PRODUCTION AND MATERIALS MANAGEMENT

M-227

Self Learning Material

Directorate of Distance Education

SWAMI VIVEKANAND SUBHARTI UNIVERSITY
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the organization into value added product/services in a controlled manner as per the policies of the organization. Therefore, it is that part of an organization, which is concerned with the transformation of a range of inputs into the required (products/services) having the requisite quality level.

The set of interrelated management activities, which are involved in manufacturing certain products, is called as production management. If the same concept is extended to services management, then the corresponding set of management activities is called as operations management.

1.3 CONCEPT OF PRODUCTION

Production function is that part of an organization, which is concerned with the transformation of a range of inputs into the required outputs (products) having the requisite quality level.

Production is defined as "the step-by-step conversion of one form of material into another form through chemical or mechanical process to create or enhance the utility of the product to the user." Thus production is a value addition process. At each stage of processing, there will be value addition.

Edwood Buffa defines production as 'a process by which goods and services are created'.

Some examples of production are: manufacturing custom-made products like, boilers with a specific capacity, constructing flats, some structural fabrication works for selected customers, etc., and manufacturing standardized products like, car, bus, motor cycle, radio, television, etc.

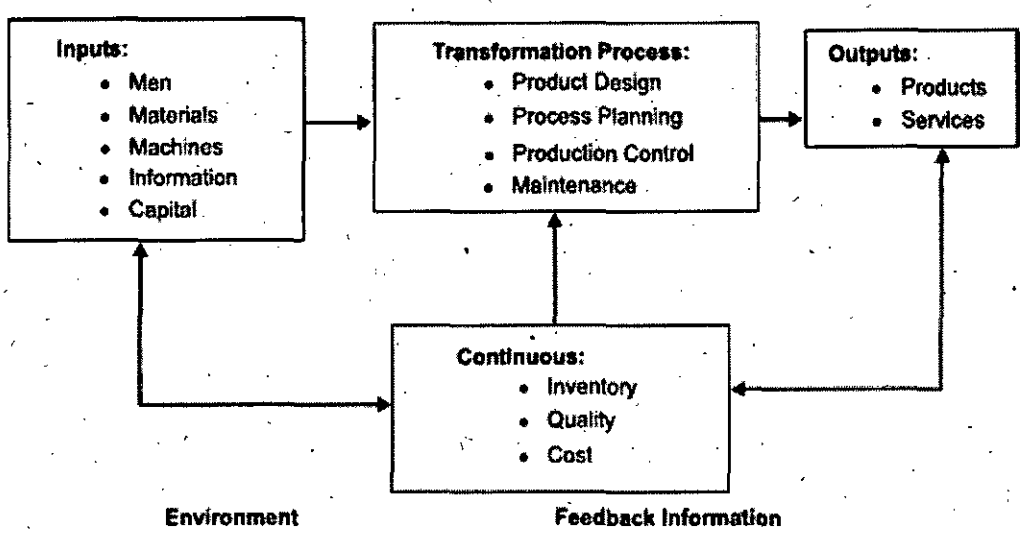

Fig. 1.1 Schematic production system

UNIT – I

PRODUCTION AND OPERATION MANAGEMENT

STRUCTURE

1.1 LEARNING OBJECTIVES

After going through this unit, students will be able to :

- state the fundamental concept of production management;
- explain the historical background of production management;
- discuss various important aspects of production and operation management.

1.2 INTRODUCTION

Production/operations management is the process, which combines and transforms various resources used in the production/operations subsystem of

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1.4 HISTORICAL EVOLUTION OF PRODUCTION AND OPERATIONS MANAGEMENT

For over two centuries operations and production management has been recognised as an important factor in a country's economic growth.

The traditional view of manufacturing management began in eighteenth century when Adam Smith recognised the economic benefits of specialisation of labour. He recommended breaking of jobs down into subtasks and recognises workers to specialised 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. Brief information about the contributions to manufacturing management is shown in the Table 1.1.

Table 1.1 Historical summary of operations management

Date	*Contribution*	*Contributor*
1776	Specialization of labour in manufacturing	Adam Smith
1799	Interchangeable parts, cost accounting	Eli Whitney and 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 and others.
1946	Digital computer	John Mauchlly and J.P. Eckert
1947	Linear programming	G.B. Dantzig, Williams & others
1950	Mathematical programming, on-linear and stochastic processes	A. Charnes, W.W. Cooper & others

1951	Commercial digital computer: large-scale computations available.	Sperry Univac
1960	Organizational behaviour: continued study of people at work	L. Cummings, L. Porter
1970	Integrating operations into overall strategy and policy, Computer applications to manufacturing, Scheduling and control, Material requirement planning (MRP)	W. Skinner J. Orlicky and G. Wright
1980	Quality and productivity applications from Japan: robotics, CAD-CAM	W.E. Deming and J. Juran

Production management becomes the acceptable term from 1930s to 1950s. As F.W. Taylor's works become more widely known, managers developed techniques that focussed 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, more sophisticated analytical approaches.

With the 1970s emerges two distinct changes in our views. 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 our field to service organizations. The second, more suitable change was the beginning of an emphasis on synthesis, rather than just analysis, in management practices.

1.5 PRODUCTION SYSTEM

The production system of an organization is that part, which produces products of an organization. It is that activity whereby resources, flowing within a defined system, are combined and transformed in a controlled manner to add value in accordance with the policies communicated by management. A simplified production system is shown above.

The production system has the following characteristics :

1. Production is an organized activity, so every production system has an objective.
2. The system transforms the various inputs to useful outputs.
3. It does not operate in isolation from the other organization system.
4. There exists a feedback about the activities, which is essential to control and improve system performance.

1. Because of general purpose machines and facilities variety of products can be produced.
2. Operators will become more skilled and competent, as each job gives them learning opportunities.
3. Full potential of operators can be utilised.
4. Opportunity exists for creative methods and innovative ideas.

Limitations

Following are the limitations of job shop production :

1. Higher cost due to frequent set up changes.
2. Higher level of inventory at all levels and hence higher inventory cost.
3. 3Production planning is complicated.
4. Larger space requirements.

Batch Production

Batch production is defined by American Production and Inventory Control Society (APICS)"as a form of manufacturing in which the job passes through the functional departments in lots or batches and each lot may have a different routing." It is characterised by the manufacture of limited number of products produced at regular intervals and stocked awaiting sales.

Characteristics

Batch production system is used under the following circumstances :

1. When there is shorter production runs.
2. When plant and machinery are flexible.
3. When plant and machinery set up is used for the production of item in a batch and change of set up is required for processing the next batch.
4. When manufacturing lead time and cost are lower as compared to job order production.

Advantages

Following are the advantages of batch production :

1. Better utilisation of plant and machinery.
2. Promotes functional specialisation.
3. Cost per unit is lower as compared to job order production.
4. Lower investment in plant and machinery.
5. Flexibility to accommodate and process number of products.
6. Job satisfaction exists for operators.

