-km)*	$X_c = \Sigma V_i X_i / \Sigma V_i$	$Y_c = \Sigma V_i Y_i / \Sigma V_i$
A	8	2.5	10	20	80	= 1678/170	= 896/170
B	20	3.0	5	60	100	= 9.87 km	= 5.3 km
C	12	6.5	8	78	96		
D	10	11	10	110	100		
E	30	11	8	330	240		
F	20	10	4	200	80		
G	40	13	3.5	520	140		
H	30	12	2	360	60		
	170			1678	896		

(*a*) Thus, X_c = 9.87 kms and Y_c = 5.3 kms

(*b*) Looking at the various coordinates in Table 2.6, we feel that (X_c = 9.87 and Y_c = 5.3) are very close to F, suggesting that it may be good to have the distribution center located here.

2.8.2.5Linear Programming (Lp)

LP model may be helpful after the initial screening phase has narrowed the feasible

alternative sites. The remaining candidates can then be evaluated, one at a time, to determine how well each would fit with existing facilities, and the alternative that leads to the best overall system (network) performance can be identified. Most often, overall transportation cost is the criterion used for performance evaluation. A special type of linear programming called the distribution or transportation method is particularly useful in location planning.

The linear programming model differs from the simple median model in two fundamental ways: (*i*) **Number of alternative sites.** The simple median model assumes that all locations are eligible to be the new location. The linear programming model, in contrast, considers only a few locations pre-
selected from preliminary feasibility studies.

(*ii*) **Direction of transportation movements.** The simple median model assumes that all shipments move in rectangular patterns. The linear programming model does not assume so.

Transportation adds no value to a good other than place utility. However, the transportation costs for raw materials and finished goods are often significant and merit special analysis. Before deciding on a plant location, management may want to know which plants will be used to produce what quantities and to which distribution warehouses all quantities should be shipped.

If the location problem can be formulated as one of minimizing a transportation cost, subject to satisfying overall supply and demand requirements, the transportation linear-programming (LP) method may be useful. The transportation model is a variation of the standard linear-programming approach and assumes the following:

2.2. The objective is to minimize total transportation costs.

2.3. Transportation costs are a linear function of the number of units shipped.

2.4. All supply and demand are expressed in homogeneous units.

1. Shipping costs per unit do not vary with the quantity shipped.

2. Total supply must equal total demand.

1. If demand is larger than supply, create a dummy supply and assign a zero transportation cost to it so that excess supply is absorbed.

2. If supply is larger than demand, create and assign a zero transportation cost to it so that excess supply is absorbed.

2.8.2.6.The Heuristic Model

To use the transportation (also called distribution) linear-programming format, (*i*) the demand require-ments and supply availabilities are formulated in a rectangular matrix. (*ii*) The transportation costs between the supply and demand points are placed in the

upper corner of each cell. (*iii*) Supply is then allocated to meet demand by placing entries, which express the number of units shipped from a supply source to a demand destination, into the cells. (*iv*) The solution procedure is an iterative one that begins with an initial solution that is feasible, but not necessarily optimal. (*v*) The solution is progressively tested and improved upon until an optimal solution is reached. The optimal solution satisfies demand at the lowest total cost.

Several methods of obtaining *initial* and *optimal* solutions have been developed:

Initial Solutions

1. Minimum cost (intuitive) method
2. Northwest corner method
3. Vogel's approximation method (VAM)

Optimal Solutions

1. Stepping-stone method
2. Modified distribution MODI)

The *minimum cost* method works well for simple problems, but VAM is likely to yield a better initial solution, which is often also the optimal solution. VAM works by sequential zeroing in on the most cost-advantageous row-and-column combinations. The *northwest-corner* method does not usu-ally yield as good an initial solution as VAM, but it is extremely easy to apply. VAM is useful for hand calculation of relatively large-scale problems. However, most large problems are solved by computer, and numerous computer programs are available, so VAM is not covered in the examples that follow. The MODI method is well-suited to computer applications. It is a modified stepping-stone algorithm that uses index numbers to systematically reach an optimum solution. Example-2.4 uses the *northwest-corner* method for the initial solution and the *stepping-stone method* for the final solution.

Example . *(Distribution linear-programming methods or DLP)*

A company has production plants at A, B, and C, all of which manufacture similar products for the housing market. The products are currently distributed through plants at X and Y.

Production Plants	*Cost to ship to distribution Plant at*		
	X	*Y*	*Z*
A	$ 10	$ 14	$ 8

B	12	10	12
C	8	12	10

The production capacities at A, B, C are 20, 30, and 40 unit loads per week respectively. Management feels that a plant at Z could absorb 20 units per week, with X and Y claiming 40 and 30 units per week respec-tively. Determine the optimal distribution arrangement and cost if the Z site is selected.

Solution. We will use the north-west corner (NWC) method for the initial allocation and the stepping-stone method for the final solution. Table 2.9 shows supply on the horizontal rows, demand on the columns, and unit transportation cost ($) in the small boxes of the matrix. The initial allocation by the NWC method is made as follows:

1. Assign as many units as possible to the NW-corner cell AX from the total available in row A. Given the 20 units available in row A and the 40 unit demand in column X, the maximum number of units that can be assigned to cell AX is 20. This is shown in the circle as initial allocate

Initial solution to DLP matrix

1. Assign additional units of supply from row B (or other rows) until the demand in column X is satisfied. This requires 20 additional units in cell BX and leaves 10 units of B's unassigned.

2. Assign remaining units to BY. Since this does not satisfy demand in column Y, an additional 20 units are allocated from row C to CY.

3. Continue down from the NW corner until the whole supply has been allocated to demand. The initial assignment is completed by assigning the 20 units remaining in row C to cell CZ.

4. Check allocations to verify that all supply and demand conditions are satisfied. Since all row and column totals agree, the initial assignment is correct. Also, see that the number of entries should satisfy (R + C – 1), where R is number of rows, and C is number of columns. Here, R + C – 1 = 3 + 3 – 1 = 5 which is satisfied here.

The *transportation cost* for this arrangement is given as

$TC_1 = (20 \times 10) + (20 \times 12) + (10 \times 10) + (20 \times 12) + (20 \times 10) = \$\ 980$ (2.6)

.

An optimal solution can be obtained by following a *stepping-stone approach*:

- It requires calculation of the net monetary gain or loss that can be obtained by shifting an allocation from one supply source to another. *The important rule to keep in mind is that every increase (or decrease) in supply at one location must be accompanied by a decrease (or increase) in supply at another.* The same holds true for demand. Thus *there must be two changes in every row or column that is changed* - one change increasing the

quantity and one change decreasing it. This is easily done by evaluating reallocations in a closed-path sequence with only right-angle turns permitted and only on occupied cells.

- A cell must have an initial entry before it can be reduced in favor of another, but *empty (or filled) cells may be skipped over to get to a corner cell*. It is better to proceed systematically, evaluating each empty cell. When any changes are made, cells vacated earlier must be rechecked. This is because moves are restricted to occupied cells. Every time a vacant cell is filled, one previously occupied cell must become vacant. The initial and (continuing) number of entries is always maintained at (R + C – 1). When a move causes fewer entries (for example, when two cells become vacant at the same time but only one is filled), a 'zero' entry must be retained in one of the cells to avoid the situation of *degeneracy.*

- The zero entry (0) assigned to either cell should ensure that a closed path exists for all filled cells. The cell with the zero entry is then considered to be an occupied and potentially usable cell. If a cell evaluation reveals an improvement potential in a given cell, but no units are available because of a zero entry in the path to that cell, the zero (zero units) should be transported to the vacant cell, just as any other units would be shipped. Then the matrix should be reevaluated. Improvements may still be pos-sible until the zero entries are relocated to where evaluations of all vacant cells are greater than or equal to 0.

- The criterion for making a reallocation is simply the desired effect upon costs. The net loss or gain is found by listing the unit costs associated with each cell (which is used as a corner in the evaluation path) and then summing over the path to find the net effect. Signs alternate from + to – depending upon whether shipments are being added or reduced at a given point. A negative sign on the net results indicates that cost can be reduced by making the change. The total savings are limited to the least number of units available for reallocation at any negative cell on the path.

2.8.2.7.Application of the model

From Table 2.8, *Filled cells are:* AX, BX, BY, CY and CZ, and *Empty cells are:* AY, AZ, BZ, and CX. We will evaluate the empty cells one by one.

Evaluate cell AY:

From Table 2.8*a*, Path: AY – BY – BX – AX – AY

Cost = +14 – 10 + 12 – 10 = + 6 (cost increase), thus, make no change.

Evaluate cell CX:

From Table 2.8*b*, Path: CX – BX – BY – CY – CX

Cost = + 8 – 12 + 10 – 12 = – 6 (cost savings). Therefore, this is a potential change. Evaluate remaining empty cells to see if other changes are more profitable.

Production Plants	*X*		*Y*	*Z*	*Supply (units)*
A	20	[10] +	[14]	[08]	20
B	20	[12]	[10] 10	[12]	30
C	+	[08]	[12] 20	[10] 20	40
Demand (units)	40		30	20	90

Evaluate cell AZ:

From Table 2.8*c*, Path: AZ – CZ – CY – BY – BX – AX – AZ

Cost = + 8 – 10 + 12 – 10 += + 2 (cost increase). Thus, no change is needed.

Table

Production Plants	*X*	*Y*		*Z*	*Supply (units)*
A	[10] 20	[14]	+	[08]	20
B	[12] 20	[10] 10		[12]	30
C	[08]	[12] 20	20	[10]	40
Demand (units)	40	30	20		90

Evaluate cell BZ:

From Table 2.8*d*, Path: BZ – CZ – CY – BY – BZ

Cost = + 12 – 10 + 12 – 10 = + 4 (cost increase). Thus, we will make no change.

2.8.2.8.Summary of evaluation:

AY = + 6, **CX = – 6**, AZ = + 2, and BZ = + 4

Therefore, cell CX presents the best opportunity for improvement. For each unit from C reallocated to X and from B reallocated to Y, a $6 savings results. Change the maximum number available in the loop (20) for a net savings of $6 × 20 = $120. *The maximum number will always be the smallest number in the cells where shipments are being reduced, that is, cells with negative coefficients.* The crossed circles with numbers

above in Table 2.9 represents that changes have been made. Note that cells BX and CY have both become vacant (a degenerate situation), so a zero has been assigned to one of the vacant cells (BX) to maintain R + C – 1 requirement of 5.

Table. Revision of matrix

Production Plants	*X*	*Y*	*Z*	*Supply (units)*
A	[10] 20	[14]	[08]	20
B	0 [12]	30 [10] 10	[12]	30
C	20 [08]	[12] 20	[10] 20	40
Demand (units)	40	30	20	90

Because a reallocation was made, the empty cells are again evaluated for further improvement as shown

below:

Cell AY: AY – BY – BX – AX = + 6 (no change)

Cell CY: CY – CX – BX – BY = + 6 (no change

Cell AZ: AZ – CZ – CX – AX = – 4 (possibility for savings)

Cell BZ: BZ – CZ – CX – BX = – 2 (possibility for savings)

Let's redraw Table 2.9 as Table 2.9*a*. Cell AZ has the greatest potential for improvement. *Note that the loop evaluating cell BZ has zero (Table 2.10a) units available for transfer from cell BX, so no reallocation could take place without first locating another route to BZ. This would be done by relocating the zero. However, in this example cell AZ offers the best improvement, so we capitalize upon the opportunity to load cell AZ.*

Table. Revision of matrix

Production Plants	*X*	*Y*	*Z*	*Production capacity or Supply (units)*
A	[10] 20	[14]	[08]	20
B	0 [12]	30 [10]	[12]	30

C	20 [08]	[12]	[10] 20	40
Demand (units)	40	30	20	90

A reallocation of 20 units to cell AZ results in the matrix shown in Table 2.10. Note that a zero has again been retained in one of the vacated cells CZ to satisfy the R + C – 1 constraint. Further evaluation of the cells indicates that no additional savings are possible. The optimal solution is finally shown in Table 2.10. The transportation cost for this allocation is:

$TC_2 = (40 \times 8) + (30 \times 10) + (20 \times 8) = \$\ 780$ (2.7)

Net savings = DTC = $TC_2 - TC_1 = \$\ (980 - 780) = \$$ 200 per week

Table. Optimal solution

Production Plants	*X*	*Y*	*Z*	*Supply (units)*
A	[10]	[14]	**20** [08]	20
B	0 [12]	**30** [10]	[12]	30
C	**40** [08]	[12]	**0** [10]	40
Demand (units)	40	30	20	90

Simulation

Although many quantitative models are available to deal with location problems, many real world problems are more complex than our examples. Some systems have multiple sources shipping to numerous plants; they in turn ship finished goods to warehouses from which further shipments are made to retailers. Multi-echelon (multilevel) production distribution systems such as these pose formidable problems. Even with the simplest revision of this system, adding or deleting one network component, the combinatorial aspects of the problem make it computationally difficult. More realistically, we may want to consider more drastic changes, such as total revision of the warehousing network. With problems of this complexity, no optimal solution is possible. Instead, approximation techniques like computer simulation are used.

2.8.2.9.Break Even Analysis

In break even charts, the total cost (fixed costs + variable costs), and revenue are plotted

against the output (either in units, dollar volume, or % of capacity). Such a graphical portrayal of revenue and costs, as a function of the output is called **'break even chart'.**

Example A businessman is thinking of opening a factory in one of these places in Ethiopia: Nazereth, Debre Zeit, or on the outskirt of Addis Ababa to produce high quality electronic components for computer. He has gathered data on fixed cost and variable cost as given in Table 2.11.

Table

			Per unit costs	
Location	*Fixed cost/year*	*Material*	*Variable labor*	*Overhead*
Addis Ababa	$ 200,000	$ 0.20	$0.40	$0.40
Debre Zeit	180,000	0.25	0.75	0.75
Nazereth	170,000	1.00	1.00	1.00

a)Represent the costs graphically.

(*b*)Over what range of annual volume is each location going to have a competitive advantage? (*c*) What is the volume at the intersection?

Solution. (*a*) Let Q = quantity of components to be produced per year, then the total cost equations for all these sites can be written as shown in Table 2.12.

Table

Location	*Fixed cost/year*	*Material cost*	*Labor cost*	*Overhead*	*Variable cost/unit*	*Total Cost Equation*
Addis Ababa	$200,000	$0.20	$0.40	$0.40	$1.00	= 200,000 + 1.0Q
Debre Zeit	180,000	0.25	0.75	0.75	$1.75	= 180,000 + 1.75Q
Nazereth	170,000	1.00	1.00	1.00	$3.00	= 170,000 + 3.0Q

A graph of the total cost for all these locations have been shown in Figure 2.2.

(*b*) & (*c*). From Figure 2.2, we see that the cost line for Nazereth and Debre Zeit cross each other. At this point of intersection the total cost for both will be equal. Thus,

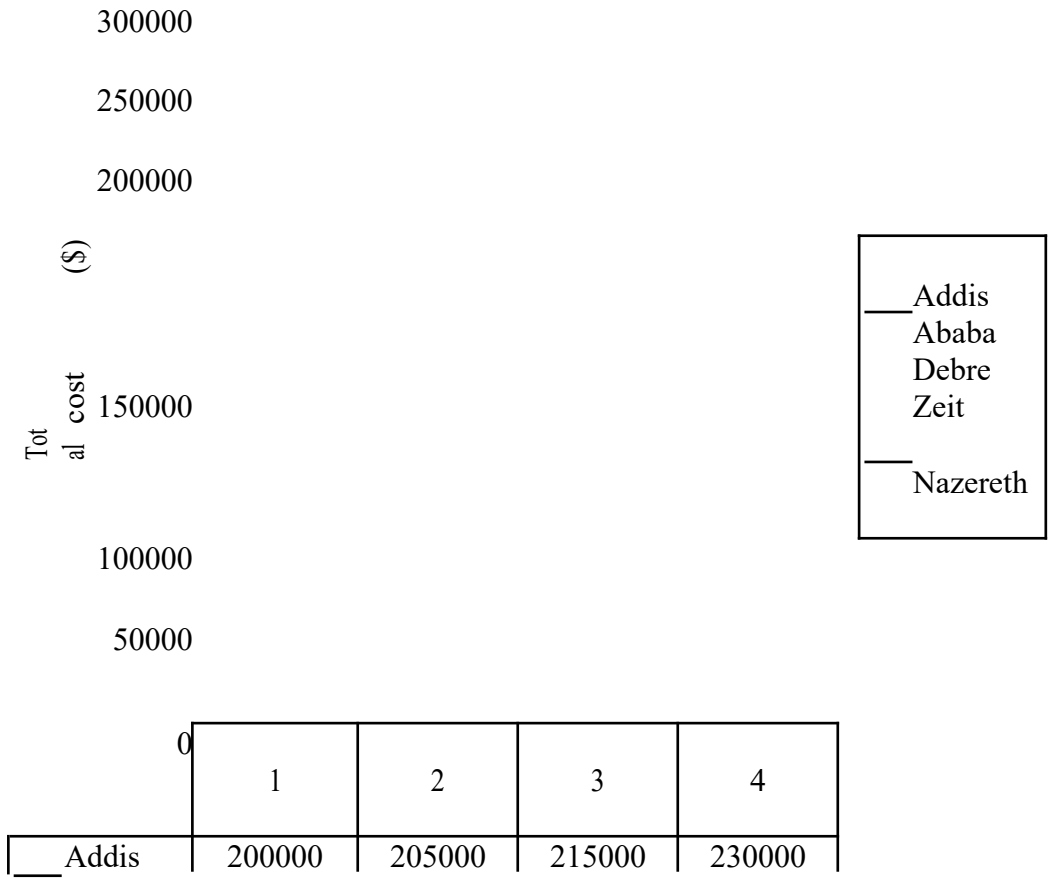
$$180{,}000 + 1.75Q = 170{,}000 + 3.0Q$$

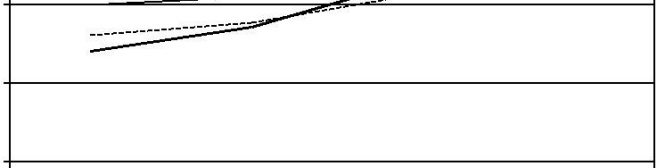
or, $$1.25\,Q = 10{,}000$$

or, $$Q = 8{,}000$$

We see from the Figure 2.2 that *below 8000 units of production, Nazereth ensures a lower total cost than Debre Zeit*, and vice-versa for production more than 8000 units.

Break Even Analysis





Ababa				
Debre Zeit	180000	188750	206250	232500
Nazereth	170000	185000	215000	260000

Units of Components

Figure Break Even Chart

8.3.Steps in site Selection

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

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

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

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

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

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

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

2.8.4.Controllable factors

2.8.4.1.Proximity to markets

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

Locating nearer to the market is preferred if:

- The products are subject to spoilage.
- After sales services are promptly required very often.

2.8.4.2.Supply of raw material

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

- When a single raw material is used without loss of weight, locate the plant at the rawmaterial source or at the market place.
- When weight loosing raw material is required, locate the plant at the raw material source itself.
- When raw material is universally available, locate close to the market area.

2.8.4.3.Transportation facilities

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

2.8.4.4. Availability of infrastructure facilities

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

2.8.4.5.Labour and wages

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

2.8.4.6. External economies of scale

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

2.8.4.7.Availability of Capital

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

2.8.4.8.Policies of the Government

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

2.8.4.9.Climatic conditions

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

2.8.4.10.Supporting industries and services

Availability of supporting industries is another consideration which affects the choice of location. Manufacturing organisation will not make all the components and parts by itself .Sometimes it subcontracts the work to vendors to manufacture. So,the

source of supply of component parts will be the one of the factors that influences the location. The presence of healthy relationship among different firms is also a pre-requisite for industries to develop. The various services like communications, banking services, professional consultancy services will play a vital role in selection of a location.

2.8.4.11.Community and labour attitudes

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

2.8.4.12.Availability of Community infrastructure

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

2.9 .FACILITY LAY OUT

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

Definition of plant layout

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

2.9.1.Objectives of lay out

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

1. Streamline the flow of materials through the plant.
2. Facilitate the manufacturing process.
3. Minimise materials handling cost.
4. Effective utilisation of men, equipment and space.
5. Flexibility of manufacturing operations and arrangements.
6. Provide for employee convenience, safety and comfort.
7. Minimize investment in equipment

2.9.2.PRINCIPLES OF LAY OUT

The following are the principles plant layout:

Principle of integration

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

Principle of minimum distance

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

Principle of cubic space utilisation

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

Principle of flow

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

Principle of maximum flexibility

The good layout is one that can be altered without much cost and time

.The future requirements should be taken into account while designing the present layout of the plant.

Principle of safety, security and satisfaction

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

Principle of minimum handling

A good layout is one that reduces the material handling.

2.9.3.Factors to be considered in plant lay out

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

Need for plant expansion

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

Protection of operation equipment

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

Maintenance requirements

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

Location

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

2.9.4.TYPES OF LAY OUT

Layouts can be classified into the following five categories:

1. Process layout
2. Product layout
3. Combination layout
4. Fixed position layout
5. Group layout

2.9.4.1..PROCESS LAY OUT

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

Advantages of process layout

Advantages of process layout are as follows:

1. In process layout machines are better utilized.

2. Flexibility is possible in process layout.

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

4. Higher utilisation of production facilities.

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

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

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

Limitations of process layout

1. Backtracking of materials.

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

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

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

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

2.9.4.2.Product lay out

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

Advantages of product lay out

1. The flow of product will be smooth.

2. Work -in-process inventory is less.

3. Processing time is less.

4. Minimum material handling cost.

6. Simplified production, planning and control systems are possible. Less space is occupied by work transit and for temporary storage.

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

8. Perfect line balancing which eliminates all bottlenecks.
9. Manufacturing cycle is short due to continuous flow of materials.
10. Small amount of work-in-process inventory.
11. Unskilled workers can manage the production.

Limitations

1. A breakdown of one machine in a product line may cause stoppages of machines in the downstream of the line.
2. A change in product design may require major alterations in the layout.
3. Comparatively high investment in equipment's is required.
4. Lack of flexibility.
5. A change in product may require the facility modification

2.9.4.3.Combination lay out

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

Advantages

The major advantages of this type of layout are:

1. Helps in job enlargement 2.Upgrades the skills of the employees.
2. Greater flexibility is possible.
3. Layout capital investment is lower

2.9.5.3.Group lay out

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

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

Advantages of Group Technology Layout

Group Technology layout can increase—

1. Component standardization and rationalization.
2. Reliability of estimates.
3. Effective machine operation and productivity.
4. Customer service.

It can decrease the—

1. Paper work and overall production time.
2. Work-in-progress and work

2.9.4.4.Fixed position layout

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

Advantages

The major advantages of this type of layout are:

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

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

3. Greater flexibility with this type of layout.

4. Layout capital investment is lower.

Organisation of physical facility

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

1. Factory building
2. Lighting
3. Climatic conditions
4. Ventilation
5. Work-related welfare facilities.

.Factory Building

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

Following factors are considered for an Industrial Building:

A. Design of the building.

B. **Type of buildings**.

A. Design of the Building

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

1. Flexibility:

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

3. Product and equipment

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

3. Expansibility: Growth and expansion are natural to any manufacturing units. The following factors should be taken in to account if the future expansion of the concern is to be provided for:
(i) The area of the land which is to be acquired should be large enough to provide for the future expansion needs of the firm.

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

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

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

B. Types of Buildings

Industrial buildings may be grouped under two types:

1. Single-storey buildings,
2. Multi-storey buildings.

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

1. SINGLE-STOREY BUILDINGS

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

Advantages

1. There is a greater flexibility in layout.
2. Expansion is easily ensured by the removal of walls.
3. low cost of transportation and material handling charges.

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

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

Limitations

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

1. More land is required for building construction.
2. High cost of heating, ventilating and cleaning of windows.

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

MULTI-STOREY BUILDINGS

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

Advantages

1. Maximum operating floor space. This is best suited in areas where land is very costly.
2. Lower cost of heating and ventilation.
3. Reduced cost of materials handling because the advantage of the use of gravity for the flow of materials.

Limitations

Following are the disadvantages of multi-storey building:

1. Materials handling becomes very complicated. A lot of time is wasted in moving them between floors.
2. A lot of floor space is wasted on elevators, stairways and fire escapes.
3. Floor load-bearing capacity is limited.
4. Natural lighting is poor in the centres of the shop.
5. Layout changes cannot be effected easily and quickly.

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

II. LIGHTING

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

III. CLIMATIC CONDITIONS

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

IV. VENTILATION

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

V. WORK-RELATED WELFARE FACILITIES

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

1. DRINKING WATER

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

2. SANITARY FACILITIES

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

3. FIRST-AID AND MEDICAL FACILITIES

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

4.REST FACILITIES

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

5. FEEDING FACILITIES

Organisation should arrange food facilities for its employees. A snack bar, buffet or mobile trolleys can provide tea, coffee and soft drinks, as well as light refreshments.

Recreational Facilities

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

Objective of a good layout

1. To reduce material handling cost
2. To provide enough production facility
3. To utilise labour efficiency
4. To provide ease of supervision.
5. To improve productivity
6. To provide safety to employees
7. To reduce the number of accidents Material requirement planning MRP

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

The following are the objectives of MRP:

1. Reduction in inventory cost
2. Meeting delivery schedule
3. Improve the performance of production

Material handling

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

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

Warehousing And Storage Layouts

The objective of warehouse layout is to find the optimum trade-off between handling cost and costs of warehouse space. So, the management's task is to maximize the utilization of the 'cubic space' of the warehouse—that is, utilize its full volume while maintaining low material handling costs, which is defined as all the *costs related to the incoming transport, storage, and outgoing transport of materials to be warehoused*. *The cost also includes equipment, people, material, supervision, insurance, and depreciation.* Effective warehouse layouts also minimize the damage and spoilage of material within the warehouse.

The variety of items stored and the number of items 'picked' affect the optimum layout. A warehouse storing a few items leads itself to higher density than a warehouse

storing a variety of items. Modern warehousing management uses automated storage and retrieval systems (ASRS). It can improve the productivity by an estimated 500% over manual methods.

An important component of warehouse layout is the relationship between the receiving/unloading area and the shipping/loading area. Facility design depends on the type of supplies unloaded, what they are unloaded from (trucks, rail cars, barges, etc), and where they are unloaded.

Cross-Docking

Cross-docking means to avoid placing materials or supplies in storage by processing them as they are received. In a manufacturing facility, product is received directly to the assembly line (JIT). In a distribution center, labeled and presorted loads arrive at the shipping dock for immediate rerouting, thereby avoiding formal receiving, stocking/storing, and order-selection activities. Because these activities do not add any value to the product, their elimination is 100% cost savings. Although, cross-docking reduces product handling, inventory, and facility costs, it requires both (i) tight scheduling and (ii) that shipments received include accurate product identification, usually with bar codes so that they can be quickly moved to the proper shipping dock (Heizer and Render).

Combination Layout

Now a days it's difficult to find any one form of layout in its 100 percent purity. In factories, where first the products are manufactured and then assembled, this method is mostly used. Often a combination of layouts must be used. Typically, a process layout is combined with a product layout.

2.11.PLANNING TOOLS & TECHNIQUES

SLP is a systematic approach to layout planning that was developed by Richard Muther and Associates. The steps of SLP are shown in Figure 3.1. As seen from the figure, one has to collect all data related to the current and forecasted production. Sometimes, it may be possible that 3 to 5 types of products account for 70 to 80 % of the total sales volume. The balance 20 to 30% can be grouped in such a way that only a few product groups need to be considered. Each product group and its respective volume for a projected horizon [Turner et al] should be listed. The projected horizon depends on how frequently the product or market changes, but a projection for each product for the next 5 years is sufficient. Any other information relevant to the layout should be included in the general comments.

The basic input data or information needed for making layout can be remembered by the following

letters:

P — **Product** and type characteristic of the material needed for this

Q — **Quantity** of each type of product

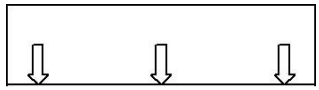
R — **Route** i.e. sequence of operation & machines needed for completing these operations

— **Supporting activities** like moving the material from one work place or machine to another and maintenance etc.

— **Timing** as to how many times in the year and how quickly the products are to be made.

1. Having collected all the data, one can go for **Step 1** of the SLP procedure called the *preparation of the process charts*. This chart depicts the flow of material graphically through the plant. If the products are few, one can make separate operations process chart for each. But, if there are many products, a multi-product process chart may be used. An '*operation chart'* shows only the operations and inspection. But a '*flow process chart'* shows operations, inspections, transportations, delays and storages. These charts are thoroughly discussed under the topic 'Work Study' in any Industrial Engineering Book.

Input data and activities



1. Flow of materials

2. Activity relationship

3. String diagram
4. Space
5. Space available
requirements
6. Space relationship diagram

7.Develop layout alternatives
. Systematic Layout Planning Procedure.

In some cases, for example a job shop, it will be difficult to represent all the flows with a few charts. So, one can go for a 'From-To Chart' in such situations. This chart

shows the number of trips from one area to another area and is based on historical data or proposed production. The trips can be attached suitable weights depending on production volume or the degree of difficulty. Table 3.1 shows a 'From-To Chart' for an office situation. The number indicates the number of trips made by the person from one place to another. Based on these charts (flow chart, and From-To Chart), one can construct the layouts. But, sometimes, these charts are not enough. There may be some areas where the product flow is non-existent, and some in which the flow sequence differs for each of the many products. In such cases, one has to go for '*activity relationship diagram'.*

Table 3.1. From-To Chart of an Office

From\To	*Chairman*	*Secretary*	*Computer center*	*Staff room*	—	*Total*
Chairman	—	8	5	3		
Secretary	20	—	2	4		
Computer center	10	5	—	2		
Staff room	8	10	25	—		
—	—	—	—	—	—	—
Total						

In short, the following tools are used in the layout preparation phase:

- *Graphic and schematic analysis:* Perhaps the most common layout planning tools are *tem-plates*—two dimensional cutouts of equipment drawn to scale.
- *Operation Process Chart* (OPC): operations, and inspections only
- *Flow Process Chart* (FPC): operations, inspections, transports, delays, and storage.
- *Multiple-product Chart* (MPC):
- *From-To Chart* (FTC):

2. An 'activity relationship diagram (ARD)' shows the desired closeness of departments and areas within the plant. It reflects the fact that not all important relationships can be shown by

Table A set of closeness ratings for ARD

Letter	*Closeness*
A	Absolute necessary

E	Especially important
I	Important
O	Ordinary closeness O K
U	Unimportant
X	Not desirable

It shows a set of closeness ratings proposed by Muther [Turner et al]. For any paired combination, an **A** rating indicates that it is absolutely necessary to locate the two areas adjacent to each other. On the other hand, an **X** rating shows that keeping two areas adjacent to each other is not desirable. For example, a machining center and the conference room can be straightaway given an **X** rating to avoid their being placed together. To decide about the closeness ratings, it is a good idea to involve all the stake-holders in future layout. They can be asked to give ratings and finally an average closeness rating can be decided.

3. **Step 3** consists of using the information generated in Steps 1 and 2 to prepare a string diagram showing near optimal placement of the facilities without considering the space constraints. The placement is done by trial and error. Usually, the areas with an A closeness are shown first and are connected with 4 straight lines, then E with 3 straight lines, and so on. When an activity has to be close to several other areas, it can be stretched out or distorted. The areas may be moved around and interchanged until a final acceptable arrangement is obtained. It is helpful to imagine the straight lines as stretched rubber bands and the jagged lines as coiled springs representing varying attraction and repulsion forces. So, an A rating would imply 4 rubber bands pulling the areas together while an I rating would imply only 2 rubber bands [Turner et al].

Many diagrams and arrangements will have to be made before a good layout is obtained. Normally, two or more alternatives are developed. Space will have to be added and some modifications made, but the overall picture should not change much. Thus, **step 3** is supposed to be the most creative and important one.

4. **Step 4** may be called the 'adjustment step'. Here the adjustment must be made for space needs as related to space availability; so, the space requirements have to be determined. This can be done through calculations, adjustments of past areas, intuition or estimates.

5. Once these space requirements are known, it is necessary to consider the space available. In some cases, since the layout must fit into the existing buildings, the space available is highly restricted. In other cases, the capital budget is the main restriction, and, therefore, the space availability may be less restricted. In any case, one has to balance the space requirements and the space availability before going to step 6.

2.11.1OTHER APPROACHES TO PLANT LAYOUT

Some authors [Heizer J. and Render B.] see the plant layout problem as a set of steps or phase as discussed below:

Phase-1

Location of area where the facilities are to be laid out. It is not necessary that the area be a completely new one. It may even be the existing layout of the plant.

Phase-II

Planning the general overall layout. This provides a block arrangement and the basic flow pattern for the area. It also gives an idea about the size, the relationship, and configuration of each major activity, department, and area.

Phase-III

Preparation of detailed layout plans. It includes planning where each piece of machinery, com-puter, and equipment will be placed.

Phase-IV

Installation. This involves both planning the installation and physically placing and hooking up the equipment.

The layout planner concentrates on Phase-II and III. Phase-I and IV are not part of the layout planning engineer's project. The layout plan depends on basic input data or factors of layout. For every layout the following **three considerations** are important:

(*a*) **Relationships:** It means the closeness desired between various activities or sections where different functions are performed.

For example, Figure 3.2*a* shows that maximum material moves from foundry section to milling, next is between pressing to milling, and so on. This means foundry should be closed to milling, milling should be closed to press, press closed to milling but also nearer to foundry and packing.

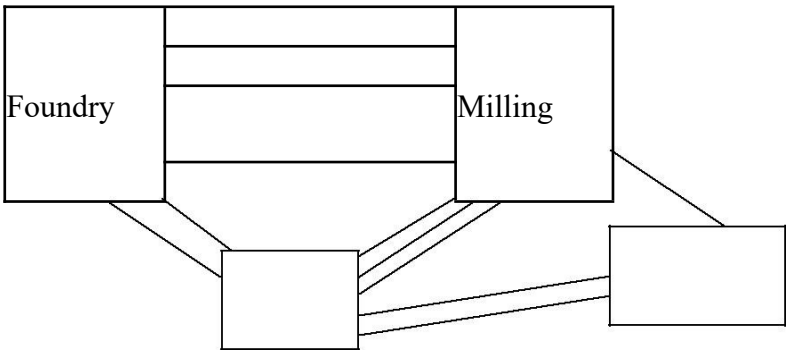


Figure 3.2. (*a*) Relationship diagram.

(*a*) **Space:** It is the area needed for the performance of every function satisfactorily as shown in Figure 3.2 (*b*). The total area needed by different sections = (A + B + C + D) m^2

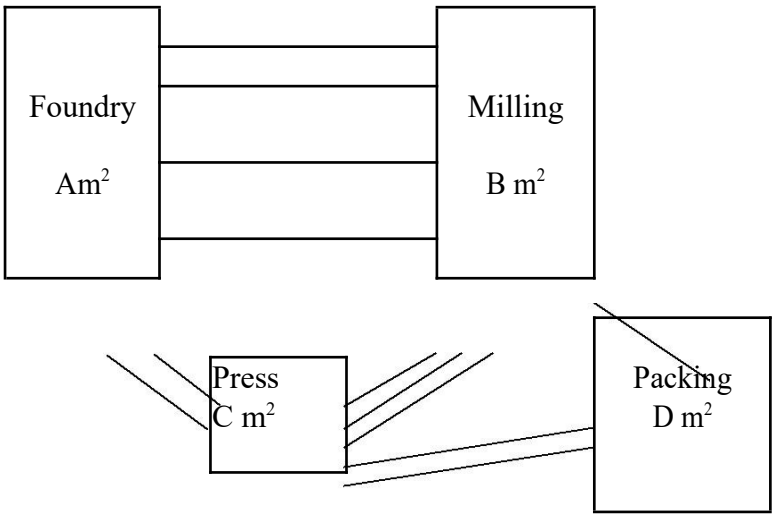


Figure 3.2. (*b*) Space required for various sections.

(*c*) **Adjustment:** It consists of arranging the activity areas in the actual plan of the building of the same area. For example, the total area needed is (A + B + C + D) square meter and based on the existing building space a possible layout plan is as shown in

- Principle of overall integration (of man, materials, machine, supporting activities, etc)
- Principle of minimum distance between operations
- Principle of flow (arranging machines according to the sequence of operations)
- Principle of cubic space
- Principle of satisfaction and safety
- Principle of flexibility of rearrangement at a minimum cost.

3.4.2TYPES OF FLOW PATTERNS

I- flow or line flow:

U-flow:

L-flow:

S-flow:

O-flow:

I + U-flow:

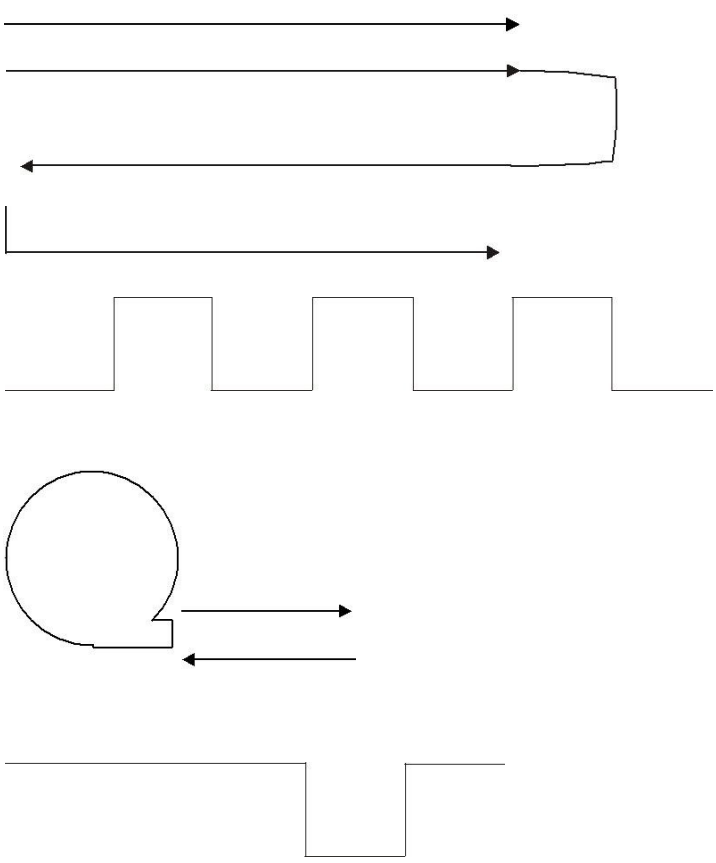


Figure 3.4. Types of Basic Flow.