Limitations

Following are the limitations of batch production :

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

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CLASSIFICATION OF PRODUCTION SYSTEM

Production systems can be classified as Job Shop, Batch, Mass and Continuous Production systems.

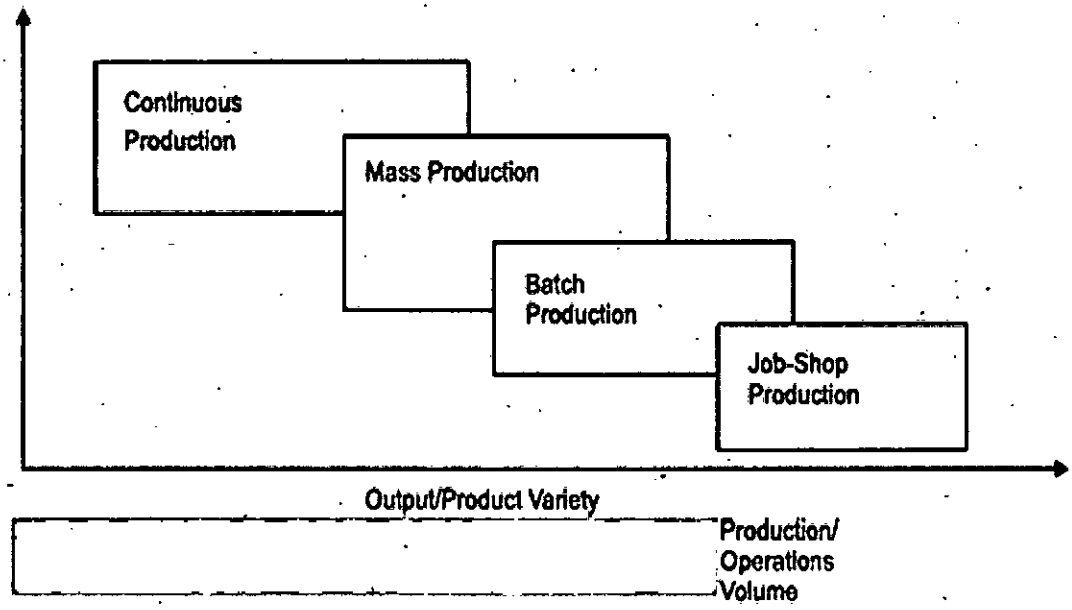

Fig 1.2 Classification of production system

Job Shop Production

Job shop production are characterised by manufacturing of one or few quantity of products designed and produced as per the specification of customers within prefixed time and cost. The distinguishing feature of this is low volume and high variety of products.

A job shop comprises of general purpose machines arranged into different departments. Each job demands unique technological requirements, demands processing on machines in a certain sequence.

Characteristics

The Job-shop production system is followed when there is :

1. High variety of products and low volume.
2. Use of general purpose machines and facilities.
3. Highly skilled operators who can take up each job as a challenge because of uniqueness.
4. Large inventory of materials, tools, parts.
5. Detailed planning is essential for sequencing the requirements of each product, capacities for each work centre and order priorities.

Advantages

Following are the advantages of job shop production :

2. Production planning and control is complex.
3. Work in process inventory is higher compared to continuous production.
4. Higher set up costs due to frequent changes in set up.

Mass Production

Manufacture of discrete parts or assemblies using a continuous process are called mass production. This production system is justified by very large volume of production. The machines are arranged in a line or product layout. Product and process standardisation exists and all outputs follow the same path.

Characteristics

Mass production is used under the following circumstances :

1. Standardisation of product and process sequence.
2. Dedicated special purpose machines having higher production capacities and output rates.
3. Large volume of products.
4. Shorter cycle time of production.
5. Lower in process inventory.
6. Perfectly balanced production lines.
7. Flow of materials, components and parts is continuous and without any back tracking.
8. Production planning and control is easy.
9. Material handling can be completely automatic.

Advantages

Following are the advantages of mass production :

1. Higher rate of production with reduced cycle time.
2. Higher capacity utilisation due to line balancing.
3. Less skilled operators are required.
4. Low process inventory.
5. Manufacturing cost per unit is low.

Limitations

Following are the limitations of mass production :

1. Breakdown of one machine will stop an entire production line.
2. Line layout needs major change with the changes in the product design.
3. High investment in production facilities.
4. The cycle time is determined by the slowest operation.

Contituous Production

Production facilities are arranged as per the sequence of production operations from the first operations to the finished product. The items are made

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to flow through the sequence of operations through material handling devices such as conveyors, transfer devices, etc.

Characteristics

Continuous production is used under the following circumstances :

1. Dedicated plant and equipment with zero flexibility.
2. Material handling is fully automated.
3. Process follows a predetermined sequence of operations.
4. Component materials cannot be readily identified with final product.
5. Planning and scheduling is a routine action.

Advantages

Following are the advantages of continuous production :

1. Standardisation of product and process sequence.
2. Higher rate of production with reduced cycle time.
3. Higher capacity utilisation due to line balancing.
4. Manpower is not required for material handling as it is completely automatic.
5. Person with limited skills can be used on the production line.
6. Unit cost is lower due to high volume of production.

Limitations

Following are the limitations of continuous production :

1. Flexibility to accommodate and process number of products does not exist.
2. Very high investment for setting flow lines.
3. Product differentiation is limited.

1.6 PRODUCTION MANAGEMENT

Production management is a process of planning, organizing, directing and controlling the activities of the production function. It combines and transforms various resources used in the production subsystem of the organization into value added product in a controlled manner as per the policies of the organization.

E.S. Buffa defines production management as, "Production management deals with decision making related to production processes so that the resulting goods or services are produced according to specifications, in the amount and by the schedule demanded and out of minimum cost."

Objectives of Production Management

The objective of the production management is 'to produce goods services of right quality and quantity at the right time and right manufacturing cost'.

1. Right Quality

The quality of product is established based upon the customers needs. The right quality is not necessarily best quality. It is determined by the cost of the product and the technical characteristics as suited to the specific requirements.

2. Right Quantity

The manufacturing organization should produce the products in right number. If they are produced in excess of demand the capital will block up in the form of inventory and if the quantity is produced in short of demand, leads to shortage of products.

3. Right Time

Timeliness of delivery is one of the important parameter to judge the effectiveness of production department. So, the production department has to make the optimal utilization of input resources to achieve its objective.

4. Right Manufacturing Cost

Manufacturing costs are established before the product is actually manufactured. Hence, all attempts should be made to produce the products at pre-established cost, so as to reduce the variation between actual and the standard (pre-established) cost.