Apart from this, one can combine this basic flows to get various combinations like (S + L)

UNIT-3

DESIGN OF PRODUCT, PROCESS & WORK SYSTEMS

3.1.Product design It is one of the crucial stages in Operations Management. The design of a product or a service is one of the most important steps. This will definitely affect the earnings from the product. The basic limiting characteristics of the production system design are set during the **product design** phase. In designing the product, or the item to be processed in nonmanufacturing systems, the product designer specifies materials, tolerances, basic configurations, methods of joining parts and the like, and through these specifications sets the minimum possible production cost. The conscious effort to design for low manufacturing cost is often referred to as production design. Given the product design, process planning for manufacture must be carried out to specify the process required and the sequence of the processes.The two basic steps in designing a product are functional design and production design

3.2 INFLUENCING FACTORS

A list of categories affected by product design include:

- ✓ Raw material
- ✓ Equipment
- ✓ Direct Labor
- ✓ Indirect labor
- ✓ Tooling
- ✓ Engineering
- ✓ Sales and administration

Many of the indirect costs tend to be hidden. For example, the number of individual parts in a design can drastically, affect the indirect costs due to greater paperwork and the greater cost of ordering, storing and controlling the larger number of parts. Thus, the selection of product design must reflect consideration of all the foregoing factors.

3.3 PRODUCT DESIGN APPROACHES

Product design is one of the crucial stages in Operations Management. The design of a product or a service is one of the most important steps. This will definitely affect the earnings from the product. The basic limiting characteristics of the production system design are set during the **product design** phase. In designing the product, or the item to be processed in nonmanufacturing systems, the product designer specifies materials, tolerances, basic configurations, methods of joining parts and the like, and through these specifications sets the minimum possible production cost. The conscious effort to design for low manufacturing cost is often referred to as production design. Given the product design, process planning for manufacture must be carried out to specify the process required and the sequence of the processes.

The two basic steps in designing a product are functional design and production design

3.3.1.Functional Design

In the functional design step the product is designed to be functional. Decisions are made on dimensions, materials to be used, type of final finish required for appearance and so on. At this stage, the designer is more concerned with the product itself than the methods of production. The main concerns are functional considerations, customer appeal, cost and ease of operation and maintenance.

3.3.2.Production Design

In the production design stage, the designer considers introduction of modifications and new concepts into the product to make it more suitable for production. Some of the concepts employed in this stage include:

3.3.3.1Standardization: The designer can facilitate the production of the part by standardization of a port or the whole product. Standardization can also cut production costs by eliminating the need for planning for several different product varieties. It allows firms to work larger and often economical, quantities of fewer items. However, standardization has

limitations such as forestalling improvements and fewer options for customers.

3.3.4Modular Design: Modular Designs facilitate production and maintenance. This type of design is used extensively in computers. Products are made easily detachable subassemblies or sections.

3.3.5.Simplification: Sometimes the designer may include some features in the design that, although not very critical to function of the product, create severe problems in the production stage. To correct these situations, sometimes some part of the design must be simplified.

Once developed, many products also undergo value analysis (value engineering). This is an attempt to see if any materials or parts can be substituted or redesigned in such a way as to continue to perform the desired or intended function, but at a lower cost.

3.4 LEGAL ISSUES IN OPERATION MANAGEMENT

Operations management is a multi-disciplinary field that focuses on managing all aspects of an organization's operations. The typical company carries out various functions as a part of its operation. The dividing of a company's activities into functional categories occurs very early on, even in a company formed and operated by a single individual. Most companies make a product of some kind or produce a salable service. They must also carry out a sales and marketing function, an accounting function, and an administrative function to manage employees and the business as a whole. Operations management focuses on the function of providing the product or service. Their job is to assure the production of a quality good and/or service. They apply ideas and technologies to increase productivity and reduce costs, improve flexibility to meet rapidly changing customer needs, assure a safe workplace for all employees, and when possible assist in assuring high-quality customer service.

For the most part, the title "Operations Manager" is used in companies that produce a tangible good—manufacturers on the whole. In service-oriented businesses, the person responsible for the operations manager role is often called by another name, one that addresses the service being offered. Examples include project manager, consultant, lawyer, accountant, office manager, datacenter manager, etc.

3.4.1KEY ISSUES IN OPERATIONS

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 the quantities demanded and in the time frames necessary to meet the businesses obligations.

3.4.2DESIGNING THE SYSTEM

Designing the system begins with product development. Product development involves determining the characteristics and features of the product or service to be sold. It should begin with an assessment of customer needs and eventually grow into a detailed product design. The facilities and equipment used in production, as well as the information systems needed to monitor and control performance, are all a part of this system design process. In fact, manufacturing process decisions are integral to the ultimate success or failure of the system. Of all the structural decisions that the operations manager makes, the one likely to have the greatest impact on the operation's success is choice of the process technology. This decision answers the basic question: How will the product be made?

Product design is a critical task because it helps to determine 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 company's ability to provide the demanded product 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 workspace 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.

3.4.3Implementation

Once a product is developed and the manufacturing system is designed, it must be implemented, a task often more easily discussed than carried out. IF the system design function was done thoroughly, it will have rendered an implementation plan which will guide activities during implementation. Nonetheless, there will inevitably be changes needed. Decisions will have to be made throughout this implementation period about tradeoffs. For example, the cost of the originally planned conveyor belt may have risen. This change will make it necessary to consider changing the specified conveyor belt for another model. This, of course, will impact upon other systems linked to the conveyor belt and the full implications of all these changes will have to be assessed and compared to the cost of the price increase on the original conveyor belt.

3.4.4Planning and Forecasting

Running an efficient production system requires a great deal of planning. 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 (who will do the work, what equipment will be used, which materials will be consumed, when the work will begin and end, and what mode of transportation will be used to deliver the product when the order is completed).

3.4.5Managing 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.

3.4.6 BUILDING SUCCESS WITH OPERATIONS

To understand operations and how they contribute to the success of an organization, it is important to understand the strategic nature of operations, the value-added nature of operations, the impact technology can have on performance, and the globally competitive marketplace.

Efficient organization operations are a vital tool in achieving competitive advantage in the daily contest for customers/clients. What factors influence buying decisions for these entities? For most services and goods, price, quality, product performance and features, product variety, and availability of the product are critical. All these factors are substantially influenced by actions taken in operations. For example, when productivity increases, product costs decline and product price can be reduced. Similarly, as better production methods are developed, quality and variety may increase.

By linking operations and operating strategies with the overall strategy of the organization (including engineering, financial, marketing, and information system strategy) synergy can result. Operations become a positive factor when facilities, equipment, and employee training are viewed as a means to achieve organizational objectives, rather than as narrowly focused departmental objectives. In recognition of this evolving viewpoint, the criteria for judging operations are changing from cost control (a narrowly defined

operating objective) to global performance measurements in such areas as product performance and variety, product quality, delivery time, customer service, and operational flexibility.

In today's business environment, a key component of operational flexibility in many industries is technological knowledge. Advances in technology make it possible to build better products using fewer resources. As technology fundamentally changes a product, its performance and quality often increases dramatically, making it a more highly valued commodity in the marketplace. But the growth in high-tech business applications has created new competitors as well, making it important for businesses to try to register advantages in any and all areas of operations management.

Over time, operations management has grown in scope and increased in importance. Today, it has elements that are strategic, it relies on behavioral and engineering concepts, and it utilizes management science/operations research tools and techniques for systematic decision-making and problem-solving. As operations management continues to develop, it will increasingly interact with other functional areas within the organization to develop integrated answers to complex interdisciplinary problems. Indeed, such interaction is widely regarded as essential to long-term business success for small business establishments and multinational corporations alike.

3.5.ETHICAL ISSUES FACED IN OPERATIONS MANAGEMENT

Managerial Mischief: It includes " illegal, unethical, or questionable practices of individual managers or organizations, as well as the causes of such behaviours and remedies to eradicate them.

Moral Mazes of management: It includes " ethical problems that managers must deal with on a daily basis, such as potential conflict of interest, wrongful use of resources, mismanagement of contracts and agreements ets.

3.5.1IMPORTANCE OF BUSINESS ETHICS:

- ✓ To retain the public image of the business.
- ✓ To take business operations seriously and direct towards missions.
- ✓ To reduce leadership and decision making dilemmas.
- ✓ To inculcate the fundamental and moral change.

Business ethics, generally defined in terms of the social, communal and environmental responsibilities of business professionals, requires managers to think beyond the bottomline when making business related decisions. Corporations and businesses have developed a lot of systems and codes of conduct to incorporate ethical issues into their decision making process.

One of the area that is most crucial to decision making is OPERATIONS MANAGEMENT. Operations management is an activity in which resources flowing within a defined system are transformed and combined in a controlled manner to add value in accordance with the policies given by the management. Operations manager utilizes the materials, capacity, and knowledge available in the production facility.

Role of the Operation Manager can be defined as follows:

- ✓ Making efficient use of materials, capacity, and knowledge available to achieve an output of the desired quality and quantity.
- ✓ To achieve these, he has to follow certain specified codes to achieve the desired output levels.
- ✓ Main task is the management of human, technology and system resources.
- ✓ Managing these resources would involve planning, organizing. directing, staffing, and controlling.

There can be two roles of an operation manager which can be classified under two models:

3.5.2Model 1 Production

The job responsibilities of the Model 1(Production) manager include

Receiving raw materials

Storing them in a safe and secure environment

Supervising the movement of material in the whole plant

Ensuring that the employees produce the right quality

Scheduling orders

Maintaining the established quality standards

Negotiating with suppliers and the customers

Packaging the product

Distributing the products

Ensuring proper health and safety for the workers in the work environment
Assessing the standard time values used in the manufacturing process
Initiating employee suggestion schemes
Taking decisions on operational and quality issues
Operations involve efficient handling of men and women. The main aim of an operation manager is to motivate the staff and set high work performance. Motivation is essential for encouraging the employees to manufacture very good quality products. Manager's success in accomplishing operations management objectives can be measured by his productivity, efficiency and effectiveness.

3.5.3.Model 2 Service

The job specifications of Model 2 manager includes:
Receiving incoming calls and mails
Storing the documents of relevance
Prioritizing of the jobs according to their performance
Motivating quality performers among staff and giving direction to the staff
Negotiating with the suppliers
Dealing with enquiries
Taking decisions on the policies that have to be implemented
Ensuring the health and safety of the workers
Maintaining computers and office equipment
Taking decisions regarding operational issues
Ensuring quality management
Services are different from manufacturing as there are no back ups or inventory. Customer involvement is always there while providing a service. In a service, production and consumption take place directly. The customer is directly involved in the

operations. Any mistake in the service that are provided will result in a loss of trust and loyalty of the customers. Hence, the operations manager of the service sector has numerous responsibilities to bring in trust and loyalty among customers.
Other activities include:
Total Quality Management TQM: It is concerned with the principles that drive an organization to offer products that are of high quality.
Forecasting: It involves predicting the future demand.

3.5.4.ETHICAL ISSUES AT WORKPLACE

Safety of Operations: Workers sometimes consume alcohol or drugs in the workplace which often can hamper the work process or their judgements in the workplace. Eg: The Alcohol and Drug use Policy of Exxon Mobil is a critical component of a Company's commitment to safety.
The International Council of Toy Industries, an association committed to the operation of toy factories in a lawful, safe and healthy manner. It upholds the principle that no underage, forced or prison labour should be employed, that no one is denied a job because of gender, ethnic origin, religion, affiliation or association, and that factories comply with laws protecting the environment.
The other ethical issues that are confronted by managers are the problem of theft by the employees and loss of important information. To avoid this, there is a need to introduce sophisticated controls and budgetary control procedures.
In the service sector the manager is faced with ethical dilemma of solving problems related to technical field. The worst scenario is in the case of computer fraud where companies lose millions of dollars due to employees' theft. To counter this, companies have to spend considerable amount of money and time, to prevent such thefts. Loss can be due to asset misappropriation, corruption, false statements, petty thefts and pilferage, use of company property for personal benefit.

3.4.5.Analytical Framework for ethical issues in Operations Management

Everyday an operations manager is faced with the dilemma of being ethical in decision making.
Six factors are involved in ethical decision making. Ethical intensity is described as the degree of importance given to an ethical issue. The factors involved in decision making are:
Magnitude of consequence: This refers to the magnitude of impact that a decision can have on the employees. In such a

scenario a manager takes a decision that is comparatively less harmful.

3.4.6.ETHICAL CASES ENVIRONMENTALLY PC

Paul Baum, Founder of Rumarson Technology Inc(RTI) based in NJ, has made the recycling of computers a mission of his company. RTI specializes in acquiring, refurbishing, and distributing computer equipment from trade in and inventory buyout programs.RTI buys old computers, refurbishes them and sells them to resellers as “nused” computer equipment. The resellers then sell the nused computers with a 25-40% warrantee. If however RTI cant sell computers then it dontes to charity. If the equipment cant be salvaged its broken down into recyclable parts and used in items such as jewellery and flower pots.

RTI believes that there are more toxins in a PC than in an oil spill. Home users are the biggest markets for RTI.

3.5.ENVIRONMENTAL ISSUES

Environmental Issues in Design and Technology is part of Key Stage 3 Design and Technology. It is one of a series of topics looking at how moral, cultural, environmental and spiritual issues may influence our work in design and technology.

3.5.1.Environment

Environment means our surroundings.

Our surroundings consist of naturally occurring things like the air, rivers and trees and it consists of things that are built by Humans. We call these two environments:

- "the natural environment" and the
- "built environment".

Left undisturbed, the natural environment sustains plant and animal life. With a small amount of damage, the natural environment has shown that it can repair itself and return to its former state. Environmental damage on a large scale however, has global consequences and can reach a point where damage is difficult, if not impossible to repair. Air pollution in one country effects others as air currents carry pollutants around the

globe. A polluted river contaminates the river bed and life in the river, then as it flows into the sea, it contaminate the sea, the sea bed and sea life. Pollutants may be transmitted through the food chain, poisoning plants and animals in the process.

Environmental pollution can occur:

- ✓ during mining processes when fossil fuels and minerals are dug out of the ground
- ✓ while raw materials are transported to processing plants
- ✓ during processing operations and the conversion of materials into products
- ✓ during transportation and storage of fuels and products
- ✓ during the use of fuels and products
- ✓ when obsolete products and waste materials are transported to recycling plants and waste dumps
- ✓ during recycling processes
- ✓ when dumped waste materials pollute the air, the soil and the water table.

The polluting effects of industry has resulted in air and water pollution, raised acidity levels in rivers, seas and the air, loss of plant and animal habitats, loss of plant and animal species, climate change and a host of other serious effects.

Our unrestrained use of finite resources has resulted in some resources, such as coal and oil, running out in certain areas. Consequently coal, oil and other materials are transported from areas of the world that have them and are prepared to export them.

Protection of our natural environment and our natural resources is so important that the survival of life on Earth depends on it.

3.5.2.Design challenge for the natural environment

The challenge for all involved with design and technology is to design and build products that:

- people need
- are safe to use
- do not pollute the earth or harm the environment in any way
- do not destroy wildlife habitats
- do not waste finite resources.

3.5.3Built Environment

The "built environment" are the buildings and other structures designed and built by Humans.

3.5.4Inside Buildings and Structures

Internal environments include the environments of personal housing, public buildings, public and personal transport and places of work. These environments are designed to give us the conditions we need to live and work comfortably, i.e. security, warmth, light, clean fresh air and access to food, drink and places for rest and relaxation. The size, shape and colour of these internal environments, together with the materials used in them, their light source, their equipment and facilities, all have effects on our comfort, safety and well being.

Individual tastes, cultural influences, fashion and the affluence of the accommodation owner/occupier helps to create diversity in the design of internal environments.

3.5.5External Environments

External environments include the size, shape and layout of buildings, parks, and transport etc. External environments should be visually pleasing and should enable the community to function properly. That means that people should be able to move easily and safely from place to place, there should be places where people can do work to earn money, there should be places where they can buy food and household goods and there should be places for relaxation, recreation, sport and education.

Inner city parks such as Central Park in New York can be marvels of design and engineering. Central Park looks natural but in fact it is carefully planned and crafted, with sophisticated systems that enable it look natural, yet be able to cope with the thousands of people that pass through it every day.

Zoos and wildlife preserves are attempts to create environments where animals can be seen in something resembling their natural habitats. Theme parks are another example of man’s attempts to manipulate the environment

for leisure activities. Others are golf courses, boating lakes, skateboard parks and dry ski slopes.

3.5.6Transport

The environmental impact of the various transport systems is significant. Road systems are rarely adequate in most European cities. In cities such as London, there are traffic jams that bring traffic to a standstill. The air pollution from internal combustion engines is endangering people's health and is increasing the levels of green house gases that create global warming and climate change. Trains today are powered mostly by diesel engines and by electric engines. Whether the engine pollutes the atmosphere directly or it is the greenhouse gases and other pollutants that are given off from the power stations that produce electricity, one way or another, man's use of energy pollutes the environment.

The increase in air travel has had many beneficial effects for travellers but the increase in pollution from aircraft has had a detrimental effect on the environment. Since shipping has stopped using wind as a power source, it too has contributed to air pollution from its engines. Spillages from oil tanker disasters have had devastating effects on the environment.

One of the greatest challenges for scientists and designers is to develop clean sources of energy that can be used for transport and for industry.

3.5.7.Industry

Industrial practices have also had detrimental effects on the environment, although there have been some attempts at repairing the damage caused by industrial activity.

Industrial activity has changed our landscape. Quarrying operations have removed hillsides, open cast mining has created massive craters, oil refineries, steel works, power stations and other industrial sites have destroyed the natural beauty of our environment. From the scarring of the earth during mining excavations, the pollutants released during various processing operations and the dumping of waste products, industrial activity has polluted and scarred our environment. That is, pollution of the land, sea and air.

3.6.PRODUCT DESIGN PROCESS

The product design process involves the steps of generating ideas, product screening, preliminary design and final design.

3.6.1 Generating Ideas (Planning)

Ideas for new products and services should be sought from a variety of sources including market research, customer viewpoints, the organisation's research and development (R&D) department if one exists, competitors or relevant developments in new technology. Competitors can provide a good source of ideas and it is important that the organisation analyses any new products they introduce to the market and make an appropriate response. Reverse Engineering is a systematic approach to dismantling and inspecting a competitor's product to look for aspects of design that could be incorporated into the organisation's own product. This is especially prevalent when the product is a complex assembly such as a car, were design choices are myriad. Benchmarking compares a product against what is considered the best in that market segment and the making recommendations on how the product can be improved to meet that standard. Although a reactive strategy, benchmarking can be useful to organisation's who have lost ground to innovative competitors.

3.6.2Product Screening

The screening process consists of market analysis, economic analysis and technical analysis.

3.6.3Market analysis

Market analysis consists of evaluating the product concept with potential customers through interviews, focus groups and other data collection methods. The physical product may be tested by supplying a sample for customer evaluation. The market analysis should identify whether sufficient demand for the proposed product exists and its fit with the existing marketing strategy.

3.6.4.PRODUCT DESIGN STRATEGY

At a strategic level the organisation can use the product life cycle to determine the likely cost and volume

characteristics of the product. The product life cycle describes the product sales volume over time. In the early introduction phase production costs are high and design changes may be frequent. However there should be little or no competition for the new product and so a premium price can be charged to customers attracted to innovative products. The growth phase sees a rapid increase in volumes and the possibility of competitors entering the market. At this stage it is important to establish the product in the market as firmly as possible in order to secure future sales. Production costs should be declining as process improvements and standardisation takes place. In the mature phase competitive pressures will increase and it is important that sales are secured through a branded product to differentiate it from competitors and a competitive price.

There should be a continued effort at design improvement to both product and process. Some products, such as consumer durables, may stay in the mature phase almost indefinitely, and techniques such as advertising are used to maintain interest and market share.

3.6.5Economic Analysis

Economic Analysis consists of developing estimates of production and demand costs and comparing them with estimates of demand. In order to perform the analysis requires an accurate estimate of demand as possible derived from statistical forecasts of industry sales and estimates of market share in the sector the product is competing in. These estimates will be based on a predicted price range for the product which is compatible with the position of the new product in the market. In order to assess the feasibility of the projected estimates of product costs in terms of such factors as materials, equipment and personnel must be estimated. Techniques such as cost/benefit analysis, decision theory and accounting measures such as net present value (NPV) and internal rate of return (IRR) may be used to calculate the profitability of a product. Another tool that can be used is the cost-volume-profit model that provides a simplified representation that can be used to estimate the profit level generated by a product at a certain product volume.

3.6.6.Technical Analysis

Technical analysis consists of determining whether technical capability to manufacture the product. This covers such issues as ensuring materials are available to make the product to the specification required, and ensuring the appropriate machinery and skills are available to work with these materials. The technical analysis must take into account the target market and so product designers have to consider the costs of manufacturing and distributing the product in order to ensure it can be sold at a competitive price. Strategic analysis involves ensuring that the product provides a competitive edge for the organisation, drawing on its competitive strengths and is compatible with the core business.

3.6.7Preliminary Design

Product concepts that pass the feasibility stage enter preliminary design. The specification of the components of the package requires a product /service structure which describes the relationship between the components and a bill of materials or list of component quantities derived from the product structure. The process by which the package is created must also be specified in terms of mapping out the sequence of activities which are undertaken. This can be achieved with the aid of such devices as process flow charts.

3.6.8Final Design

The final design stage involves the use of a prototype to test the preliminary design until a final design can be chosen. Computer Aided Design (CAD) and Simulation Modelling can be used to construct a computer-based prototype of the product design.

Methods for Improving Product Design

A number of methods are available that help to improve the design process.

3.6.9 Design for Manufacture (DFM)

Although the ability of the product or service to fulfil customers needs is a major factor in design there is also a need to ensure that the product designed can be produced easily and at low cost.

Design for Manufacture (DFM) is a concept which provides guidelines on how this can be achieved using

techniques such as simplification, standardisation and modularization.

Simplification involves a reduction in the number of components in the design in order to reduce cost and increase reliability. Standardisation involves using components that can be used in a number of products again reducing costs through economies of scale and minimising inventory.

Modularisation means using modules or blocks of components that are standard across products.

Again costs are reduced and reliability increased.

3.6.10 Concurrent Engineering

Concurrent engineering is when contributors to the design effort provide work throughout the design process as a team. This differs from the traditional design process when work is undertaken separately within functional areas such as engineering and operations. The problem with the traditional approach is the cost and time involved in bringing the product to market. In a traditional approach time is wasted when each stage in the design process waits for the previous stage to finish completely before it can commence and their may be a lack of communication between functional areas involved in the different stages of design. This can lead to an attitude of "throwing the design over the wall" without any consideration of problems that may be encountered by later stages. An example of this is decisions made at the preliminary design stage that adversely effect choices at the product build stage. This can cause the design to be repeatedly passed between departments to satisfy everyone's needs, increasing time and costs. By facilitating communication through the establishment of a project team problems of this type can be reduced.

3.6.11.Process Selection

When considering product design the issue of the design of the process that is used to produce that design should be considered also. The design of processes is different in all organisations and should be related to the volume and variety of the demand for the product in the market. In order to assist in selecting the appropriate process, process designs can be categorised under four

process types of project, batch, mass and continuous. A description of each process type is followed by some examples of where each process type might be used.

3.7.PRODUCT DESIGN DECISONS

Product launches are a crucial part of a company's goal to continually innovate within its industry. This involves careful planning because each new product reflects a considerable amount of capital investment. Product design is one of the important elements in new product development. It progresses through a number of important stages that include market research, internal communications and decision making processes.

3.7.1Idea Development

Prior to the internal decision making process, extensive market research is generally performed to ensure that new product concepts are consistent with customer needs and desires. This includes conducting qualitative and quantitative studies that test ideas with customers. It also includes closely evaluating similar competitor products. Suppliers are also an important source of information in making decisions about product design elements such as materials.

3.7.2Senior Management

Product development teams must sell new product concepts to senior management who are tasked with determining whether to commit resources to new products. At this stage, product ideas are evaluated to consider whether existing operational resources are sufficient to meet the manufacturing and production requirements needed for the new product. Product ideas are also evaluated for consistency with the company's business goals and objectives, brand marketing directions and financial requirements.

3.7.3Interdepartmental Communications

To ensure high levels of awareness and commitment to a new product, internal communications are initiated at the preliminary design and testing stage to gain insights from the various departments that will take part in the product's development and marketing. In addition to focus group studies with customers, interdepartmental insights are gathered and considered when refining product prototypes.

This includes manufacturing, design, research and development, distribution and marketing departments.

3.7.4.Sales and Marketing

Once final product specifications are completed, sales and marketing department professionals become more involved in the decision making process as that relates to launching new product designs. This includes developing marketing and sales plans designed to get the new product to the target market.

3.8.WORK STUDY

Work is an activity in which one exerts physical and mental effort to accomplish a given task or perform a duty.

3.8.1OBJECTIVES

The objective of work study is to assist management obtain the optimum use of the human and material

resources available to an organisation for the accomplishment of the work upon which it is engaged. Fundamentally, this objective has three aspects:-

1. the most effective use of plant and equipment;
2. the most effective use of human effort; and
3. the evaluation of human work

Too often it has been the practice, wherever human activities have been organised, to accept opinion in place of fact, with the result that decisions have tended to be based upon what was believed to be true rather than upon what was known to be true. The function of work study is to obtain facts, and then to use those facts as a means of improvement. Consequently, work study may be regarded principally as a procedure for determining the truth about the activities of existing people and existing plant and equipment as a means of the improvement of those activities. It will provide the means of achieving higher productive efficiency under prevailing circumstances.

3.8.2WORK STUDY PROCEDURES

Work Study is the systematic examination of the methods of carrying out activities such as to improve the effective use of resources and to set up standards of performance for

the activities carried out.

A generic term for those techniques, particularly method study and work measurement, which are used in the examination of human work in all its contexts, and which lead systematically to the investigation of all the factors which affect the efficiency and economy of the situation being reviewed, in order to effect improvement.

3.9Method Study

Method-study concerned with “the way in which work is done (i.e., method)”. It is used to simplify the way to accomplish a work and to improve the method of production.

Method-study results in a more effective use of material, plant, equipment and manpower.

Method study is essentially concerned with finding better ways of doing things. It adds value and increase the efficiency by eliminating unnecessary operations, avoidable delays and other forms of waste.

The improvement of efficiency is achieved through:

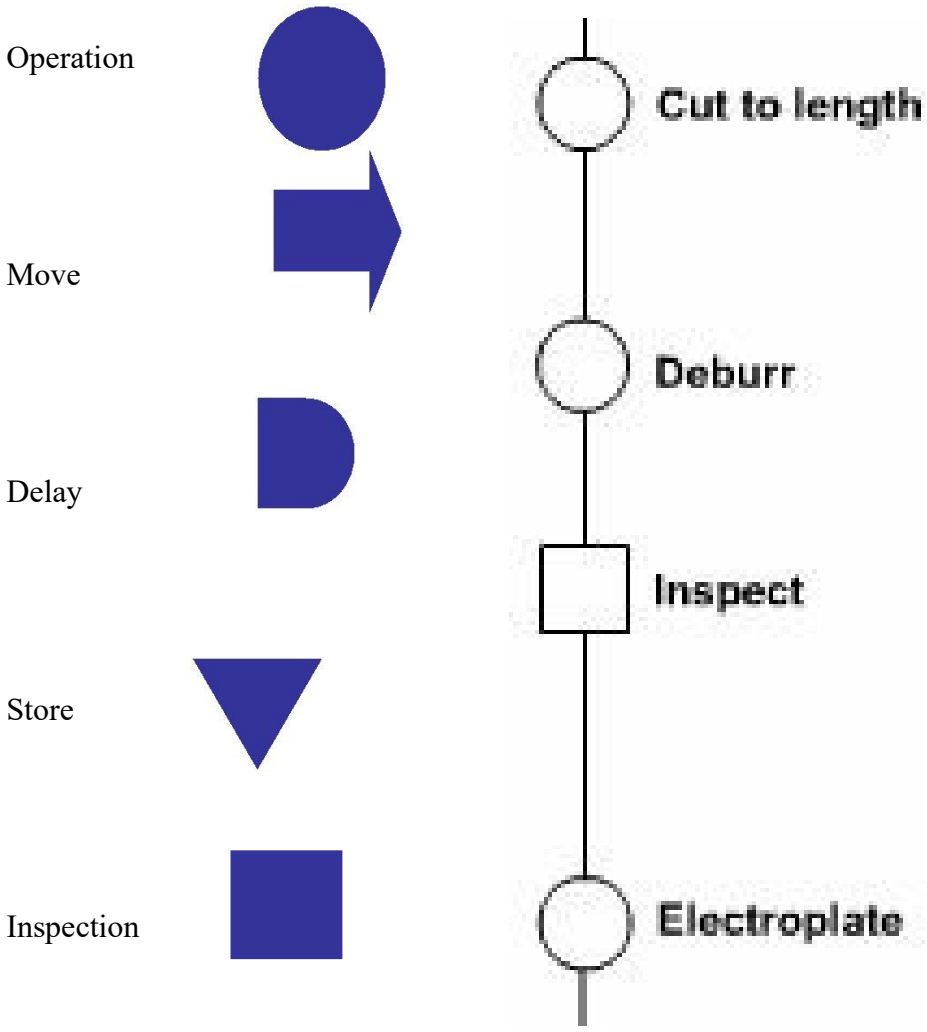
1.Present and analysis true facts concerning the situation.

2.To examination those facts critically

3.To develop the best answer possible under given circumstances based on critical examination of facts.

3.9.1.1Recording techniques for method study

Operation process chart: An operation process chart provides the chronological sequence of all operations and inspections that occur in a manufacturing or business process. Operation process chart used only two symbols, i.e., operation and inspection.



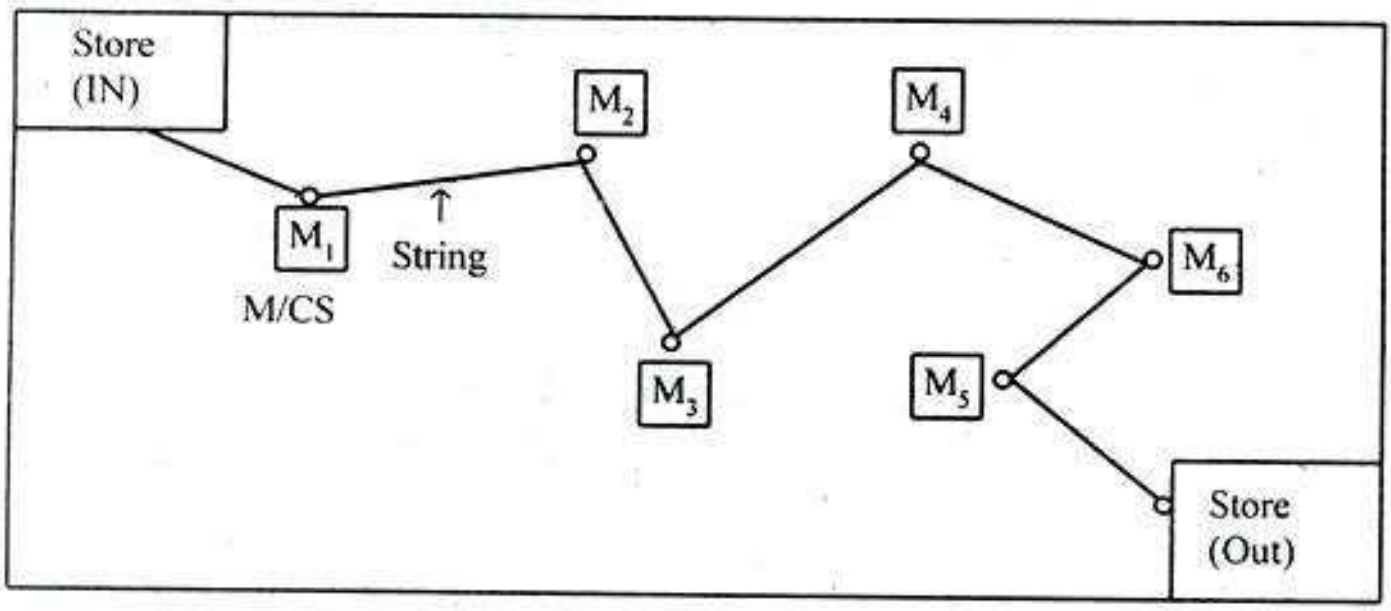
3.9.1.1.2Recording techniques for method study

Flow process chart: A flow process chart is used for recording greater detail than is possible in an operation process chart. It is made for each component of an assembly rather than for the whole assembly.

Event Description	Symbol
In store	
To press #1	
Wait	
Blank	
Stack	
Blank To Press #2	

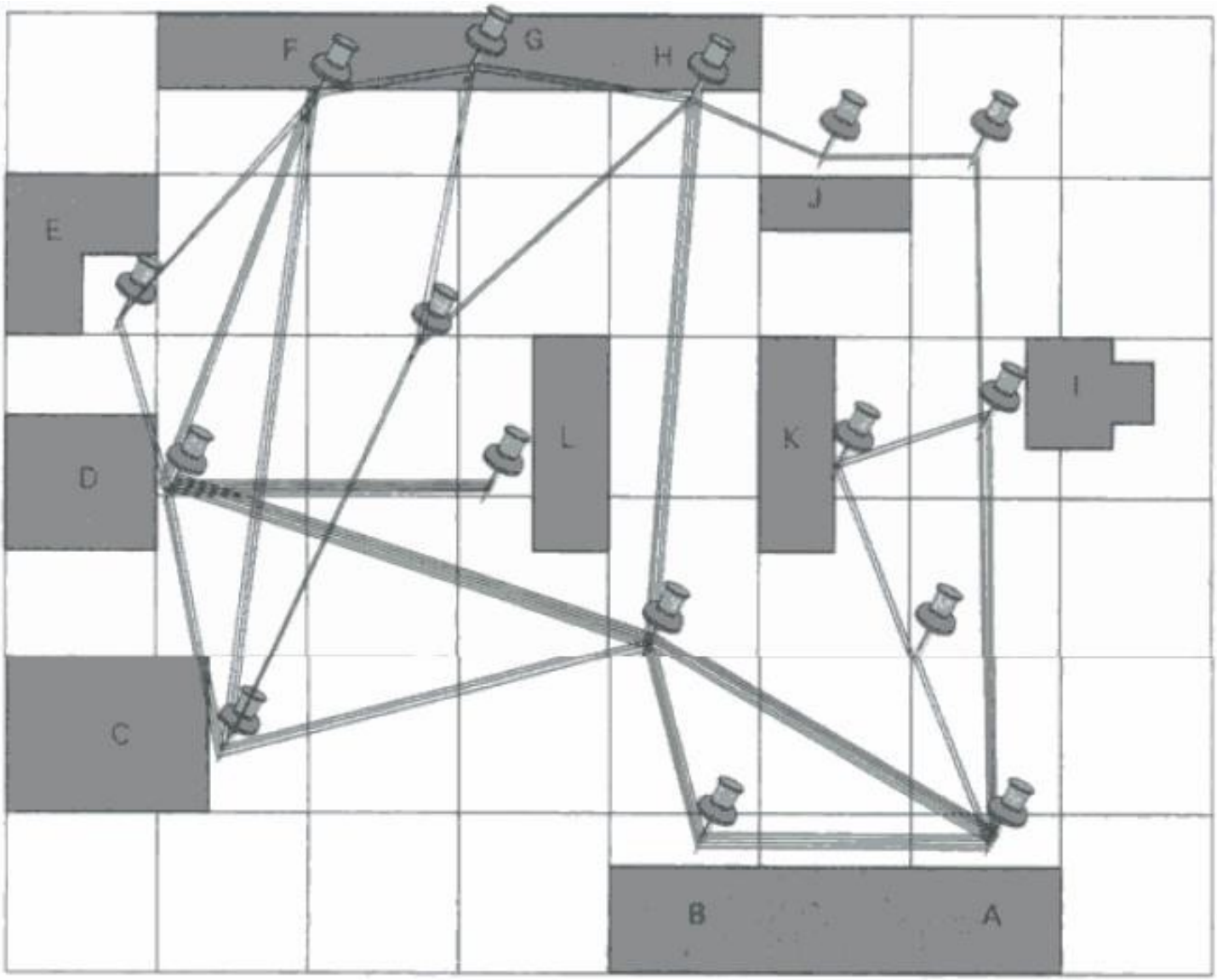
3.9.1.1.3Recording techniques for method study

String Diagram: String Diagram is a scale layout drawing on which, length of a string is used to record the extent as well as the pattern of movement of a worker working within a limited area during a certain period of time. It is a scale diagram on which color threads are wrapped around pins or pegs, which are used to indicate the paths taken by either worker or material or equipment when processing is done on material from start to finish.



3.9.1.1.4 Recording techniques for method study

String Diagram:



Steps or procedure involved in methods study

- ✓ Examine: examine the way the job is being performed and test its purpose, place, sequence and method of performance.

- ✓ In this step, the information provided by charts and diagrams is critically examined and screened by asking some searching questions. Like, what is done?, why it is done?, what else might be done? Etc.

- ✓ This examination is carried out with a view to eliminate, combine, rearrange and/or simplify the activities.

- ✓ Develop: develop the most practical, economical, and effective method.

- ✓ After critical examination of records is complete, it is necessary to transform the learning's into the development of new methods. Some approaches are:

- ✓ Eliminate unnecessary activities.

- ✓ Combine two or more activities. For example, if one uses a combination tool for two operations, say, facing and drilling, the total set-up time will reduce.

- ✓ Re-sequence activities so as to reduce time and effort.

- ✓ Simplify process to reduce number of operations or reduce effort or reduce throughput, etc.

- ✓ Attack on constraints, which are preventing the method to perform better.

Evaluate: evaluate different alternatives to develop a new improved method comparing the cost-effectiveness of the selected new method with the current method of performance.

Define: define the new method in a clear manner and present it to those concerned, i.e., management, supervisors and worker.

- ✓ A report on new improved method should be prepared. It should include:

- Description of the method.
- Cost of installing the new method, including cost of new equipment and of re-laying out shops or working areas.
- Diagram of the work place layout.

3.10.WORK MEASUREMENT PRODUCTIVITY

3.10.1MOTION STUDY

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

The objectives of motion study are:

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

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

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

3.10.1Principles of Motion study

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

The principles are grouped into three headings:

- ✓ Use of the human body.
- ✓ Arrangement of workplace.
- ✓ Design of tools and equipment.

3.10.1.1USES OF HUMAN BODY

1. The two hands should begin and complete their movements at the same time.
2. The two hands should not be idle at the same time except during periods of rest.
3. Motions of the arms should be made simultaneously.
4. Hand and body motions should be made at the lowest classification at which it is possible to do the work satisfactorily.

3.10.1.2.ARRANGEMENT OF THE WORKPLACE

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

2. Tools and materials should be pre-positioned.

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

3. DESIGN OF TOOLS AND EQUIPMENTS

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

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

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

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

3.10.2.Objectives of Work Measurement

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

1. Comparing alternative methods.
2. Manpower requirement planning.
3. Planning and control.
4. Realistic costing.
5. Financial incentive schemes.
6. Delivery date of goods.

3.10.3Techniques of Work Measurement

- ✓ Repetitive work: The type of work in which the main operation repeats continuously during the time spent at the job.
- ✓ Non-repetitive work: It includes some type of maintenance and construction work, where the work cycle is not repeated.