1.7 OPERATING SYSTEM

Operating system converts inputs in order to provide outputs which are required by a customer. It converts physical resources into outputs, the function of which is to satisfy customer wants *i.e.*, to provide some utility for the customer. In some of the organization the product is a physical good (hotels) while in others it is a service (hospitals). Bus and taxi services, tailors, hospital and builders are the examples of an operating system.

Everett E. Adam & Ronald J. Ebert define operating system as,"An operating system (function) of an organization is the part of an organization that produces the organization's physical goods and services."

Ray Wild defines operating system as,"An operating system is a configuration of resources combined for the provision of goods or services."

Concept of Operations

An operation is defined in terms of the mission it serves for the organization, technology it employs and the human and managerial processes it involves. Operations in an organization can be categorised into manufacturing operations and service operations. Manufacturing operations is a conversion process that includes manufacturing yields a tangible output: a product, whereas, a conversion process that includes service yields an intangible output: a deed, a performance, an effort.

DISTINCTION BETWEEN MANUFACTURING OPERATIONS AND SERVICE OPERATIONS

Following characteristics can be considered for distinguishing manufacturing operations with service operations :

1. Tangible/Intangible nature of output
2. Consumption of output
3. Nature of work (job)
4. Degree of customer contact
5. Customer participation in conversion
6. Measurement of performance.

Manufacturing is characterised by tangible outputs (products), outputs that customers consume overtime, jobs that use less labour and more equipment, little customer contact, no customer participation in the conversion process (in production), and sophisticated methods for measuring production activities and resource consumption as product are made.

Service is characterised by intangible outputs, outputs that customers consumes immediately, jobs that use more labour and less equipment, direct consumer contact, frequent customer participation in the conversion process, and elementary methods for measuring conversion activities and resource consumption. Some services are equipment based namely rail-road services, telephone services and some are people based namely tax consultant services, hair styling.

1.8 OPERATIONS MANAGEMENT

Managing operations can be enclosed in a frame of general management function as shown in Fig. 1.3. Operation managers are concerned with planning, organizing, and controlling the activities which affect human behaviour through models.

PLANNING

Activities that establishes a course of action and guide future decision-making is planning. The operations manager defines the objectives for the operations subsystem of the organization, and the policies, and procedures for achieving the objectives. This stage includes clarifying the role and focus of operations in the organization's overall strategy. It also involves product planning, facility designing and using the conversion process.

ORGANIZING

Activities that establishes a structure of tasks and authority. Operation managers establish a structure of roles and the flow of information within the

operations subsystem. They determine the activities required to achieve the goals and assign authority and responsibility for carrying them out.

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CONTROLLING

Activities that assure the actual performance in accordance with planned performance. To ensure that the plans for the operations subsystems are accomplished, the operations manager must exercise control by measuring actual outputs and comparing them to planned operations management. Controlling costs, quality, and schedules are the important functions here.

BEHAVIOUR

Operation managers are concerned with how their efforts to plan, organize, and control affect human behaviour. They also want to know how the behaviour of subordinates can affect management's planning, organizing, and controlling actions. Their interest lies in decision-making behaviour.

MODELS

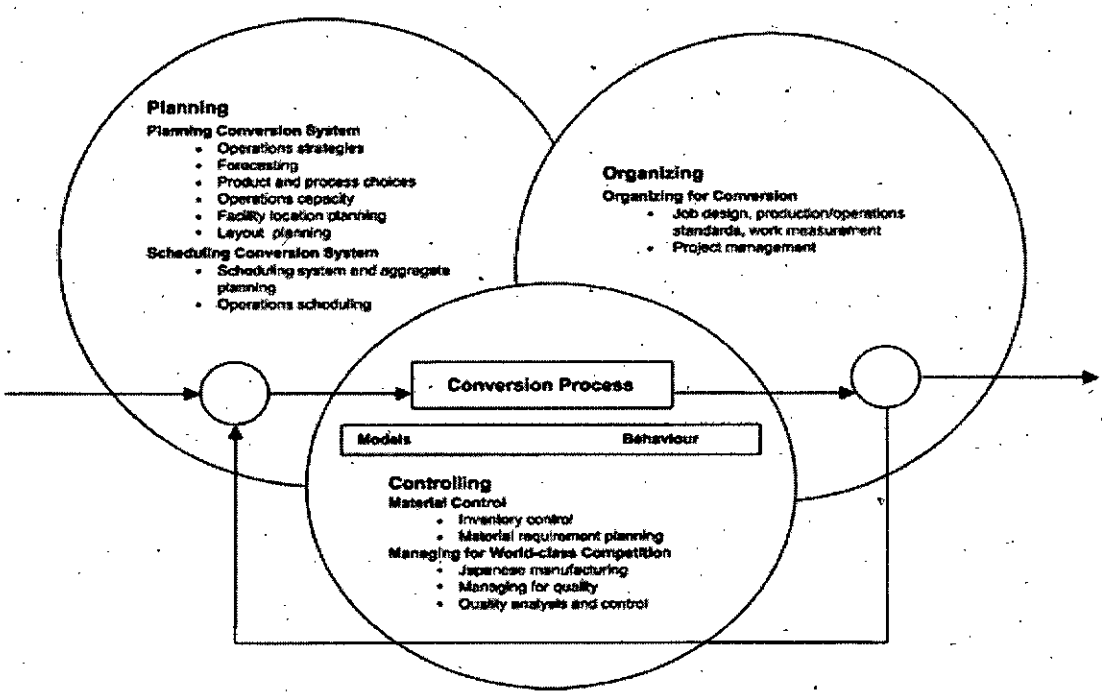

Fig. 1.3 General model for managing operations

As operation managers plan, organise, and control the conversion process, they encounter many problems and must make many decisions. They can simplify their difficulties using models like aggregate planning models for examining how best to use existing capacity in short-term, break even analysis to identify break even volumes, linear programming and computer simulation for capacity

utilisation, decision tree analysis for long-term capacity problem of facility expansion, simple median model for determining best locations of facilities etc.

Objectives of Operations Management

Objectives of operations management can be categorised into customer service and resource utilisation.

Customer Service

The first objective of operating systems is the customer serivce to the satisfaction of customer wants. Therefore, customer service is a key objective of operations management. The operating system must provide something to a specification which can satisfy the customer in terms of cost and timing. Thus, primary objective can be satisfied by providing the'right thing at a right price at the right time'. These aspects of customer service—specification, cost and timing—are described for four functions in Table 1.2. They are the principal sources of customer satisfaction and must, therefore, be the principal dimension of the customer service objective for operations managers.