Various techniques of work measurement are:

- ✓ Time study
- ✓ Synthesis
- ✓ Work sampling
- ✓ Predetermined motion and time study
- ✓ Analytical estimating

3.10.3.1Time study: A work measurement technique for recording the times and rates of working for the elements of a specified job carried out under specified conditions. Time study is for

analysing the data so as to determine the time necessary for carrying out the job at the defined level of performance.

3.10.3.2Synthetic data: It is the method of totaling element times obtained previously from time studies on other jobs containing the elements concerned or from synthetic data.

3.10.3.3Work sampling: A technique in which a large number of observations are made over a period of time of one or group of machines, processes or workers. Each observation records what is happening at that instant and the percentage of observations recorded for a particular activity, or delay, is a measure of the percentage of time during which that activities delay occurs.

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

UNIT-IV
MATERIALS MANAGEMENT

4.MATERIALS MANAGEMENT

Material management is an approach for planning, organizing, and controlling all those activities principally concerned with the flow of materials into an organisation.

The objectives of material management can be classified into two categories viz; primary objectives and secondary objectives.

4.1 Objectives

4.1.1Primary Objectives:

The following are the primary objectives:

4.1.1.1 Low Prices:

If materials department succeeds in reducing the price of items it buys, it contributes in not only reducing the operating cost but also in enhancing the profits.

4.1.1.2. Lower Inventories:

By keeping inventories low in relation to sales, it ensures that less capital is tied up in inventories. This increases the efficiency with which the capital of the company is utilized resulting in higher return on investment. Storage and carrying costs are also lower.

4.1.1.3. Reduction in Real Cost:

Efficient and economical handling of materials and storage lowers the acquisition and possession cost resulting in the reduction in the real cost.

4.1.1.4 Regular Supply:

Continuity of supply of materials is essential for eliminating the disruption in the production process. In the absence of regular supply of materials, production costs go up.

4.1.1.5. Procurement of Quality Materials:

Materials department is responsible for ensuring quality of materials from outside suppliers. Therefore, quality becomes the single most objective in procurement of materials.

4.1.1.6. Efficient handling of Materials:

The effective material control techniques help the efficient handling of materials resulting in the lowering of production cost.

4.1.1.7. Enhancement of firm's goodwill:

Good relations with the suppliers of materials enhance the company's standing in the society as well as in the business community.

4.1.1.8. Locating and developing future Executives:

Materials manager must devote special effort to locate men at lower position who can take up the executive posts in future. It helps in developing talented personnel who are ready to undertake future responsibilities of the business relating to materials management.

4.1.2Secondary Objectives:
The following are the important secondary objectives of materials management.

4.1.2.1 Reciprocity:
The purchase of raw materials from the organisations/customer's by the concern and in turn, sale of finished products to the above customers is known as reciprocity. It serves the twin purpose of increasing purchasing as well as sales.

4.1.2.2 New Developments:
The staff of the materials department deals regularly with the suppliers responsible for new developments in material handling. These developments can be successfully applied in material handling and management.

4.1.2.3. Make or Buy Decisions:
The material manager with regular reviews of cost and availability of materials can safely conclude that whether the material is to be purchased or developed in the organisation itself.

4.1.2.4. Standardisation:
Standardisation of materials is greatly helpful in controlling the material management process. With regular stock-taking, the non-standardised items can be rejected and standard components may be brought into product designs to reduce the cost of production. It is further helpful in promoting the standardisation with suppliers.

4.1.2.5. Assistance to Production department:
By supplying the standardised materials or components to the production department, quality products can be assured. It is helpful in imparting the economic knowledge in bringing about the desired improvement in the product.

4.1.2.6. Co-operation with other departments:
Successful management of materials department contributes to the success of every other department in the organisation. At the same time the success of materials department depends on how successful it is in getting the co-operation of the staff of the other departments.

4.1.2.7. Conception of future outlook:
The materials manager must have some conception of future outlook for prices, cost and general business activity. Forecasting can be made about the future trends in materials. The materials manager should be able to foresee the prices and costs of the raw materials and general business conditions through their daily contracts with the suppliers.

From the above it is clear that materials management serves two fold objectives viz., to strive for a reduction in cost of production and distribution and to help the enterprise in attaining its objectives.

These dual objectives of the materials management further aim at maintaining the regular flow of production by purchasing materials of right quality, in a right quantity at a right time from a right source, on right terms and conditions and at lower price.

It is helpful in efficiently controlling the inventories. It is further beneficial in developing good buyer seller relations. Coordination with other departments is established and considerably helps the organisation to grow and advance in technical field.

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4.2.Material planning is a scientific way of determining the requirements starting with raw materials, consumables, spare parts and all other materials that are required to meet the given production plan for a certain period.
Material planning is derived from the over all organisational planning and hence it is always a sub-plan of the broad organisational plan.
What it does is forecasting and initiating for procurement of materials

4.2.1Factors affecting Material planning :

4.2.1.1 Macro factors : Global factors such as price trends, business cycles, government's import and export policies etc are called the Macro factors. Credit policy of the government is a critical factor as banks follow these guidelines only while extending financial support to a business entity.

4.2.1.2 Micro factors : These are essentially the factors existing within the organisation such as corporate policy on Inventory holding, production plan, investments etc. For any organisation, factors such as Lead time of procurement , acceptable inventory levels, working capital, seasonality, delegation of power are micro factors.

Techniques of planning materials :
There are a few techniques used for planning material for the given period. The following two are , however, commonly used :

Materials Requirement Planning (MRP)
2) Requirement based on past consumption

MRP has ,as its starting point, the annual production plan of the manufacturing concern.

Once a firm determines its annual production plan , the over all material requirement , to meet the given production plan, is worked out. It is a detailed analysis encompassing the materials and quantities available for use, materials with quantities not available and

hence needing procurement, the actual lead time of procurement etc.

Since , it is always possible to have a situation where some parts of an assembly are available and some others not available, Bill of Materials is exploded. It is quantifying all the materials (components) needed for various assemblies , all needed as per the production plan. BOM is thus a list displaying the code, nomenclature of an item , its unit and quantity , location of use and also the estimated price of each component. An explosion chart is a series of bills of materials grouped together in a matrix form so that combining the requirements for different components can be made.

4.2.2Budgetary control methods

4.2.2.1 Budget:

- A formal statement of the financial resources set aside for carrying out specific activities in a given period of time.

- It helps to co-ordinate the activities of the organisation.

An example would be an advertising budget or sales force budget.

4.2.2.2 Budgetary control:

- A control technique whereby actual results are compared with budgets.

- Any differences (variances) are made the responsibility of key individuals who can either exercise control action or revise the original budgets.

4.2.2.3Budgetary control and responsibility centres;

These enable managers to monitor organisational functions.

A responsibility centre can be defined as any functional unit headed by a manager who is responsible for the activities of that unit.

There are four types of responsibility centres:

a) *Revenue centres*

Organisational units in which outputs are measured in monetary terms but are not directly compared to input costs.

b) *Expense centres*

Units where inputs are measured in monetary terms but outputs are not.

c) *Profit centres*

Where performance is measured by the difference between revenues (outputs) and expenditure (inputs). Inter-departmental sales are often made using "transfer prices".

d) *Investment centres*

Where outputs are compared with the assets employed in producing them, i.e. ROI.

4.2.3.Advantages of budgeting and budgetary control

There are a number of advantages to budgeting and budgetary control:

- Compels management to think about the future, which is probably the most important feature of a budgetary planning and control system. Forces management to look ahead, to set out detailed plans for achieving the targets for each department, operation and (ideally) each manager, to anticipate and give the organisation purpose and direction.

- Promotes coordination and communication.

- Clearly defines areas of responsibility. Requires managers of budget centres to be made responsible for the achievement of budget targets for the operations under their personal control.

- Provides a basis for performance appraisal (variance analysis). A budget is basically a yardstick against which actual performance is measured and assessed. Control is provided by comparisons of actual results against budget plan. Departures from budget can then be investigated and the reasons for the differences can be divided into controllable and non-controllable factors.

- Enables remedial action to be taken as variances emerge.

- Motivates employees by participating in the setting of budgets.

- Improves the allocation of scarce resources.

- Economises management time by using the management by exception principle.

4.2.4Problems in budgeting

Whilst budgets may be an essential part of any marketing activity they do have a number of disadvantages, particularly in perception terms.

- Budgets can be seen as pressure devices imposed by management, thus resulting in:

a) bad labour relations
b) inaccurate record-keeping.

Departmental conflict arises due to:

a) disputes over resource allocation
b) departments blaming each other if targets are not attained.

It is difficult to reconcile personal/individual and corporate goals.

Waste may arise as managers adopt the view, "we had better spend it or we will lose it". This is often coupled with "empire building" in order to enhance the prestige of a department.

Responsibility versus controlling, i.e. some costs are under the influence of more than one person, e.g. power costs.

Managers may overestimate costs so that they will not be blamed in the future should they overspend.

4.2.5Characteristics of a budget

A good budget is characterised by the following:

- Participation: involve as many people as possible in drawing up a budget.
- Comprehensiveness: embrace the whole organisation.
- Standards: base it on established standards of performance.
- Flexibility: allow for changing circumstances.
- Feedback: constantly monitor performance.
- Analysis of costs and revenues: this can be done on the basis of product lines, departments or cost centres.

4.2.6Budget organisation and administration:

In organising and administering a budget system the following characteristics may apply:

a) *Budget centres:* Units responsible for the preparation of budgets. A budget centre may encompass several cost centres.

b) *Budget committee:* This may consist of senior members of the organisation, e.g. departmental heads and executives (with the managing director as chairman). Every part of the organisation should be represented on the committee, so there should be a representative from sales, production, marketing and so on. Functions of the budget committee include:

- Coordination of the preparation of budgets, including the issue of a manual
- Issuing of timetables for preparation of budgets
- Provision of information to assist budget preparations
- Comparison of actual results with budget and investigation of variances.

c) *Budget Officer:* Controls the budget administration The job involves:

- liaising between the budget committee and managers responsible for budget preparation
- dealing with budgetary control problems
- ensuring that deadlines are met
- educating people about budgetary control.

d) *Budget manual:*

This document:

- charts the organisation
- details the budget procedures
- contains account codes for items of expenditure and revenue
- timetables the process
- clearly defines the responsibility of persons involved in the budgeting system.

4.2.7.Budget preparation

Firstly, determine the principal budget factor. This is also known as the key budget factor or limiting budget factor and is the factor which will limit the activities of an undertaking. This limits output, e.g. sales, material or labour.

a) Sales budget: this involves a realistic sales forecast. This is prepared in units of each product and also in sales value. Methods of sales forecasting include:

- sales force opinions
- market research
- statistical methods (correlation analysis and examination of trends)
- mathematical models.

In using these techniques consider:

- company's pricing policy
- general economic and political conditions
- changes in the population
- competition
- consumers' income and tastes
- advertising and other sales promotion techniques
- after sales service
- credit terms offered.

b) Production budget: expressed in quantitative terms only and is geared to the sales budget. The production manager's duties include:

- analysis of plant utilisation
- work-in-progress budgets.

If requirements exceed capacity he may:

- subcontract
- plan for overtime

- introduce shift work
- hire or buy additional machinery
- The materials purchases budget's both quantitative and financial.

c) Raw materials and purchasing budget:

- The materials usage budget is in quantities.
- The materials purchases budget is both quantitative and financial.

Factors influencing a) and b) include:

- production requirements
- planning stock levels
- storage space
- trends of material prices.

d) Labour budget: is both quantitative and financial. This is influenced by:

- production requirements
- man-hours available
- grades of labour required
- wage rates (union agreements)
- the need for incentives.

e) Cash budget: a cash plan for a defined period of time. It summarises monthly receipts and payments. Hence, it highlights monthly surpluses and deficits of actual cash. Its main uses are:

✓ to maintain control over a firm's cash requirements, e.g. stock and debtors

✓ to enable a firm to take precautionary measures and arrange in advance for investment and loan facilities whenever cash surpluses or deficits arises
✓ to show the feasibility of management's plans in cash terms
✓ to illustrate the financial impact of changes in management policy, e.g. change of credit terms offered to customers.
✓ Receipts of cash may come from one of the following:
✓ cash sales
- payments by debtors
- the sale of fixed assets
- the issue of new shares
- the receipt of interest and dividends from investments.

✓ Payments of cash may be for one or more of the following:
✓ purchase of stocks
- payments of wages or other expenses
- purchase of capital items
- payment of interest, dividends or taxation.

4.3Purchasing- Objectives Of Purchasing

- ✓ To purchase the required material at minimum possible price by following the company policies.
- ✓ to keep department expenses low.
- ✓ Development of good & new vendors(suppliers).
- ✓ Development of good relation with the existing suppliers.
- ✓ training & development of personal employees in department.
- ✓ to maintain proper & up to date records of all transactions.
- ✓ Participating in development of new material and products.
- ✓ to contribute in product improvement.
- ✓ to take Economic "MAKE OR BUY" decisions.
- ✓ to avoid Stock- out situations.
- ✓ to develop policies & procedure.

4.4.Function of Purchasing

The purchasing department is an organisational unit of a firm whose duties include some part or all of the purchasing function. This disconnection between function and, department is not always appreciated or understood by top management.

The purchasing function is usually performed most economically and efficiently by a specialised, centralised purchasing department, directed by a skilled purchasing manager.

However, the purchasing function does not have to be performed in such a manner. In theory, it can be performed, and in practice, it sometimes is performed by any number of different company officers or departments.

The functions of purchasing department are varied and wide which are based upon different approaches. The purchasing activities may be divided into those that are always assigned to the purchasing department and those that are sometimes assigned to some other department. The followings are some of the important functions which are necessary to be performed.

- ✓ Receiving indents
- ✓ Assessment of demand or description of need
- ✓ Selection of sources of supply
- ✓ Receiving of quotation
- ✓ Placing order
- ✓ Making delivery at the proper time by following up the orders.
- ✓ Verification of invoices
- ✓ Inspection of incoming materials
- ✓ Meeting transport requirements of incoming and outgoing materials
- ✓ Maintaining purchasing records and files
- ✓ Reporting to top management
- ✓ Developing coordination among other departments
- ✓ Creating goodwill of the organisation in the eyes of the suppliers.

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

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

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

The real problem arises when the order is placed for want of preciseness in the description of goods needed, the items are received and these are not acceptable to the user department and it also becomes difficult to convince the suppliers to return the goods in case of faulty supplies. Therefore, purchasing department must have adequate knowledge of items being purchased to be able to secure full description.

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

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

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

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

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

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

4.4.4. Receiving of quotation:

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

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

- ✓ Catalogues, price lists etc.
- ✓ Telephonic quotations.
- ✓ Previous purchase records.
- ✓ Quotation letter or tender i.e., letter of inquiry.
- ✓ Sample and related price cards.
- ✓ Negotiation between suppliers and the purchase department like catalogue, price lists etc.

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

4.4.5. Placing order:

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

- ✓ Description and specifications of the material.
- ✓ Quantity order.
- ✓ Transport and packing charges and shipping instructions.
- ✓ Name and address of the supplier.
- ✓ Date, time and place of delivery.
- ✓ Price, discount and terms of payment.
- ✓ Signature of the purchase manager.
- ✓ The name and address of the buyer.

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

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

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

4.4.7. Verification of invoices:

In normal course, it is also the responsibility of purchase department to check the invoices and accordingly advise the accounts department for clearing the payment to the parties

concerned. Contradictory statements have been given as to who should be assigned this function.

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

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

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

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

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

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

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

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

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

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

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

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

4.5..PURCHASING POLICES

In applying our purchasing policy, we pursue fairness by following ten guidelines.

- ✓ Quality, price, reliability, and supply stability are the main criteria upon which we base decisions on initiating new business and carrying out specific transactions.
- ✓ As a rule, we compare offers from several vendors sImultaneously to nurture competition and select suppliers fairly.
- ✓ We purchase from multiple suppliers to avoid excessive reliance on a single vendor and to prevent vendors from depending excessively on us.
- ✓ We create opportunities for newcomers by periodically reviewing our regular vendors.
- ✓ We request offers only when considering purchasing. If asked, we explain, within limits, our reasons for not accepting an offer or competitive bid.
- ✓ As a rule, we specify terms in written contracts. Ongoing transactions are also based on written contracts.
- ✓ We to not require vendors to purchase our products or services.
- ✓ We preserve the confidentiality of vendor information obtained in transactions.
- ✓ We do not engage in transactions that lead to the violation of a third party's intellectual property rights.
- ✓ Our purchasing personnel do not permit personal interest to influence relationships with existing or prospective vendors.

4.6.VENDOR RATING & VALUE ANALYSIS

4.6.1.Selection Criteria

The Contractor shall identify potential vendors using the following criteria:

a. Provide a discussion of the analysis and procedures used to select vendors for further consideration. Include in this discussion any independent analysis / evaluations used in your determinations.
b. If a vendor currently has network switches in use on the base and those products meet the other criteria of this section, as is or with potential upgrades, the vendor's products must be included in the detailed analysis.

c. A minimum of two vendors must be considered in detailed analysis for each technology in the proposed design.
d. Vendor equipment must meet the minimum ITS requirements listed in Table 4.1.1. An "X" indicates that requirement is mandatory.
e. Mandatory IPv6 requirements apply to layer 3 devices only.

4.6.2.Discussion

The contractor shall:

a. List each potential vendor identified above for each technology that will be used in the design.
b. State reasons for selection or non-selection for detailed analysis.
c. State the status and functional capability of each vendor's proposed design to support activation of IPv6 capabilities across the network.

Then score as follows:

1. If vendor provided data: 1
2. If vendor did not provide data: 0

a. Determine the Maximum Score by assuming that a single switch can be rated as meeting all maximum requirements.
b. Determine the score for each closet
c. Sum the scores for each closet to obtain the ITN Score

4.7.STORES MANAGEMENT –NATURE

A professionally managed Stores has a process and a space within, to receive the incoming materials (Receiving Bay), keep them for as long as they are not required for use (Custody) and then to move them out of stores for use (Issue).

In a manufacturing firm this process forms a cycle to maintain and run the activities of Stores.
The basic responsibilities of stores are to act as custodian and controlling agent for parts, supplies, and materials, and to provide service to users of those goods

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 ie. 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. This basic reason has propelled the evolution of philisophies such as JIT, JIT II etc.

Thus , the basic functions , to manage a stores, carried out are:

Receiving of incoming consignments (goods)
Safe keeping of goods (Custody)
Disposal of undesirable goods
Inventory Management
House keeping and record maintenance

It all starts with a suitable Lay out design of stores. Depending upon the nature of items used for processing by the organisation the lay out and type of stores are selected. For example , a process that requires use of raw materials , not costly enough, an open and nearby stores with truck / rail inside movement possibility can be adequate. Similarly, for storing costly material, a closed and restricted type of stores shall be needed.

However, irrespective of the type and lay out , any Stores would have , as its starting activity , receiving and accounting of the incoming goods.

This part of Stores is known as **Receiving Bay.**

Once the material has been received and cleared through inspection and accepted for use, it needs safe custody till it's actually used.

It calls for a separate physical storage space , open or closed, as per need. It maintains all documents that are able to trace an item , show all its details and preserve it up to its shelf life in the manner prescribed or till it is issued for use.

to the user, as and when needed. A stage comes when the material is needed for use. Stores thus releases the material from its custody to the user department and the process is called 'issue of goods. It might also happen that after partial use , some materials having useable value in future are returned to the stores and thus they also become part of the custody again.

In the long drawn process of preserving the materials till its use ,some materials might get obsolete and unserviceable and may require removal from stores , in order to clear space for other incoming goods. This activity is known as **Disposal of goods** for which auction etc is done.

Since the material has a cost , the organisation would definitely like to incur optimum cost on this account and thus there is a need to manage the materials within a stores

such that the total cost of maintaining materials remains optimum.

The materials , lying unused but have future economic value are said to form inventory which needs professional handling. **Inventory control / management** thus is a vitally important aspect of any stores function. One of the basic functions of stores is **to account for every material** received in Stores by maintaining proper records of all the incoming, stored and outgoing materials so that proper accounting and audit trail is maintained.

Hence , record keeping is a vital function of stores . Of course , it also goes along the various activities and with development in the information technology domain, the record keeping in stores too is through electronic medium making the whole process smooth and efficient.

Any Stores as such is a physical entity which deals with material receipt , preservation and issue.**Material handling** therefore is another vital function.

Just as Lay out of a Stores is designed considering the nature of material Stores has to handle, material movement equipment and implements also are important.

4.8.LAYOUT CLASSIFICATION & CODING

Depending upon the nature of business, location of action, raw material, market place etc. Stores' Layout is planned. Hence it is necessary to have a look at different types / classification of Stores:

There are basically two broad classes :

4.8.1.Functional Stores: It depends on the use to which the material is put – chemicals, tools, raw materials stores, etc

4.8.2.Physical Stores: It depends on the size and location – Central stores, Sub-stores, Transit stores, Site stores etc.

Functional Stores can be further classified as:

4.8.3.Raw materials store:

This is where raw materials used in the factory are stored. Usually, this is the largest kind and the location should be such that it is situated alongside a railway, canal or river. Where the deliveries are by road, there must be adequate space for trucks to move, turn and park. If sufficient provision is not made for quick and easy loading or unloading, heavy demurrage can result.

Not all such stores need covered sheds. For example, an engineering company whose raw material is steel will store the steel plates in an open yard. Similarly, a powerhouse using coal or a fertiliser plant using sulphur will store material in the open. A refinery will store its crude-oil in tanks.
In certain cases where the raw materials may be explosive dangerous or poisonous in nature, complete segregation will be necessary.

4.8.4.Production Store:
Production also requires a large number of materials, generally called "consumables", - eye-shields, cutting oils, abrasives, gloves, aprons, jigs, small tools etc. A store stocking such items is called a Production Store.

4.8.5.General Store:

Various kinds of miscellaneous items like paints, brushes, cleaning materials, wood and spirit are kept here. In some cases where there is no Production Store, the materials mentioned in (ii) are kept in the General Store.

4.8.6.Tools Store:

All kinds of tools files, measuring instruments, saws, small tools like hammers, pliers, etc. or sell them as scrap. Steel scrap is usually kept separately, preferably in the open. Some metal scrap like copper can be very costly and should, therefore, be kept safely in covered stores.

4.8.7.Salvage Store:

Here materials rejected on the factory floor are stored either with a view to salvage them or to sell them as scrap. Steel scrap is usually kept separately, preperably in the open. Some metal scrap like copper can be very costly and should, therefore, be kept safely in covered stores.

4.8.8Packing store:

Packing materials are kept here and these include wood for making crates, cardboard cartons or bottles, as in a pharmaceutical company, or empty cylinders.

4.8.9.Spare parts store:

These spares are usually required by Maintenance for repair or overhauling of equipment and machinery in the factory. Such a store can also have spares and components, which have been manufactured in plant or purchased from outside and meant for production. This is also called a finished parts store, semi-finished parts store or component store.

4.8.10.Receipt Store:

This is where goods are received from vendors or those cleared from the railway station, airport or the docks. The materials arriving here have to be retained until they are inspected, finally accepted and sent on to the respective places for storage, or directly to where they will be used.

4.8.11.Quarantine Store:

Here materials received from outside awaiting inspection, and this is usually a part of the receipt store. The term quarantine is used because often inspection may not be completed in a day; e.g., a lab test may be required for specific items. In such cases, these materials are placed in the Quarantine Store.

4.8.12.Finished Goods store:

Finished products of the company meant for despatch to customers or for transfer to another stock point or distribution center are kept here.

4.8.13.Work-in-progress Store:

In many cases a particular shops produce an item in batches, e.g., 1000 units. The other shops might not be able to reach this figure or the actual quantity required might only be 200. Here rest of the 800 units in semi-finished from are kept in the WIP Store for future use. This is neither raw materials nor finished goods. It is in an intermediate state. In some instances the Spare Parts Store can also be a WIP Store.

4.8.14.Stationary store: Keeps office stationary for issued to various departments departments of the company.

4.8.15.Bonded store: This is a store is goods on which customs or excise duty has not been paid

4.8.16.Refrigerated store:

This type of store is used for storage of perishable items like fruit, meat, chemicals, medicine, vegetable, etc. it further comprises:

Chilled space store, where the temperature can be controlled between 32 F and 50 F. Freeze space store, where the temperature can be controlled below 32 F

4.8.17.Flammable materials store:

This is used for the storage of highly combustive material like oil, paints, etc. this store consists of separate compartments partitioned by fire walls, which is done with a view to prevent movement of flames from one area to another in the event of a fire. These fire walls will normally have a four hour fire resistance rating. The main dependence for fire protection is placed on an automatic deluge type sprinkler system connected to an adequate water supply.

4.8.18.Dehumidified store:

It meets the need of materials or equipment to be stored in a moisture-free atmosphere (humidity free condition). When properly sealed and conditioned almost any type of item can be stored here efficiently.

4.8.19.Transit Sheds:

These are normally roofed sheds without any walls and open on four sides and are mainly intended to protect goods from sun and rain. One can find such sheds in ports, adjacent to berthed cargo ships. They are specially adapted for the items are handling of material shipped or received by sea. Here the items are handled and stored in bulk quantities. In certain cases, the Food Corporation of India stores bags of rice or wheat in such open sheds. 'Transit' signifies that storage is temporary and that the goods are to be moved out soon.

4.8.20.Dry Tanks:

Dry tanks are used for long term storage and are constructed entirely with steel, except for a concrete floor. Because of the size and shape of dry tanks, there is no operating aisle for materials handling equipment. There is no direct access into the tanks, which are sealed after materials are stored in them. The dry tanks can be temperature controlled and dehumidified.

4.8.21.Shed storage:

A shed is a roofed structure without complete side and end walls, and is used for the storage of materials that require maximum ventilation or those that do not require protection from weather. This type of building is a compromise between a yardstore and a closed stores building, because it offers more protection to materials than former but less than the latter. If necessary, tarpaulins, can be used on the side for protection during the monsoon. It is built at ground level with a concrete floor.

4.8.22.Open Yard:

This is used for storing bulk items, which do not require specialised storage. Even though there is no protection from sun and rain, the surface of the open yard is normally levelled and is covered by sheets or steel mats.

4.9.INVENTORY – OBJECTIVES

- ✓ INVENTORY MANAGEMENT must tie together the following objectives ,to ensure that there is continuity between functions :

• Company's Strategic Goals.

• Sales Forecasting

• Sales & Operations Planning

• Production & Materials Requirement Planning.

Inventory Management must be designed to meet the dictates of market place and support the company's Strategic Plan . The many changes in the market demand , new opportunities due to worldwide marketing , global sourcing of materials and new

manufacturing technology means many companies need to change their Inventory Management approach and change the process for Inventory Control .

Inventory Management system provides information to efficiently manage the flow of materials , effectively utilize people and equipment , coordinate internal activities and communicate with customers . Inventory Management does not make decisions or manage operations, they provide the information to managers who make more accurate and timely decisions to manage their operations.

INVENTORY is defined as the blocked Working Capital of an organization in the form of materials . As this is the blocked Working Capital of organization, ideally it should be zero. But we are maintaining Inventory . This Inventory is maintained to take care of fluctuations in demand and lead time. In some cases it is maintained to take care of increasing price tendency of commodities or rebate in bulk buying.

Traditional Supply Chain solutions such as Materials Requirement Planning , Inventory Control , typically focuses on implementing more rapid and efficient systems to reduce the cost of communicating information between and across the Inventory links in the SCM.COM focuses in optimizing the total investment of materials cost and workload for every Inventory item throughout the chain from procurement of raw materials to finished goods Inventory . Optimization means providing a balance of supply to meet the demand at a minimum total cost , Inventory level and workload to meet customers service goal for each items in the link of Inventory Chain .

It is strategic in the sense that top management sets goals . These include deployment strategies (Push versus Pull) , control policies , the determination of the optimal levels of order quantities and reorder points and setting safety stock levels . These levels are critical , since they are primary determinants of customer service levels.

Keeping in view all concerns , the latest concept of Vendor Managed Inventory is used to optimize the Inventory . We are entering into Vendor Managed Inventory , Annual Rate Contracts with manufacturers or their authorized dealers , who maintain Inventory on our behalf and supply the items as and when required .

VMI reduces stock-outs and optimize inventory in supply chain . Some features of VMI include :

• Shortening of Supply Chain

• Centralized Forecasting

• Frequent communication of inventory, stock-outs and planned promotions

• Trucks are filled in a prioritized order , e.g. items that are expected to stock out have top priority then items that are furthest below targeted stock levels then advance shipments of promotional items

Despite the many changes that companies go through, the basic principles of Inventory Management and Inventory Control remain the same. Some of the new approaches and techniques are wrapped in new terminology, but the underlying principles for accomplishing good Inventory Management and Inventory activities have not changed.

The Inventory Management system and the Inventory Control Process provides information to efficiently manage the flow of materials, effectively utilize people and equipment, coordinate internal activities, and communicate with customers. Inventory Management and the activities of Inventory Control do not make decisions or manage operations; they provide the information to Managers who make more accurate and timely decisions to manage their operations.

The basic building blocks for the Inventory Management system and Inventory Control activities are:

Sales Forecasting or Demand Management
Sales and Operations Planning
Production Planning
Material Requirements Planning
Inventory Reduction

The emphases on each area will vary depending on the company and how it operates, and what requirements are placed on it due to market demands. Each of the areas above will need to be addressed in some form or another to have a successful program of Inventory Management and Inventory Control.

Inventory is usually a distributor's largest asset. But many distributors aren't satisfied with the contribution inventory makes towards the overall success of their business:

• The wrong quantities of the wrong items are often found on warehouse shelves. Even though there maybe a lot of surplus inventory and dead stock in their warehouse(s), backorders and customer lost sales are common. The material a distributor has committed to stock isn't available when customers request it.
• Computer inventory records are not accurate. Inventory balance information in the distributor's expensive computer system does not accurately reflect what is available for sale in the warehouse.
• The return on investment is not satisfactory. The company's profits, considering its substantial investment in inventory, is far less than what could be earned if the money were invested elsewhere.

The organization set-up of the stores will depend upon the requirements, and have to be tailor-made to meet the specific needs of an enterprise. It may also be stated here that separate buildings are not necessary for these stores. They can all be in one building in the manner described above. The afore mentioned list is by no means complete; one can have an infinite variety. For example, one a military establishment or a very big shipping or Airlines Company can have a large number of sepcialized types of stores.

4.9.1Physical considerations: There can be various types of stores based on the quantity of stocks held or distance from the point of usage, like central stores sub-stores, transit stores, site store etc.

4.9.2Central store:

There can be a central store serving three or four factories or several shops in a large factory or it can be a central warehouse containing finished goods. The word 'central' only denotes that it severs various units each of which may have separate sub-stores or departmental stores. Central stores also exist in multi-plant situations.

One of the problems in having a central store is the handling costs involved in transferring materials to the sub-stores or shop floor. Usually, therefore, the central stores located at the point of greater usage.

One of the main control factors in the establishment of a central store is to ensure that unnecessary inventories are not built up by the sub-stores, or that matter by the sub-stores and the central stores should be considered as one.

4.9.3.Sub-store:
A sub-store is located at the place of usage. It can be even within the shop floor

4.9.4.Departmental Store:

This serves a particular department of a factory. For example, in a textile mill there can be several departments like spinning, weaving, bleaching, printing, etc. each of which can be served by a separate store. The reason behind this is that each requires sparate kinds of materials. This store, then becomes a specialised store. Actually. There need be little difference between this category of store and a sub-store.

4.9.5.Group Stores:

In some companies it can happen that several factories belonging to the same group are all in one compound. For example the J. K. Group of Industries has several factories belonging to the same owner, which have been set up in one big industrial estate. There can be a garment factory, a chemical plant, a radio factory and a foundry all belonging to one group and located at the same place. The group stores can serve all these units.

4.9.6.Site store:

This is usually at a project site containing building or construction materials like cement, steel, tools,etc.
Transit store: as its name implies, this is where goods are stored for a temporary period.

4.9.OVERVIEW OF JIT

The main idea behind the principle of JIT is to exclude the roots of manufacturing waste by getting just the right quantity of raw materials and generating just the right quantity of products in the right place at the right time. In other words JIT is a process aimed at increasing value added and eliminating waste by providing the environment to perfect and simplify the processes.

JIT works as a pull system and applies to generally every level in a multi-level production system. A *pull system* is actually "the subsequent process that pulls its requirements from the preceding processes in question". One useful and effective way to implement this "pull" production is a kanban system [Cralg Felder].

Companies are beginning to turn to internet based technologies to communicate with their sup-pliers, making the JIT ordering and delivering process speedier and more flexible. Although applied mostly to manufacturing, the concepts are not limited to this area of the business. Indeed JIT concepts are always applied to non-manufacturing areas in the same way as in manufacturing areas in the excel-lent company.

The philosophy of JIT is a continuous improvement that puts emphasis on prevention rather than correction, and demands a company wide focus on quality [Matt Schemidt]. It is about developing competence and simplification in the way we do things by squeezing out waste every step of the way. But there are no short cuts to excellence. We can learn from, and so avoid the pitfalls of, companies which have already embarked on the JIT journey. It is not necessary to make the same mistakes[S.M Thacker].

The requirement of JIT is that equipment, resources and labor are made available only in the amount required and at the time required to do the job. It is based on producing only the necessary units in the necessary quantities at the necessary time by bringing production rates exactly in line with mar-ket demand [Marc L. Songini]. In short, JIT means making what the market wants, when it wants it, while using a minimum of facilities, equipment, materials, and human resources.

The relationship of JIT to manufacturing strategy development can be considered in terms of both its impact on customer needs and of matching or improving or competitor activities. Table-8.1 shows how JIT benefits can be used to provide different forms of competitive advantage. For example, an improvement in *flexibility* helps to make the facility more *responsive* to changes to customer de-mand, and shortens lead time.

4.9.1.ADVANTAGES AND DISADVANTAGES OF JIT

Advantages of JIT

Advocates of JIT claim it is a revolutionary concept that all manufacturers will have to adopt in order to remain competitive [Marc L. Songini]. JIT encompasses the successful execution of all production activities required to produce a product, from designing to delivery. Its benefits are many:

1. Shortened lead time.

2. Reduced time spent on non-process work.

3. Eliminate waste and rework and consequently reduce requirements for raw materials, person, power and machine capacity

4. It increases worker motivation and teamwork.

5. Reduced inventory. As a result:

- Frees up working capital for other projects.

- Less space is needed.

- Customer responsiveness increases.

6. Reduce or eliminate setup times

7. Reduce lot sizes (manufacturing and purchase): reducing setup times allows economical pro-duction of smaller lots; close cooperation with suppliers is necessary to achieve reductions in order lot sizes for purchased items, since this will require more frequent deliveries.

8. Problem clarification.

9. Cost savings

(*a*) ***Materials Cost Savings*****:** Materials cost savings is basically the reduction of costs incorpo-rated with purchasing, receiving, inspection, and stockroom costs. Elements in Materials Cost Saving are:

- Reduction of Suppliers

- Long-term Contracts

- Reduce Order Scheduling

- Simplify Receiving Systems

- Eliminate unpacking

- Eliminate Inspection

- Eliminate inventory Stocking

- Eliminate Excess Material.

(*b*) ***Manufacturing Cost Savings*****:** Manufacturing cost savings identifies saving in the engineer-ing, production, and the quality control activities. A major part of manufacturing cost sav-ings is keeping a high level of quality, quality reduces cost and increases revenue.

(*c*) ***Sales Cost Savings*****:** Sales cost saving comes in the form of reducing overlap between the

supplier and the customer, which is inspection and testing. The most effective situation that the sales department can establish is finding customers that also use JIT systems.

- ✓ Total product cycle time drops.
- ✓ Product quality improved.
- ✓ Reduced scrap and rework
- ✓ Smoother production flow
- ✓ Less inventory, of raw materials, work-in-progress and finished goods.
- ✓ Higher productivity
- ✓ Higher worker participation
- ✓ More skilled workforce, able and willing to switch roles
- ✓ Reduced space requirement
- ✓ Improved relationships with suppliers

4.9.2Disadvantages of JIT

There are often a number of barriers that also have to be overcome to achieve the final goal.

- The JIT method demands a much disciplined assembly-line process. The entire factory has to be in sync to successfully exploit its methods. Manufacturers can afford fewer errors in the delivery of the supplier's component; if a part isn't there, the assembly line stops, and that can result in the loss of manpower and cash.
- Changes in production planning, inaccurate forecasting procedures resulting in under or over forecasting of demand, equipment failures creating capacity problems and employee absen-teeism all create problems in implementing JIT.
- JIT requires special training and the reorganization of policies and procedures.
- The organizational cultures vary from firm to firm. There are some cultures that tie to JIT success but it is difficult for an organization to change its cultures within a short time.
- Difference in implementation of JIT. Because JIT was originally established in Japan, the benefits may vary.
- Resistance to change. JIT involves a change throughout the whole organization, but human nature resists changing. The most common resistances are emotional resistance and rational resistance. Emotional resistances are those psychological feeling which hinder performance such as anxiety. Rational resistance is the deficient of the needed information for the workers to perform the job well.

- JIT requires workers to be multi-skilled and flexible to change.

UNIT-V
SCHEDULING & PROJECT MANAGEMENT

5. PROJECT

It is a *temporary* endeavor undertaken to create a *unique product* or service. We call it t*empo-rary* because every project has a definite beginning and a definite end. *Temporary* does not necessarily mean short in duration; many projects last for several years. In every case, however, the duration of a project is finite. Projects are not ongoing efforts. In addition, temporary does not generally apply to the product or service created by the project. Most projects create a lasting result. For example, a project to erect a national monument will create a result expected to last for centuries. *Unique* means that the product or service is different in some distinguishing way from all similar products or services. For example, a Professor may be teaching a subject repeatedly for many semesters but every time the students are different, or he may be using a different style of teaching or examples to explain the subject to the students. That way, every time the Professor is facing a new challenge, and a new project in itself. Some **examples of**

Projects are:

- Developing a new product or service.
- Effecting a change in structure, staffing, or style of an organization.
- Designing a new transport vehicle.
- Developing a new information system.
- Constructing a building or facility.
- Running a campaign for political office.
- Implementing a new business procedure.

Project Management is the application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project.

5.1 SOME TERMS RELATED TO NETWORK PLANNING

Event: An event is a specific instant of time which marks the start and the end of an activity. Event consumes neither time nor resources. It is denoted by a circle or a node and the event number is written within the circle. Example of events: start of examination, end of the game, start of meeting, meeting ended, etc.

Activity: A project consists of different types of tasks or jobs to be performed. These jobs or tasks are called activities. An activity may be a process, a material handling or material procurement

cycle. Examples of activities: Laying the foundation of a building, process of writing examination, arranging for bank loans, etc. An activity is shown by an arrow and it begins and ends with an event. Unlike event, an activity consumes time and resources. An activity is denoted by *a*, *b*, *c*, etc. which is marked below the arrow and estimated time to accomplish the activity is written above the arrow.