Table 1.2 Aspects of customer service

Principal function	***Principal customer wants***	
	Primary considerations	*Other considerations*
Manufacture	Goods of a given, requested or acceptable specification	Cost, *i.e.*, purchase price or cost of obtaining goods. Timing, *i.e.*, delivery delay from order or request to receipt of goods.
Transport	Management of a given, requested or acceptable specification	Cost, *i.e.*, cost of movements. Timing, *i.e.*, 1. Duration or time to move. 2. Wait or delay from requesting to its commen-cement.
Supply	Goods of a given, requested or acceptable specification	Cost, *i.e.*, purchase price or cost of obtaining goods. Timing, *i.e.*, delivery delay from order or request to receipt of goods.
Service	Treatment of a given, requested or acceptable specification	Cost, *i.e.*, cost of movements. Timing, *i.e.*, 1. Duration or time required for treatment. 2. Wait or delay from requesting treatment for commencement.

Generally an organization will aim reliably and consistently to achieve certain standards and operations manager will be influential in attempting to achieve these standards. Hence, this objective will influence the operations manager's decisions to achieve the required customer service.

Resource Utilisation

Another major objective of operating systems is to utilise resources for the satisfaction of customer wants effectively, *i.e.,* customer service must be provided with the achievement of effective operations through efficient use of resources. Inefficient use of resources or inadequate customer service leads to commercial failure of an operating system.

Operations management is concerned essentially with the utilisation of resources, *i.e.,* obtaining maximum effect from resources or minimising their loss, under utilisation or waste. The extent of the utilisation of the resources' potential might be expressed in terms of the proportion of available time used or occupied, space utilisation, levels of activity, etc. Each measure indicates the extent to which the potential or capacity of such resources is utilised. This is referred as the objective of resource utilisation.

Operations management is also concerned with the achievement of both satisfactory customer service and resource utilisation. An improvement in one will often give rise to deterioration in the other. Often both cannot be maximised, and hence a satisfactory performance must be achieved on both objectives. All the activities of operations management must be tackled with these two objectives in mind, and many of the problems will be faced by operations managers because of this conflict. Hence, operations managers must attempt to balance these basic objectives.

Table 1.3 The twin objectives of operations management

The customer service objective. To provide agreed/adequate levels of customer service (and hence customer satisfaction) by providing goods or services with the right specification, at the right cost and at the right time.	***The resource utilisation objective.*** To achieve adequate levels of resource utilisation (or productivity) *e.g.,* to achieve agreed levels of utilisation of materials, machines and labour.

Table 1.3 summarises the twin objectives of operations management. The type of balance established both between and within these basic objectives will be influenced by market considerations, competitions, the strengths and weaknesses of the organization, etc. Hence, the operations managers should make a contribution when these objectives are set.

1.9 MANAGING GLOBAL OPERATIONS

The term'globalization' describes businesses' deployment of facilities and operations around the world. Globalization can be defined as a process in which geographic distance becomes a factor of diminishing importance in the establishment and maintenance of cross border economic, political and socio-cultural relations. It can also be defined as worldwide drive toward a globalized economic system dominated by supranational corporate trade and banking institutions that are not accountable to democratic processes or national governments.

There are four developments, which have spurred the trend toward globalization. These are :

1. Improved transportation and communication technologies;
2. Opened financial systems;
3. Increased demand for imports; and
4. Reduced import quotas and other trade barriers.

When a firm sets up facilities abroad it involve some added complexities in its operation. Global markets impose new standards on quality and time. Managers should not think about domestic markets first and then global markets later, rather it could be think globally and act locally. Also, they must have a good understanding of their competitors.

Some other important challenges of managing multinational operations include other languages and customs, different management style, unfamiliar laws and regulations, and different costs.

Managing global operations would focus on the following key issues :

- To acquire and properly utilize the following concepts and those related to global operations, supply chain, logistics, etc.
- To associate global historical events to key drivers in global operations from different perspectives.
- To develop criteria for conceptualization and evaluation of different global operations.
- To associate success and failure cases of global operations to political, social, economical and technological environments.
- To envision trends in global operations.
- To develop an understanding of the world vision regardless of their country of origin, residence or studies in a respectful way of perspectives of people from different races, studies, preferences, religion, politic affiliation, place of origin, etc.

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1.10 SCOPE OF PRODUCTION AND OPERATIONS MANAGEMENT

Production and operations management concern with the conversion of inputs into outputs, using physical resources, so as to provide the desired utilities to the customer while meeting the other organizational objectives of effectiveness, efficiency and adoptability. It distinguishes itself from other functions such as personnel, marketing, finance, etc., by its primary concern for 'conversion by using physical resources.'

Following are the activities which are listed under production and operations management functions :

1. Location of facilities
2. Plant layouts and material handling
3. Product design
4. Process design
5. Production and planning control
6. Quality control
7. Materials management
8. Maintenance management.

Location of Facilities

Location of facilities for operations is a long-term capacity decision which involves a long term commitment about the geographically static factors that affect a business organization. It is an important strategic level decision-making for an organization. It deals with the questions such as 'where our main operations should be based?'

The selection of location is a key-decision as large investment is made in building plant and machinery. An improper location of plant may lead to waste of all the investments made in plant and machinery equipments. Hence, location of plant should be based on the company's expansion plan and policy, diversification plan for the products, changing sources of raw materials and many other factors. The purpose of the location study is to find the optimal location that will results in the greatest advantage to the organization.

Plant Layout and Material Handling

Plant layout refers to the physical arrangement of facilities. It is the configuration of departments, work centres and equipment in the conversion process. The overall objective of the plant layout is to design a physical arrangement that meets the required output quality and quantity most economically.

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

'Material Handling' refers to the 'moving of materials from the store room to the machine and from one machine to the next during the process of manufacture'. It is also defined as the 'art and science of moving, packing and storing of products in any form'. It is a specialised activity for a modern manufacturing concern, with 50 to 75% of the cost of production. This cost can be reduced by proper section, operation and maintenance of material handling devices. Material handling devices increases the output, improves quality, speeds up the deliveries and decreases the cost of production. Hence, material handling is a prime consideration in the designing new plant and several existing plants.

Product Design

Product design deals with conversion of ideas into reality. Every business organization have to design, develop and introduce new products as a survival and growth strategy. Developing the new products and launching them in the market is the biggest challenge faced by the organizations. The entire process of need identification to physical manufactures of product involves three functions: marketing, product development, manufacturing. Product development translates the needs of customers given by marketing into technical specifications and designing the various features into the product to these specifications. Manufacturing has the responsibility of selecting the processes by which the product can be manufactured. Product design and development provides link between marketing, customer needs and expectations and the activities required to manufacture the product.

Process Design

Process design is a macroscopic decision-making of an overall process route for converting the raw material into finished goods. These decisions encompass the selection of a process, choice of technology, process flow analysis and layout of the facilities. Hence, the important decisions in process design are to analyse the workflow for converting raw material into finished product and to select the workstation for each included in the workflow.

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 includes planning, routing, scheduling, dispatching and follow-up.

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

Routing may be defined as the selection of path which each part of the product will follow, which being transformed from raw material to finished products. Routing determines the most advantageous path to be followed from department to department and machine to machine till raw material gets its final shape.

Scheduling determines the 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.