Dummy activity: When two activities start at the same instant of time (like activities *b* and *c* in Figure 9.1), the head events are joined by a dotted arrow-known as a dummy activity. A dummy activity does not consume time. It may be critical or non-critical. It becomes a critical activity when its earliest start time (EST) is same as its latest finishing time (LFT).

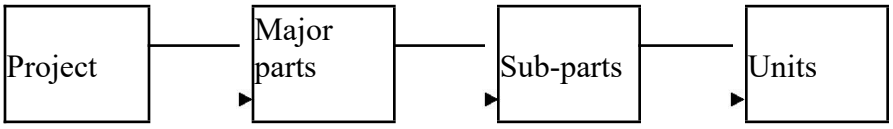
Critical activities: An activity is called critical if its earliest start time plus the time taken by it is equal to the latest finishing time. In a network diagram, critical activities are those which if consume more than their estimated time, the project will be delayed. A critical activity in a network diagram is denoted by a thick arrow to distinguish it from a non-critical activity.

Critical path: Critical path (CP) is formed by critical activities. A CP is the longest path and consumes the maximum time. A CP has zero float. A dummy activity joining two critical activities is also a critical activity. Any amount of delay on CP will delay the entire project by the same amount. So, a CP re.

Subprojects: Projects are frequently divided into more manageable smaller projects which are called subprojects. Subprojects are often contracted out to an external enterprise or to another func-tional unit in the performing organization. Examples of subprojects include:

- A single project phase.
- The installation of plumbing or electrical fixtures on a construction project.
- Automated resting of computer programs.

Work Breakdown Structure (WBS): WBS represents a systematic and logical breakdown of the project into its component parts. It is constructed by dividing the project into major parts, with each of these being further divided into sub-parts. This is continued till a breakdown is done in terms of manageable units of work for which responsibility can be defined.



WBS is a *deliverable* oriented grouping of project elements which organizes and defines the total scope of the project. Each descending level represents an increasingly detailed definition of a project component which may be products or services. WBS helps in:

- Effective planning by dividing the work into manageable elements which can be planned, budgeted, and controlled.

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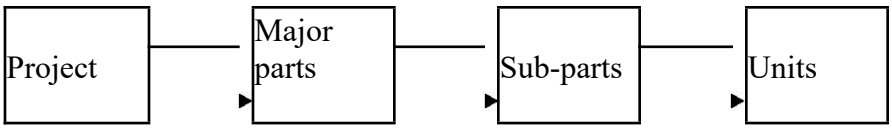

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SCHEDULING TECHNIQUES - CPM AND PERT MODEL

Notations: t_p = pessimistic time
t_o = optimistic time
t_m = most likely time
t_e = expected time of an activity
T_e = expected length of the project
σ_t = standard deviation of time
V_t = variance of time
EST = early start time of an event

LFT = late finish time of an event

t_{ij} = time duration needed to complete the job ij

CPM stands for C*ritical Path Method*. It has mostly been used in deterministic situations like construction projects. For the most part, houses, bridges, and skyscrapers use standard materials whose properties are well known. They employ more or less standard components and stable technology. Changes occur mainly in design, size, shapes, and arrangements of different components- rather than in design concepts. CPM takes just one time into account, and it deals with deterministic situation. It is activity oriented and can be used for both large and small projects. It is widely recognized and is the most versatile and potent management planning technique. CPM is used for planning and controlling the most logical and economic sequence of operations for accomplishing a project.

CPM Technique

CPM follows the following steps for accomplishing a project planning:

- Break down the project into various activities systematically.
- Label all activities.
- Arrange all the activities in logical sequence.
- Construct the arrow diagram.
- Number all the nodes (events) and activities.
- Find the time for each activity.
- Mark the activity times on the arrow diagram.
- Calculate early and late, start and finishing times.
- Tabulate various times and mark EST and LFT on the arrow diagram.
- Calculate the total project duration.
- If it is intended to reduce the total project duration. Crash the critical activities of the net-work.
- Optimize the cost.
- Update the Network.
- Smooth the network resources.

PERT is Program Evaluation and Review Technique. This is mostly used in non-deterministic or probabilistic or stochastic situations such as: space research, R & D projects. These projects (going to Mars, Moon, etc) are relatively new; their technology is rapidly changing, and

their products are nonstandard. There is some standard hardware in ICBMs (Inter-continental Ballistic Missiles) and lunar rockets, but much of their design and construction needs new type of materials and technology, and projects are contracted, planned, and scheduled before all technological problems have been solved.

Thus, there is a large amount of uncertainty in design, construction, and configuration of the new weapons systems and spaceships. There is little past history on which to base network construction and time estimates.

PERT was first used in 1957 for the planning and control of the Polaris Missiles program in US navy with a goal to finish the project two years in advance.

- PERT is commonly used to conduct the initial review of a project .It is very useful device to plan the time and resources.
- PERT is used in activity where timings could not be estimated with enough certainty. It can be employed at those places where a project cannot be easily defined in terms of time or resources required.
- However, events can be readily defined which means it is known that, first, part A will be manufactured, only then subassembly S can be built, and so on.
- PERT offers a lot of advantages for non-repetitive type of projects, R & D, prototype produc-tion, space research, defense projects, etc.
- Because of the uncertainty of activity timings, PERT fits into a probabilistic model. Probabil-ity concept helps in estimating activity timings. The statistical probability feature of PERT foretells the probability of reaching the specified target dates.
- PERT is mainly concerned with events and is thus seen as an event oriented system.

PERT Techniques

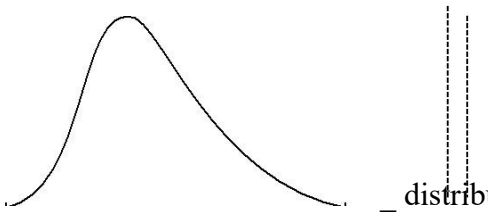
The PERT planning technique consists of the following steps:

- The project is broken down into different activities systematically.
- Activities are arranged in logical sequence.
- The network diagram is drawn. Events and activities are numbered.
- Using three time estimate, the expected time for each activity is calculated.
- Standard deviation and variance for each activity are computed.
- Earliest starting times, and latest finishing times are calculated.

- Expected time, earliest starting time, and latest finishing times are marked on the network diagram.
- Slack is calculated.
- Critical path(s) are identified and marked on the network diagram.
- Length of critical path or total project duration is found out.
- Lastly, the probability that the project will finish at due date is calculated.

5.2.1.TIME ESTIMATES IN PERT

To take care of uncertainty, PERT takes three time estimates into account: *optimistic, most likely, and pessimistic time.* PERT time estimates follow beta distribution.



_ distribution ᵗo ᵗm ᵗe ᵗp

Optimistic time(to): This is the shortest time taken by an activity if everything goes exception-ally well.

Most likely time(tm): It is the time in which the activity is normally expected to complete under normal contingencies.

Pessimistic time (tp): It is the maximum time that would be required to complete the activity if bad luck were encountered at every turn. This does not include catastrophes like earthquakes, floods, fires, etc.

These time estimates are not always easy to prepare, but together they give useful information about the expected uncertainties of an activity. For standard activities, the three time estimates should not vary much from each other. But the greater the uncertainty of an activity, the wider will be the range of the estimated completion times.

PERT calculates the expected value of duration as a weighted average of three time estimates. It assumes that to and tp are equally likely to occur, and tm is four times more likely to occur than the other two. Hence, the expected time

$t_e = (t_o + 4t_m + t_p)/6$

The expected time is the time that we would expect if the activity were repeated a large number of times. But in reality, activities do not get repeated many times; they usually occur just once.

5.3.WORK CENTRES NATURE & IMPORTANCE

Today's corporate organisations have developed a completely new way of doing business that has overturned the rigid, hierarchical and divided system of labour in years past. This new model hinges on projects: distinct activities grouped together with the aim of attaining a specified goal – whether it's a new software package, a marketing strategy or a new brand of toothpaste.

Modern organisations are characterised as dispersed, technology driven, human focused and skill based. Rather than relying on pigeonholed workers to conduct single routine tasks, they rely on teams of connected experts to work together on holistic projects, focusing their energy on one goal at a time.

Projects are completed by teams of people who are specially chosen for their skills, knowledge and potential to contribute to the final result. The team is led by a project manager. He or she is responsible for keeping the project tasks on schedule, communicating with all stakeholders and managing resources – the people, money, tools and time needed to achieve the goal. The project manager is the centre of the project and the driving force behind the team.

The discipline of project management is extremely versatile and can be adapted to any business or industry. Its strength is focused teams of experts who can quickly adapt, organise and troubleshoot, meaning that most problems can be resolved efficiently.

Here are three reasons why project management is important to modern businesses.

5.3.1.Human focused

Today's employees are no longer satisfied with comfortable, rote work for which they need not take any responsibility. In fact, many people are looking for more creative, empowered and hands-on positions where they can make a real impact. Project-based organisations provide this since they focus on goals and outcomes rather than working according to the clock. This makes it a more logical and stimulating structure for skilled people.

In addition, since project management relies so much on good communication, the discipline emphasises the need to focus on the realities of working with people – mistakes and successes, good and bad days, conflicts and so on. Research has proven that the more understanding and flexible an employer is, the more devoted, productive and happy the staff are.

5.3.2.Flexible but structured

Project management perfectly combines the two needs of organisations – first, to be adaptable to changing circumstances, and second, to be structured, predictable and organised. Good project managers spend a lot of time ensuring that everybody knows what their responsibilities are and when requirements are due. They are also masters at adapting these schedules if something goes wrong, or things proceed better than expected.

Project-based organisations can be adapted much more easily than other business structures since whole teams can shift together to accommodate changes.

5.3.3.Efficient

A core project team with an excellent manager can be much more efficient than a whole stable of workers because, as a cohesive and dedicated unit, they can focus all of their energy on the task at hand. Fewer people can accomplish a single project, meaning that human resources are freed up for other work.

One of the essential concepts of project management is balancing the three requirements of cost, time and quality – a project needs to be under budget, delivered by the deadline, and of sufficiently high quality. Often, however, these three factors are in conflict and not all of them can be achieved at once; a project may be running late due to some unavoidable delays, or the quality desired may require more money than was initially budgeted for. A good project manager balances these three factors and produces the most efficient result possible.

On top of that, good planning and organisation can save a lot of mistakes, confusion, backtracking and delays – all of which decrease the efficiency of an organisation. Planning for risks is inextricably linked to project management; the sooner these can be avoided, mitigated or prepared for, the better for the team, project and organisation as a whole.

5..4.PRIORITY RULES & TECHNIQUES

The Project Management Institute defines project management as "the application of knowledge, skills, tools, and techniques to project activities to meet project requirements" (PMBOK Guide, 3rd Edition, Project Management Institute Inc., PN, 2005). To sum up, project management is all about making the project happen. It is a discipline of initiating, planning, executing, and managing resources with the goal of completing specific deliverables within budget and time.

A successful project manager is one who can envision the entire project from start to finish, and have the prowess to realise this vision. To keep pace with business and IT, project managers need to make their management practices more flexible.

5.4.1.Be Agile

Traditional project management methodologies are proving to be too rigid, bureaucratic, and time consuming for today's dynamic business environment. In fact, these methodologies can work against IT departments. Today, you need to respond with agility to rising issues and changes. The formal documentation and processes involved in traditional project management can weigh you down.

5.4.2.Donot Micromanage

The ideal project managers are leaders, not control freaks. Some project managers can be overly analytical and invest too much time in perfecting details, when they should really focus on

achieving milestones and the completion of the project. Flexible project management requires a balance of both the left and right brain, hard and soft skills.

5.4.3.Keep Improving your Project Management Practice

Technology is always evolving to meet the changing needs of users. In the same way, your approach to project management should evolve alongside business and IT processes. Communicate with your team, client, and business partners, as to how you can improve your project management practices.

5.4.4.Ongoing Planning

The single most important activity of project managers is planning. Planning must be detailed, organised, and require team participation. And like the real world, plans always change and reprioritise with situations. For this, plan, re-plan, and plan.

5.4.5Work with a sense of Urgency

Wouldn't it be great to work with an unlimited pool of time, money, and resources? Here on Earth, however, we have fixed 24 hours in a 7-day week, and we have been taught early on of the importance of spending within our means. Because projects are constricted with a set timeline, budget, and resources, it is of utmost importance that the project process is constantly being driven towards completion. Regular updates, meetings, and follow-ups are essential.

5.4.6.Visuvalise and communicate all Project Deliverables and Activities

In short, the project manager and team must have a picture of the finished deliverables in the minds of everyone involved. This guides everyone in the same direction. Avoid vague descriptions at all costs, be specific, draw diagrams and pictures, and make certain everyone agrees with it.

5.4.7.Complete Deliverable step by step

The thought of climbing a mountain in one go can be crippling. But to see it as a succession of steps and peaks is less intimidating and more achievable. In the same way, you don't want to jump in a project with the intent of building all project deliverables at once. Work on each item step-by-step, get process reviews and approvals, and always maintain a sense of direction.

5.4.8.Healthy Risk Management

Assign a risk officer who will be responsible for detecting potential project issues. You want someone who has a healthy dose of skepticism.

- All team members should not hesitate to report concerns or challenges.
- Maintain a live project risk database that tracks all issues and resolutions.
- Do not obsess. Assessing risks should not be your main priority. The last thing you want is to be wasting your time and resources on risk management, as it will prevent you from ever completing a project, let alone give you the courage to start it. Remember, you want a healthy dose of risk management, not a crippling one.

5.4.9Open Commnication

Communication is vital in all aspects of project management. Adhere to a policy of open communication, encouraging all members to voice opinions and concerns. This cuts through waiting games and significantly reduces the risk of mistakes, saving you time and money.

5.4.10.Never Lose sight the 3 factors: Time, Budget and Quality

While project management practices have changed to be more flexible and open, the foundation remains the same. Project success occurs when it is delivered on time, within budget, with a level of deliverables that are satisfactory to the client. The Project Manager's main role is to keep all team members aware of these big 3 - Time, Budget, and Quality.

5.5.SHOP FLOOR CONTROL

Definition

Shop floor control comprises the methods and systems used to prioritize, track, and report against production orders and schedules. It includes the procedures used to evaluate current resource status, labor, machine usage, and other information required to support the overall planning, scheduling, and costing systems related to shop floor operation. Shop floor control typically calculates work in process based on a percentage of completion for each order and operation that is useful in inventory valuations and materials planning.Article

Shop floor control is responsible for the detailed management of activities and the flow of materials inside the plant, including employees, materials, machines, and production time. Shop floor control activity typically begins after planning (e.g., with MRP, ERP); once planned, orders and purchase requisitions are created. Shop floor control attends to the following functions (sequentially):

- Planned orders
- Conversion of planned orders to process/production
- Production and process order scheduling
- Capacity requirements planning
- Material availability assessment
- Release of production/process orders
- Material withdrawals
- Order confirmations
- Goods receipt documentation

- Order settlement

Shop floor control may also include identifying and assessing vulnerabilities and risks due to the shop floor environment, employees, process, and the technologies employed at the shop-floor level. Based on the assessment of these factors, shop floor control initiates measures to keep risk at an acceptable minimum level.

5.5.1.Best practices for shop floor control include:

- Efficiently execute, prioritize, and release work orders to the shop floor with real-time status of progress and completion.
- Deliver accurate and up-to-date information on materials consumption and availability, which is essential for reliable inventory planning and costing.
- Effectively execute change management processes to ensure that the proper revision of products, bills of materials, and processes are always in place for production.
- Automate shop floor equipment control and data collection to reduce human errors and increase productivity.
- Provide the correct manufacturing SOPs, technical drawings, and diagnostics to shop floor operators to reinforce training and ensure proper processing.
- Download setup programs directly to equipment based on product and process specifications.

With fully interactive access to shop floor control software, supervisors can monitor shop activities and make better decisions on the spot, especially using mobile computing equipment.

In summary, shop floor control within a manufacturing execution system (MES) can improve the productivity of any shop, regardless of its manufacturing style or capacity. Assembling, cutting metal, or fabricating all require common functions; shop floor control programs can adapt to the operation. When evaluating the need for shop floor control, remember that the driving force is data. Properly executed, shop floor control should deliver the right information at the right time to the right place—without fail. Consequently, shop floor efficiency and productivity rise appreciably.

5.6.FLOW SHOP SCHEDULING

Please try these problems now before reading any further. It is true that I have given you little or no guidance on how they are to be solved. I have done so for good reason. Scheduling is a subject in which the problems look easy, if not trivial. They are, on the contrary, among the hardest in mathematics. You will not appreciate this without trying some for yourself. Solving them is relatively unimportant; I shall solve them for you shortly anyway. What is important is that you should discover their difficulty.

1. Is the following schedule feasible for Algy and his friends?

	Read By			
Paper	1st	2nd	3rd	4th
F.T.	C	D	B	A
G.	B	C	A	D
D.E.	B	C	A	D
S.	B	A	D	C

5

2. How many different schedules, feasible or infeasible, are there?

3. What is the earliest time that Algy and his friends can leave for the country?

4. Digby decides that the delights of a day in the country are not for him. Instead he will spend the morning in bed. Only when the others have left will he get up and read the papers. What is the earliest time that Algy, Bertie, and Charles may leave?

5. Whether or not you have solved Problems 3 and 4, consider how you would recognize the earliest possible departure time. Need you compare it explicitly with those of all the other feasible schedules, or can you tell without this process of complete enumeration of all the possibilities?

1.3 THE GENERAL JOB·SHOP SCHEDULING PROBLEM

If the theory of scheduling were simply concerned with the efficient reading of newspapers, then, of course, no one would study it. I began with that example so that you might meet and attempt to solve a scheduling problem unhindered by the definitions and notations that are usually required. The time has come to introduce these definitions and that notation. The terminology of scheduling theory arose in the processing and manufacturing industries. Thus we shall be talking about jobs and machines, even though in some cases the objects referred to bear little relation to either jobs or machines. For instance, in the example of the last section we shall see that Algy, Bertie, Charles and Digby are 'jobs', whilst the newspapers are 'machines'. However, that is anticipating. We begin by defining the general job-shop problem. Shortly we shall show that its structure fits many scheduling problems arising in business, computing, government, and the social services as well as those in industry.

We shall suppose that we have *n* jobs {J., J_2, …. J_n} to be processed through m machines {M_1, M_2 ….M_m}. Some authors, particularly those writing on computer scheduling, refer to machines as processors. We shall suppose that each job must pass through each machine once and once only. The processing of a job on a machine is called an operation. We shall denote the operation on the i^{th} job by the j^{th} machine by o_{ij}. Technological constraints demand that each job should be processed through the machines in a particular order. For general job-shop problems there are no restrictions upon the form of the technological constraints. Each job has its own processing order and this may bear no relation to the processing order of any other job. However, an important special case arises when all the jobs share the same processing order. In

such circumstances we say that we have a f1ow shop problem (because the jobs *flow* between the machines in the same order).

5.7.JOHNSON'S ALGORITHM

It is a way to find the shortest paths between all pairs of vertices in a sparse, edge weighted, directed graph. It allows some of the edge weights to be negative numbers, but no negative-weight cycles may exist. It works by using the Bellman–Ford algorithmto compute a transformation of the input graph that removes all negative weights, allowing Dijkstra's algorithm to be used on the transformed graph.[1][2] It is named after Donald B. Johnson, who first published the technique in 1977.[3]

A similar reweighting technique is also used in Suurballe's algorithm for finding two disjoint paths of minimum total length between the same two vertices in a graph with non-negative edge weights

Descriptions

1. First, a new node q is added to the graph, connected by zero-weight edges to each of the other nodes.
2. Second, the Bellman–Ford algorithm is used, starting from the new vertex q, to find for each vertex v the minimum weight $h(v)$ of a path from q to v. If this step detects a negative cycle, the algorithm is terminated.
3. Next the edges of the original graph are reweighted using the values computed by the Bellman–Ford algorithm: an edge from u to v, having length $w(u,v)$, is given the new length $w(u,v) + h(u) − h(v)$.
4. Finally, q is removed, and Dijkstra's algorithm is used to find the shortest paths from each node s to every other vertex in the reweighted graph.