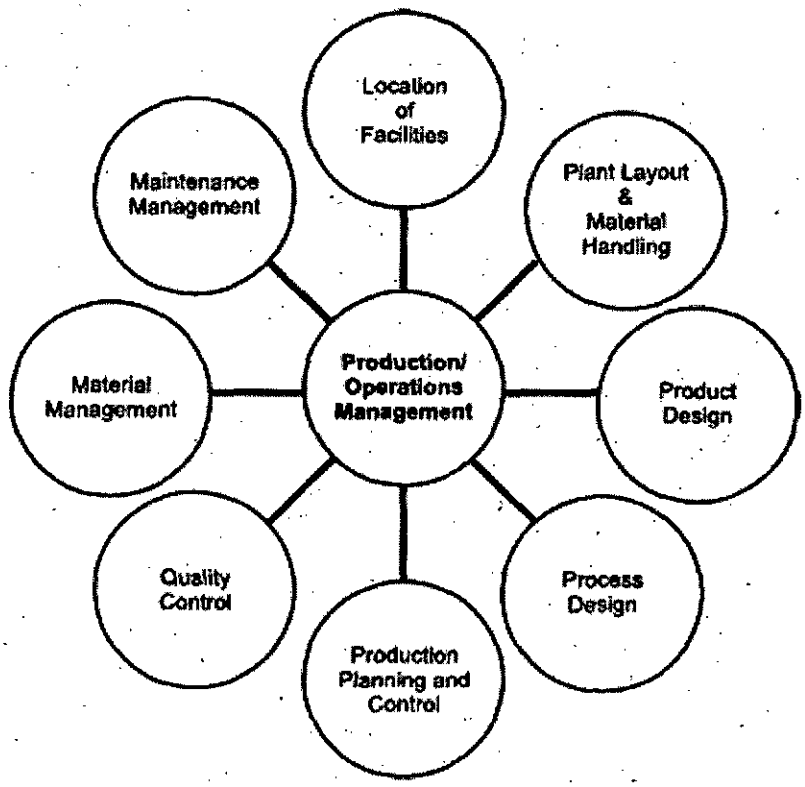

Fig. 1.4 Scope of production and operations management

Dispatching is concerned with the starting the processes. It gives necessary authority so as to start a particular work, which has already been planned under'Routing' and'Scheduling'. Therefore, dispatching is'release of orders and instruction for the starting of production for any item in acceptance with the route sheet and schedule charts'.

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

Quality Control

Quality Control (QC) 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 feed back system and corrective action procedure.

Quality control can also be defined as'that industrial management technique by means of which 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 improve the companies income by making the production more acceptable to the customers *i.e.*, by providing long life, greater usefulness, maintainability, etc.
- To reduce companies cost through reduction of losses due to defects.
- To achieve interchangeability of manufacture in large scale production.
- To produce optimal quality at reduced price.
- To ensure satisfaction of customers with productions or services or high quality level, to build customer goodwill, confidence and reputation of manufacturer.
- To make inspection prompt to ensure quality control.
- To check the variation during manufacturing.

Material Management

Materials management is that aspect of management function which is primarily concerned with the acquisition, control and use of materials needed and flow of goods and services connected with the production process having some predetermined objectives in view.

The main objectives of materials management are :

- To minimise material cost.
- To purchase, receive, transport and store materials efficiently and to reduce the related cost.
- To cut down costs through simplification, standardisation, value analysis, import substitution, etc.
- To trace new sources of supply and to develop cordial relations with them in order to ensure continuous supply at reasonable rates.

- To reduce investment tied in the inventories for use in other productive purposes and to develop high inventory turnover ratios.

Maintenance Management

In modern industry, equipment and machinery are a very important part of the total productive effort. Therefore, their idleness or downtime becomes are very expensive. Hence, it is very important that the plant machinery should be properly maintained.

The main objectives of maintenance management are :

1. To achieve minimum breakdown and to keep the plant in good working condition at the lowest possible cost.
2. To keep the machines and other facilities in such a condition that permits them to be used at their optimal capacity without interruption.
3. To ensure the availability of the machines, buildings and services required by other sections of the factory for the performance of their functions at optimal return on investment.

1.11 FACILITIES LOCATION

Every organisation has to face location problem one or the other day . Before finding out those reasons for location decision and the factors affecting thereof one would like to know the following :

Factors Affecting Size of the Firm

1. ***Availability of capital :*** the size of the firm depends upon the availability of capital.
2. ***Entrepreneurial ability and efficiency*** : the ability, experiences and managerial efficiency of the entrepreneur is one of the important factors that determine the size of the business unit.
3. ***Risk of uncertainties :*** firms have to face fluctuations in demand for their products and accordingly adjust their policies and strategies in order to survive and maintain the positioning in the market.

Type of Organization

The size of the firm also depends on the type of organization, e.g., sole trading business concern or individual proprietorship, partnership firm, private companies that are managing business on small and medium scale. Joint Stock Companies require capital on large scale.

Availability of inputs : The size can be larger if the inputs are available on a large scale. Where the inputs will have to be transported from a distance and there is also some uncertainty, the size is bound to be small.

Nature of product : In the case of processing of raw materials resulting in the production of joint and by products, the scale is naturally more if the entrepreneur decides to process all the products. In case of production of less standardized and more artistic products the size is bound to be small.

Laws of returns : But where increasing returns apply, large production will result in lower cost, so that the firms can keep on growing larger in size provided the demand for the product is elastic.

Government regulation or licensing policy of government : The size of the firm depends on the decision taken by the entrepreneur and on the attitude of the government.

Factors Affecting the Plant Location

Factors of Localisation

(a)Primary Factors

1. *Supply of raw material :* It is necessary to consider the adequate supply of raw materials and the nature of raw materials. The cost of raw materials is an important element of the total cost of production.
2. *Nearness to market :* Nearness to market is important from the point of view of control over the market. In those industries where the raw materials are obtained from different source, nearness to source of raw materials is not as important as nearness to the market.
3. *Transport Facilities :* Speedy transport facilities are needed for the regular and timely supply of raw materials at low.
4. *Supply of labour :* The supply of labour at low cost is important. It should also be regular. Nearness to source of labour supply is very important. Therefore, producers should have regular labour supply by reducing absenteeism and strikes due to unsatisfactory working conditions.
5. *Power :* Power may be electrical, diesel and atomic energy. All types of power required must be in abundance in order to ensure smooth flow of production.
6. *Supply of capital :* Industries require huge capital hence capital market must be developed at industrial centres. Not only this, industrial development banks and other financial services must also be encouraged.

(b)Secondary Factors

1. *Natural factors :* Affect the location of those industries which require a particular climate or weather conditions.
2. *Political factors :* States with stable government attract more industries.
3. *Government Subsidies and Facilities :* Government gives subsidies and good

industrial development facilities in backward areas. Industries reach these places to reap the benefits of such facilities.

4. *Historical and Religious Factors :* some places have industrial importance and some have religious importance *e.g.,* Kohlapur, Benaras, Agra, Nasik etc. Industries grow because of these important features.
5. *Initial Start and Goodwill :* Once one industry starts at a certain place other industries come their *e.g.,* Jamshedpur became an industrial town in the following manner.
6. *Personal Factor :* Personal likeness for a place affects the establishment of business at a place .
7. *Miscellaneous factors :*

   (a) sufficient water supply

   (b) Disposal of waste

   (c) Dangers of air-attacks

   (d) Community attitude

   (e) Ecological and environment considerations etc.

Selection Of Site (Urban, Rural Or Suburban Area)

There are broadly three possible alternatives open for the selection of the locality of the industrial unit :

1. urban or city area
2. rural area
3. suburban area

The relative advantages and disadvantages of each area are discussed as under :

Urban Area

Due to certain typical advantages available only in the city area, promoters show preference for the city area as the location of the industrial unit.

Advantages of City Area

1. Availability of good transportation facilities
2. Good and prompt postal and communication services
3. Banking and credit facilities.
4. Services of insurance companies.
5. Sufficient storing facilities.
6. Ample availability of skilled and unskilled workers.
7. Vicinity of the market.
8. Facility of the ancillary and service units.

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9. Transport facilities by road and railways.
10. Development of the training institutes.
11. Educational, medical and recreational institutes increase the amenities of lives.

Disadvantages of Urban or City Area

1. The cost of land is very high.
2. Sufficient land is not available.
3. The cost of labour is relatively high.
4. The rate of labour turnover is very high.
5. Trade union movement is very strong.
6. The rates of taxes are also relatively high.
7. The industrialization in the city area gives birth to slums and dirty residences which creates the typical problems of sanitation and health.

Rural Area

The following are its advantages and limitations.

Advantages of Rural Area

1. The land is available at cheaper rates.
2. Large plots of the land available.
3. The rates of labour are relatively lower.
4. The rate of labour turnover is low.
5. The industrial relations between labour and management are relatively amicable.
6. The municipal restrictions, which are found in city areas, do not exist in rural areas, *e.g.*, height of building, constructed area in total land etc.
7. Slums and dirty residence are not found in rural areas.
8. No danger of bombardment in wartime.

Limitations of Rural Area

1. Transportation facilities are not available
2. Sometimes the services of post and telegraph and means of communication are not available
3. Banking and credit facilities are also not available
4. Absence of insurance facilities
5. Storing and warehouse facilities
6. Passenger facilities are not available
7. The advantage of ancillary units and service unit is not available
8. Such units are very far from the market place and this increases the cost of distribution of finished goods

9. Skilled workers are not available
10. Municipal facilities like water supply, drainage, fire fighting are not available in rural areas
11. There is absence of recreation facilities, good educational institutes, good and sufficient medical facilities etc.

Suburban Area

The city area as a location of industrial unit has got many negative aspects. The other extreme is a rural area, which again is not free from many limitations. The better compromise in the decision is in the selection of suburban area as the location of the industrial unit. Suburban area is the area located on the outskirts of the city area. Suburban area matches the advantages of the rural area with those of city area which is located at a short distance, *e.g.*, Odhav, narol, kathawada, naroda, and vatva are the suburban areas of the ahmedabad city.

Advantages of Suburban Area

1. Land is available at a cheaper rate
2. Adequate land is available
3. Infrastructure facilities like road, water supply, drainage etc.
4. Skilled and unskilled both type of labourers are available
5. It is possible to tap the advantage of industrial training institutes, management development programmes etc, which are available in nearby city area
6. The nearby city area provides a substantial market for the products of the unit
7. Educational institutes, medical facilities and other recreational facilities are available in the suburban area itself as well as in the nearby city area

The limitation of suburban area as a site for industry is that in the development process, it may be converted into a part of the urban area with all its merits and demerits.

Recent Trends in the Location of Industries

The traditional factors like nearness of sources of materials, motive power, nearness of markets, labour supply etc. have no longer remained the effective pulling forces for location of industries. The location trends have changed substantially due to the development of substitute raw materials, network of electrification and transportation by roads and railway, mobility of the labour and persuasive and compulsive policies of the government for balanced regional development.

The recent trends in the selection of industrial locations can be described as under.

1. ***Priority for the sub urban areas :*** the industrialist shows their preference of the sub urban area as the sight for establishment of a new unit or relocation of the existing one. The industrial policy of the government does not permit the establishment of a new unit or expansion of an existing one in city areas.
2. ***Industrial development in the notified backward areas :*** in order to have balanced regional development, the central government as well as the state government has notified certain backward areas; example punch mahals, bharuch and sunder nagar are the centrally notified backward district of gujarat state. Similarly, gujarat state government has also notified certain backward talukas. Different types of incentives like cash subsidy, tax relieves, concessional financial assistance, cheaper land and power supply etc. are provided. So, many such areas have been developed substantially in recent times. An illustration can be cited for the industrial development of dhabol in punch mahals, ankleshwar in bharuch and sunder nagar.
3. ***Establishment of industrial estate :*** industrial estate is a piece of vast land divided into different plots wherein factory shades are constructed. The government of India has planned a national policy for the development of industrial estate. It has assigned a responsibility of the development of the industrial estate to state governments. In each state, the state development corporation (sdc) has developed many industrial estates practically in all the districts of the state. Industrial estates have also been developed by private entrepreneurs and chambers of commerce. The plots of land along with factory shades and infrastructure facilities are developed in the industrial estates and are sold to the prospective promoters. The establishment of industrial states has greatly affected the location of industry.
4. ***Decentralization of industries :*** under the conscious industrial policy of the government, concentration of industrial units is prevented through licensing policy. New units are not permitted to be started and certain industrially congested areas. Similarly, existing units are established in additional plants in a less developed areas or sometimes relocate the whole unit in such areas.
5. ***Increased role of the govt in the decision of location of industries :*** government through persuasive and compulsive methods greatly affects the location decisions in recent times. It provides certain attractive incentives to the promoters to establish their units in less developed areas, at the same time it does not permit excessive industrialization in certain developed areas.
6. ***Competition between government and institutions :*** as industry provides

job opportunities to the local population, many local organizations attempt to tempt the prospective promoters to establish the units in their areas. They provide different types of incentives like cheap land, relief in local taxes etc. Sometimes the objective of local organizations and the government comes in conflict on the issue of the location of the industries. Thus, the whole pattern of decision about the location of industries has undergone substantial changes in recent times.

1.12 PLANT LAYOUT

Plant layout means the disposition of the various facilities (equipments, material, manpower etc.) within the areas of the site selected. Plant layout begins with the design of the factory building and goes up to the location and movement of work. All the facilities like equipment, raw material, machinery, tools, fixtures, workers etc. are given a proper place. In the words of James Lundy, "It identically involves the allocation of space and the arrangement of equipment in such a manner that overall cost are minimized". According to MoNaughton Waynel, "A good layout results in comforts, convenience, appearance, safety and profit. A poor layout results in congestion, waste, frustration and inefficiency".