5.8.GANTT CHART

A **Gantt chart** is a type of bar chart, developed by Henry Gantt in the 1910s, that illustrates a project schedule. Gantt charts illustrate the start and finish dates of the terminal elements and summary elements of a project. Terminal elements and summary elements comprise the work breakdown structure of the project. Modern Gantt charts also show the dependency (i.e., precedence network) relationships between activities. Gantt charts can be used to show current schedule status using percent-complete shadings and a vertical "TODAY" line as shown here.

Although now regarded as a common charting technique, Gantt charts were considered revolutionary when first introduced.[1] This chart is also used in information technology to represent data that have been collected.

Advantages

When you set up a Gantt chart, you need to think through all of the tasks involved in your project. As part of this process, you'll work out who will be responsible for each task, how long each task will take, and what problems your team may encounter.

This detailed thinking helps you ensure that the schedule is workable, that the right people are assigned to each task, and that you have workarounds for potential problems before you start.

They also help you work out practical aspects of a project, such as the minimum time it will take to deliver, and which tasks need to be completed before others can start. Plus, you can use them to identify the critical path – the sequence of tasks that must individually be completed on time if the whole project is to deliver on time.

Finally, you can use them to keep your team and your sponsors informed of progress. Simply update the chart to show schedule changes and their implications, or use it to communicate that key tasks have been completed

5.8.1.APPOINTMENT AND SCHEDULING REQUIREMENTS FOR PERSONAL HEALTH SERVICES

In consideration of the patient population needs and to promote efficiency in local health department operations, a patient appointment system is essential. The following are general guidelines regarding patient appointments with specific requirements for the Women, Infants and Children (WIC) program (in accordance with federal regulations and state policy):

5.8.2.All Local Health Department Personal Health Services

Every effort shall be made to provide health services within ten (10) calendar days from a patient's request for an appointment.

5.8.3.Appointments/Scheduling for WIC Applicants

- The time frame for migrants, pregnant women and infants is a maximum of ten (10) calendar days from their request for services.
- The time frame for all other WIC applicants to be served should be ten (10) calendar days from their request, but in no event shall the time frame exceed twenty (20) calendar days. Reference the WIC section of the Administrative Reference for more explanation.
- The name, address, telephone number and date of request for WIC services shall be recorded for all applicants.

5.8..4.Late Arrivals or Missed Appointments for WIC Services

- Pregnant women missing initial WIC certification shall be contacted regarding their appointment.
- Priority shall be given to providing services within the pregnant woman's first trimester.
- WIC patients who are late for their food instrument pick-up appointments shall be served on the day of the appointment.
- Missed appointments for WIC certification shall be rescheduled as soon as possible, but not to exceed thirty (30) calendar days of the missed appointment. Reference the WIC section of the Administrative Reference for more explanation.

5.8.5.Making the Appointment System Functional

- If these appointment/scheduling objectives cannot be met, the health department director shall perform an analysis of the appointment/scheduling process, patient caseload, patient/clinic flow, and staffing complement. Following the analysis, the director shall make any necessary changes to the appointment/scheduling process to ensure the appointment/scheduling objectives are met.

- The Department for Public Health will provide input and guidance, if requested.

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5.9.PERSONAL SCHEDULING IN SERVICES

Public health services benefit the entire population. The local health department (LHD) shall make personal and environmental health services available to all persons within the appropriate guidelines prescribed by the Department for Public Health (DPH). With the exception of communicable diseases and family planning services, priority may be given to residents of the health department's service area. Local health departments do not possess the discretionary authority to exclude aliens (non United States citizens) solely on the basis of their alien status.

Patient Fees

A patient fee may be assessed for personal health services (except WIC and HANDS) if the patient does not have any governmental or private insurance coverage as the primary payor or unless otherwise directed by law or regulation. See 902 KAR 8:170, Section 3 [4] for specific requirements regarding patient fees. Additionally, the initial visit for Fluoride Varnish and Folic Acid Supplementation/Counseling is not charged but subsequent visits may include a patient fee.

There are three methods by which patient fees may be assessed:

1. Applying the Uniform Percentage Payment Schedule with the fee determined by the patient's ability to pay

   Patient fees based on the Uniform Percentage Payment Schedule with the fee determined by a patient's ability to pay begin at 0% for patients with an income below 101% poverty* and ends at 100% pay for patients with an income above 250% poverty. (See the LHD Patient Self-Pay Fee Matrix and the Uniform Percentage Payment Schedule in AR Volume II; Patient Services Reporting and Billing Procedures.)

2. Applying a nominal flat fee up to five (5) dollars

A nominal fee (flat fee) up to five (5) dollars per CPT code is charged for communicable disease services, e.g. primary diagnosis of tuberculosis (TB), sexually transmitted diseases (STD) and the human immunodeficiency virus (HIV) as well as a flat fee for childhood immunizations as specified by the Department for Public Health. 902 KAR 8:170, section 3 (4) (b) 1.

3. Charging a fixed full charge

   A fixed full charge is applied to certain services approved by DPH. (See the LHD Patient Self-Pay Fee Matrix in AR Volume II; Patient Services Reporting And Billing Procedures.)

5.9.1.Inability To Pay Patient Fees

In accordance with 902 KAR 8:170, Section 3 (4) (b) 2 a, inability to pay the assessed patient fee shall not be a barrier to services. Local Health Departments should post signage stating an individual's inability to pay will not prevent the individual from being provided services. This signage should be posted in the lobby and at the registration desk(s).

***** Poverty level as per DHHS Poverty Income Guidelines published annually in the February edition of the Federal Register.

5.9.2.STANDARD PROCEDURES FOR INTERPRETIVE SERVICES

This communication addresses the Standard procedures for interpreters either employed or contracted by local health departments. Review the Personnel Section of the Administrative Reference for additional information concerning Title VI (Civil Rights Act of 1964) and Limited English Proficiency compliance requirements. The Department for Public Health (DPH) and its contracted local health departments must make interpretive services available to all eligible persons benefiting from programs provided through these Agencies and funded by Federal monies. Failure to provide quality interpretive services may prevent eligible persons from receiving benefits to which they are entitled. Quality interpretive services may be assured when standards for performance are established and those performing these services are held accountable to meet these standards.

There are standard procedures for interpretive services that DPH has adopted as best practices, some of which include:

1. Knowledge and understanding of the language needed interpreted.
2. Appreciation of cultural differences and assumptions.
3. Knowledge and understanding of health care terminology and the ability to interpret and give detailed explanation.
4. The ability to translate brief written text such as application forms, signage or medication labels.
5. Knowledge of and adherence to mainstream standards of interpretive practice.

6. The ability to apply the LEP patient's primary language using knowledge of medical terminology and cultural understanding in a cross linguistic interview.

To ensure that services are delivered to patients identified as having limited English proficiency (LEP), DPH and agencies contracting with DPH shall be required to:

1. Post multi-lingual signs in all waiting and intake areas to explain to LEP patients that an interpreter will be provided for them at no cost to them.
2. Use "I speak" cards or the language identification service provided through Language Services Associates at the initial contact to invite people with LEP to identify their primary language.
3. Identify each LEP patient and record the primary language of such patient.
4. Use only interpreters who have been approved by DPH/AFM and ensure that interpreters are provided at no cost to the patients.
5. Ensure that no unreasonable delay in services occurs during the process.
6. Provide translated copies of essential program forms and documents to LEP patients as required by law.
7. Stipulate in service contracts that contractors are responsible for language services needed to service LEP patients.
8. Ensure that staff is trained on cultural competency, effective communication and the use of interpreters/translators.
9. Monitor compliance in each office to ensure that proper procedures are followed.
10. Monitor compliance of contractors to ensure that proper procedures are followed.

5.9.3.Policies And Procedures

The Cabinet for Health and Family Services (CHFS) will publish policy and procedural guidance related to information technology used in the CHFS network environment. Although recommended and encouraged, personal computers not connected to the CHFS network need not comply with state standards for hardware and software. For those PCs that do connect to the CHFS network, state standards and Cabinet policies and procedures must be followed. Health department compliance and assistance is critical to protect patient information and the integrity of the network.

5.9.4.Computer Use/Access

Local Health Departments must have a computer use/access policy and procedure for authorizing access to computer equipment. Each user at a local health department must have an access and security password assigned in order to sign on and use local health department computer equipment. Consult the local personnel office to view a copy of the confidentiality agreement document pertaining to access as an employee. Users are responsible for proper use and access to the equipment, and for helping safeguard the integrity of the network. Security breaches or compromises are to be reported immediately to supervisors. Failure to do so risks inappropriate access to patient health information which is a violation of federal law (Health Insurance Portability and Accountability Act [HIPAA] of 1996). It also creates the risk of improper access or manipulation of accounting and personnel data in the system. Each local health department shall have an Information Technology (IT)

Administrator who manages local access and coordinates support issues with the Cabinet for Health and Family Services.

5.9.5.Support and Maintenance

Personal computers are the property of the local health department unless otherwise provided by an external agency such as WIC. Routine support and maintenance of those personal computers, software and peripherals are the responsibility of each health department. A limited number of federally provided computers and/or printers have been made available for WIC and Environmental use, but with the understanding that care and maintenance will be provided by local health departments. They are also specifically tagged as state property.

Health departments have agreed to abide by state standards for PCs and should check with the Department for Public Health before purchasing new or replacement equipment if the PC will be used on the CHFS Network.

.9.6.DAYS AND HOURS OF OPERATION

The following are exceptions to the hours of operation:

- Inclement weather that causes the local health department to close.
- Staff meeting(s) and/or training session(s) that require attendance of all employees.

All other closures for either a partial day or a longer period of time must have the approval of the Department for Public Health, Division of Administration and Financial Management (AFM). The request for exception must be submitted to the attention of the AFM Division Director and indicate provisions that have been made for services a patient may need during the time of the closure such as WIC, Home Health visits, etc.

Extended Hours

- In order to accommodate the working public, local health departments/boards of health shall assess the feasibility of offering extended hours. Early morning, late afternoon, evening and weekend hours shall be considered in addition to regular working hours. Extended hours shall be a decision of the governing board of health with input from local health department patients and a community assessmentPolicies And Procedures

The Cabinet for Health and Family Services (CHFS) will publish policy and procedural guidance related to information technology used in the CHFS network environment. Although recommended and encouraged, personal computers not connected to the CHFS network need not comply with state standards for hardware and software. For those PCs that do connect to the CHFS network, state standards and Cabinet policies and procedures must be followed. Health department compliance and assistance is critical to protect patient information and the integrity of the network.

5.9.7.Systems Planning

Local health departments have responsibility for local hardware and software. Each LHD is responsible for creating and maintaining a local systems replacement plan and accompanying fiscal plan for life cycle replacement of hardware and software used. Replacement items must meet state

OPERATION MANAGEMENT QUESTION BANK

2 MARKS

UNIT -1

1. What do you mean by production management?
2. What do you mean by production system?
3. Mention the difference types of production system
4. What is job shop production?
5. Define batch production
6. What is meant by mass production?
7. What is meant by continuous production?
8. Mention two advantages of job shop production
9. Mention any two limitations of mass production
10. Mention any two advantages of batch production
11. Mention any two limitations of mass production
12. Mention any two advantages of continuous production
13. Mention any two limitations of continuous production
14. What is production function?
15. List the components of production function
16. Define production management
17. Mention the recent trends in production and operations management?

18. List the role of operation management in strategic management
19. List the factors that are considered for competitive priorities
20. Define vertical integration
21. Assimilate the meaning of control decisions.
22. Define the term production sharing

UNIT -2

1. Define Demand forecast
2. List any two determinants of demand forecast
3. Write the need for demand forecasting
4. Enumerate the demand patterns in forecasting
5. List the qualitative and quantitative methods in demand forecasting
6. What is meant by Regression analysis?
7. What is meant by Tracking Signal?
8. What is meant by correlation?
9. Brief on Delphi method
10. Define capacity planning
11. Mention the factors that affect capacity
12. State the role of long-term capacity planning
13. Distinguish between production capacity and design capacity
14. Mention the need for long-term capacity planning
15. What is meant by capacity cushion?
16. List theobjectives of capacity planning
17. Write the steps in effective capacity planning
18. State the types of capacity planning
19. Define CRP (Capacity Requirement Planning).
20. Expand RCCP
21. Identify the role of aggregate planning
22. Mention the objectives of aggregate planning
23. Sequence the methods of aggregate planning
24. Mention the role of MRP
25. State the inputs of MRP system
26. State the outputs of MRP
27. Outline MRP II
28. Extend the attributes of ERP

UNIT -3

1. State the role of product Design
2. List some factors that influence product design
3. Enumerate the characteristics of product design
4. Discuss process planning
5. Analyze process strategies
6. State the characteristics of service
7. Differentiate the three types of services operation
8. Define Work study
9. Definemethod study
10. Advantages of method study

11. Identify the techniques of work measurement
12. Express the role of productivity?
13. What is meant by SIMO chart
14. Distinguish CAD and CIM
15. Define work study
16. Enumerate the objectives of work study
17. Define method study
18. Discuss time study in product design
19. Enlist the benefits of work study
20. Show the advantages of method study
21. Differentiate the role of motion study
22. Define the techniques of work measurement
23. Define productivity
24. Define product design
25. List the factors influencing product design
26. Mention the characteristics of product design
27. Define process
28. State process planning
29. Differentiate process selection and process strategies
30. List the major process decisions
31. Enumerate the characteristics of services
32. Mentionthe types of service operations

UNIT-4

1. Define material management
2. List the objectives of material management
3. State material planning
4. List the factors influencing material planning
5. Analyze the benefits of material planning
6. Define material budgeting
7. Define MMIS
8. Highlights the role of purchasing
9. List the objectives of purchase management
10. Enumerate the functions of purchasing department
11. What is meant by speculative buying?
12. What is meant by back ordering?
13. Define vendor rating
14. List the vendor rating techniques
15. List the two types of layout of stores
16. Discuss the role of inventory
17. What is meant by carrying cost?
18. Enumerate the costs involved in carrying costs
19. List few inventory control techniques
20. What is meant by Economic order Quantity(EOQ)
21. What is meant by Just In Time?
22. Mention the characteristics of JIT

23. Mention the seven wastes of JIT
24. Define value analysis

UNIT-5

1. Define project planning
2. List the elements of project management
3. Discuss project planning
4. Define project scheduling
5. State project control
6. Specify the various project scheduling techniques
7. What is meant by Gantt chart?
8. Enumerate the role of facility location
9. What is meant by PERT?
10. What is meant by critical path method?
11. Define the role of activity in a critical path
12. What is meant by Float or Slack?
13. What is meant by Independent float?
14. Analyze any two characteristics of networkanalyses
15. Distinguish PERT and CPM
16. Mention the softwares used for project management
17. List the theories of location
18. Mention the objectives of facilities location.
19. Why Facilities Location is important?
20. List the procedure of Location selection
21. Mention the factors of facilities Location
22. Mention the methods of Facilites Location Alternatives
23. Define facility layout
24. State theprinciples of facility layout
25. Mentionthe tools and techniques of facility layout
26. Enumerate the types of facility layout
27. Mention the merits and demerits of Product layout
28. Mention the benfits and costs of process layout.
29. Mention the merits of fixed layout
30. Write a note on cellular manufacturing.
31. List the advantages and disadvantages of Cellular Manufacturing
32. List the factors influencing facility layout
33. Mention Criteria for selection and Design of layout
34. Write down the methods of selecting and design the layout.
35. Mention the softwares of Facilites layout
36. Differentiate ALDEP and CORELAP

16 MARKS

UNIT 1

1. Explain the production system and its importance
2. Discuss the different approaches to analyze the nature of a production system?

3. Explain detail the production function
4. Explain the recent trends in production and operations management
5. Explain role of operations management in strategic management
6. Explain the competitive priories in strategic management
7. Analyses the issues in international operations management
8. Express the influence of an operations strategy product/service plan.
9. Enumerate the five basic elements of operational excellence
10. Brief on the element of competitive priorities

UNIT 2

1.Define the role of demand forecasting
2.Discuss the different methods of Demand forecasting
3.Explain forecasting evaluation and selection method.
4.Explain capacity Planning
5.Explain the activities involved in long range capacity planning decision
6.Briefly Explain RCCP
7.Explain the role of aggregate planning
8.List and illustrate Aggregate planning method in detail
9.Discuss the information flow for planning and control with MRP?
10.Write short notes on a) MRP and MRPII b) ERP c) Bill of material
11."Long range capacity planning is of strategic importance to an organization" justify

UNIT 3

1. Outline the product design process with adequate illustration
2. Jot down the factors influencing product design
3. Analyzeexplicitly the various approaches to product design
4. Elaborate the legal, ethical and environmental issues related to product design
5. Describe the characteristics of product design
6. How do you source ideas for designing a new product or redesigning a product
7. Explain the various process strategies to transform resources into goods and services
8. Discuss scheduling of services in the following service system
1. hospitals 2. Banks 3. Airlines
9. Explain the strategies adopted in scheduling service operation
10. Analyse process charting with reference to the standard symbols used
11. Enumerate the steps In process planning
12. Elaborate the role of the various types of service operations
13. List the methods to improve productivity
14. analyzebriefly the various steps involved in work study
15. Explain exclusively the principles of motion economy for eliminating wastefulness/
16. Describe the product design process
17. Briefly elucidate the factors influencing product design
18. analyze the various approaches to product design

19. A component is to be processed on two machines, lathe and milling machine. The sequence of operating is first turning and then milling. Estimate the number of machines required to machine 2500 components per week if available machine hours per week are 48

UNIT 4

1.Define Materials Management

2. Elucidate explicitly the objectives and importance of material management
3. Analyses in detail material planning
4. Describe the material control process in management
5. Enumerateon material management information system
6. List the objectives and functions of purchase management
7. Describe purchasing policies in detail
8. Briefly illustrate the techniques involved in vendor rating
9. Enumerate value analysis and its process
10. Enumerate on stores management
11. Highlights the principles of good stores layout
12. Discuss inventory costs
13. Describe in detail the various inventory control techniques
14. Enumerate various JIT techniques

UNIT 5

1. Elucidate their role of project management briefly analyze its elements
2. Write downthe various steps involved in drawing up a CPM network
3. Analyze the crashing of a CPM network with an illustrative example
4. Briefly elaborate project scheduling techniques
5. Illustrate in detail the facility location theories
6. Describe the probabilistic activity times and time estimates
7. Elaborate webers theory of industrial location
8. Write in detail the different types of facilities
9. Express the steps in location selection and describe each location model
10. Advocate the various principles of facility layout
11. Explain the factors affecting location Decision.
12. Elaborate the merits and demerits of the types of facility layout
13. What roles does globalization play in the facilities location problem and the give the application areas and inputs of line of balance?
14. There are five existingfacilities which are to be served by a single new facility. The details of the existing facilities are

Existing facility(I)	1	2	3	4	5
Coordinates(a,b)	5,10	20,5	15,20	30,25	25,5
Number of trips of loads/year(Wi)	100	300	200	300	100

Find the optimum location of the new facility based on the gravity location concept .