Plant layout is very complex in nature as it involves concept relating to such fields as engineering, architecture, economics and business administration. Hence a plant layout, with proper design, encompasses all production and service facilities and provides for the most effective utilization of men, with materials and machines constituting the process, is a master blue print for coordinating all operations.

Objectives of a Good Plant Layout

The principal objective of a proper plant layout is to maximize the production at the minimum of the costs. This objective should be kept in mind while designing a layout for a new plant as well as while making the necessary changes in the exiting layout in response to change in management polices and processes and techniques of production with the production system, i.e. workers, supervisors and managers.

If a layout is to fulfill this goal, it should be planned with the following clear objectives in mind.

(1) There is the proper utilization of cubic (*i.e.*, length, width and height). Maximum use of volume available should be made. For example, conveyors can be run above head height and used as moving work in progress or tools and equipments can be suspended from the ceiling. The principle is particularly true in stores where goods can be stored at considerable height without inconvenience.

(2) Waiting time of the semi-finished products is minimized.

(3) Working conditions are safer, better (well ventilated rooms etc.) and improved

(4) Material handling and transportation is minimized and efficiently controlled. For this, one has to consider the movement distances between different work areas as well as the number of times such movements occur per unit period of time.

(5) The movements made by the worker are minimized.

(6) Suitable spaces are allocated to production centers.

(7) Plant maintenance is simpler.

(8) There is increased flexibility for changes in product design and for future expansion. It must be capable of incorporating, without major changes, new equipment to meet technological requirement or to eliminate waste.

(9) A good layout permits material to move through the plant at the desired speed with the lowest cost.

(10) There is increased productivity and better product quality with reduced capital cost.

(11) Boosting up employee morale by providing employee comforts and satisfaction.

(12) The work should be so arranged the there is no difficulty in supervision, coordination and control. There should be no 'hiding-places' into which goods can be mislaid. Goods – raw materials and ready stocks – must be readily observed at all times. It will reduce the pilferage of material and labour.

It should be noted here that the above stated objectives of plant layout are laudable in themselves; it is often difficult to reconcile all of them in a practical situation. And as such, the highest level of skill and judgment are required to be exercised. For this, close association between the entrepreneurs and experienced engineers is a must.

Types of Plant Layout

There are three basic types of plant layout :

(1) Functional or process layout,

(2) Product or line layout,

(3) Stationary layout. However the choice of one or the other type of layout depends upon the machine and techniques used in the production.

(a) Process Layout: It is also known as functional layout and is characterized by keeping similar machines or similar operation at one location (place). In other words, separate departments are established for each specialized operation of production and machines relating to that functions are assembled there. For

example, all lathe machines will be at one place, all milling machines at another and so on. This type of layout is generally employed for industries engaged in job-order production and non-standardized products. The process layout may be illustrated in the table given below.

(b)

Receiving Lathe Deptt	Milling Deptt	Surface	Shipping Packaging
		Finishing	
		Assembling	Inspection

Advantages

(1) Wide flexibility exits as regards allotment of work to equipments and workers. The production capacity is not arranged in rigid sequence and fixed rate capacity with line balancing. Alteration or change in sequence of operation can easily be made as and when required without upsetting the existing plant layout plan.

(2) Better quality product, because the supervisors and workers attend to one type of machine and operations.

(3) Variety of jobs, coming as different job orders make the work more interesting for workers.

(4) Workers in one section are not affected by the nature of operations carried out in another section. *e.g.*, the rays of welding do not affect a lathe operator, as the two sections are quite separate.

(5) Like product layout, the breakdown of one machine does not interrupt the entire production flow.

(6) This type of layout requires lesser financial investment in machines and equipments because general-purpose machine, which are usually of low cost, are used and duplication of machine is avoided. Moreover, general-purpose machine do not depreciate or become obsolete as rapidly as specialized machines. It results in lower investment in machines.

(7) Under process layout, better and efficient supervision is possible because of specialization in operation.

Disadvantages

(1) Automatic material handling is extremely difficult because fixed material handling equipment like conveyor belt is not possible to use.

(2) Completion of same product takes more time.

(3) Raw material has to travel larger distances for getting processed to finished food. This increases material handling and the associated costs.

(4) It is not possible to implement the group incentive schemes on the basic of quantity of the product manufactured.

(5) This type of layout requires more floor space than the product layout because a distinct department established for each operation.

(6) Compared to line layout inventory investment are usually higher in case of process layout. It increases the need of working capital in the form of inventory.

(7) Under process layout, cost of supervision is high because *(i)* the number of employees per supervisor is less that result in reduced supervisory span of control, and *(ii)* the work is checked after each operation.

(c) Product Layout: It is also known as line (type) layout. It implies that various operations on a product are performed in a sequence and the machine are placed along the product flow line *i.e.,* machines are arranged in the sequence in which a given product will be operated upon. This type of layout is preferred for continuous production i.e. involving a continuous flow in- process material towards the finished product stage.

Advantages

(i) Automatic material handling, lesser material handling movement, times and cost.

(ii) Product completes in lesser time. Since material is fed at one end of the layout and finished product is collected at the other end, there is no transportation of raw material backward and forward. It shortens the manufacturing time because it does not require any time-consuming interval transportation till the completion of the process of production. Line balancing may eliminate idle capacity.

(iii) Smooth and continuous flow of work- This plant ensures steady flow of production with economy because bottlenecks or stoppage of work at different point of production is got eliminated or avoided due to proper arrangement of machine in sequence.

(iv) Less in-process inventory- The semi-finished product or work-in-progress is the minimum and negligible under this type of layout because the process of production is direct and uninterrupted.

(v) Effective quality control with reduced inspection points -It does not require frequent changes in the machine set-up. Since production process is integrated and continuous, defective parts can easily be discovered and segregated. This makes inspection easy and economical.

(vi) Maximum use of space due to straight production flows and reduced need of interim storing.

Disadvantages

(i) Since the specific product determines the layout, a change in product involves major changes in layout and thus the layout flexibility is considerably reduced.

(ii) The pace or rate of working depends upon the output rate of the slowest machine. This involves excessive idle time for other machines if the production line is not adequately balanced.

(iii) Machines being scattered along the line, more machines of each type have to be purchased as stand by, because if one machine in the line fails, it may lead to shut down of the complete production line.

(iv) It is difficult to increase production beyond the capacities of the production lines.

(v) As the entire production is the result of the joint effort of all operation in the line, it is difficult to implement individual incentive schemes.

(vi) Since there is no separate department for various types of work, supervision is also difficult.

(vii) Under this system, labour cost is high because

(a) Absenteeism may create certain problems because every worker is specialist in his own work or he specializes on a particular machine .In order to avoid the bottleneck, surplus workers who are generalists and can be fitted on a number of machines will have to be employed;

(b) Monotony is another problem with the workers .By doing the work of repetitive nature along assembly line, they feel bored. They have no opportunity to demonstrate their talent;

(c) Noise, vibrations, temperature, moisture, gas etc. may cause health hazards. In this way, labour costs are high.

It is now quite clear from the above discussion that both the systems have their own merits and demerits. Advantages of one type of layout are generally the disadvantages of other type. Thus with a view to securing the advantage of both the systems a combined layout may be designed.

Static Product Layout or Project Layout or Stationary Layout

The manufacturing operations require the movements of men, machines, and materials, in the product layout and process layout generally the machines are fixed installations and the operators are static in terms of their specified workstations. It is only the materials, which move from operation to operation for the purpose of processing. But where the product is large in size and heavy in weight, it tends to be static e.g. ship building. In such a production system, the product remains static and men and machines move performing the operations on the product.

Advantages of Stationery Layout

The advantages of this type of layout are as under :

1. ***Flexible :*** This layout is fully flexible and is capable of absorbing any sort

of change in product and process. The project can be completed according to the needs of the customers and as per their specifications.

2. ***Lower labour cost :*** People are drawn from functional departments. They move back to their respective departments as soon as the work is over. This is economical, if a number of orders are at hand and each one is in the different stage of progress. Besides, one or two workers can be assigned to a project from start to finish. Thus it reduces labour cost.
3. ***Saving in time :*** The sequence of operations can be changed if some materials do not arrive or if some people are absent. Since the job assignment is so long, different sets of people operate simultaneously on the same assignment doing different operations
4. ***Other benefits :***

(1) It requires less floor space because machines and equipment are in moving position and there is no need of fixing them.

(2) This arrangement is most suitable way of assembling large and heavy products.

Disadvantages Of Stationery Layout

The disadvantages of this type of layout are:

1. ***Higher capital investment :*** As compared to product or process layout, capital investment is higher in this type of layout. Since a number of assignments are taken, investments in materials, men and machines are made at higher cost.
2. ***Unsuitability :*** This type of layout is not suitable for manufacturing or assembling small products in large quantities. It is suitable only in case where the product is big or the assembling process is complex.

Factors Influencing Plant Layout

The following are some important factors, which influence the planning of effective layout to a significant degree.

(1) ***Nature of the product :*** The nature of the product to be manufactured will significantly affect the layout of the plant. Stationary layout will be most suitable for heavy products while line layout will be best for the manufacture for the light products because small and light products can be moved from one machine to another very easily and, therefore, more attention can be paid to machine locations can be paid to machine locations and handling of materials.

(2) ***Volume of production:*** Volume of production and the standardization of the product also affect the type of layout. If standardized commodities are to be manufactured on large scale, line type of layout may be adopted.

(3) ***Basic managerial policies and decisions:*** The type of layout depends very

much on the decisions and policies of the management to be followed in producing the commodity with regard to the size of plant, kind and quality of the product, scope for expansion to be provided for, the extent to which the plant is to be integrated, amount of stocks to be carried at anytime, the kind of employee facilities to be provided etc.

(4) ***Nature of plant location:*** The size shape and topography of the site at which the plant is located will naturally affect the type of layout to be followed in view of the maximum utilization of the space available .For *e.g.*, if a site is near the railway line the arrangement of general layout for receiving and shipping and for the best flow of production in and out the plant may be made by the side of the railway lines.

(5) ***Types of Industry Process :*** This is one of the most important factors influencing the choice of type of plant layout. Generally the types of layout particularly the arrangement of machines and work centers and the location of workmen vary according to the nature of the industry to which the plant belongs. For the purpose of lay out, industry may be classified into two broad categories : *(i)* Intermittent and *(ii)* continuous. Intermittent type of industries is those, which manufacture different component or different machines.

Such industries may manufacture the parts, when required according to the market needs. Examples of such industries are shipbuilding plants. In this type of industry functional layout may be the best. The second type of industry in 'continuous industry. in this type of industry raw material are fed at one end and the finished goods are received at another end. A continuous industry may either be analytical or synthetic . A analytical industry breaks up the raw material into several parts during the course of production process or changes its form, e.g. oil and sugar refineries. A synthetic industry on the other hand mixes the two or more materials to manufacture one product along with the process of production or assembles several parts to get finished product. Cement and automobiles industries are the examples of such industry. Line layout is more suitable in continuous process industries..

6. ***Types of methods of production :*** Layout plans may be different according to the method of production proposed to be adopted. Any of the following three methods may be adopted for production- (1) Job order production, (2) batch production, and (3) mass production. Under job production goods are produced according to the orders of the customers and therefore, specification vary from customer to customer and the production cannot be standardized. The machines and equipment can be arranged in a manner to suit the need of all types of customers. Batch production carries the production of goods in batches or group at intervals. In this type of

manufacturing the product is standardized and production is made generally in anticipation of sales. In such cases functional or process layout may be adopted. In case of mass production of standardized goods, line layout is most suitable form of plant layout.

7. ***Nature of machines :*** Nature of machines and equipment also affects the layout of plants. If machines are heavy in weight or create noisy atmosphere, stationery layout may reasonably be adopted. Heavy machines are generally fixed on the ground floor. Ample space should be provided for complicated machines to avoid accidents.
8. ***Climate :*** Sometimes, temperature, illumination and air are the deciding factors in the location of machines and their establishments. For example, in lantern manufacturing industry, the spray-painting room is built along the factory wall to ensure the required temperature control and air expulsion and the process of spray painting may be undertaken.
9. ***Nature of material :*** Design and specification of materials, quantity and quality of materials and combination of materials are probably the most important factors to be considered in planning a layout. So, materials storage, space, volume and weight of raw materials, floor load capacity, ceiling height ,method of storing etc. should be given special consideration. This will affect the space and the efficiency of the production process in the plant. It will facilitate economic production of goods and prompt materials flow and soundly conceived materials handling system.
10. ***Type of machine :*** Machines and equipment may be either general purpose or special purpose. In addition certain tools are used. The requirements of each machine and equipment are quite different in terms of their space; speed and material handling process and these factors should be given proper consideration while choosing out a particular type of layout. This should also be considered that each machine and equipment is used to its fullest capacity because machines involve a huge investment. For instance, under product layout, certain machines may not be used to their full capacity so care should be taken to make full use of the capacity of the machines and equipment.
11. ***Human factor and working conditions :*** Men are the most important factor of production and therefore special consideration for their safety and comforts should be given while planning a layout, specific safety items like obstruction- free floor, workers not exposed to hazards, exit etc. should be provided for. The layout should also provide for the comforts to the workers such as provision of rest rooms, drinking water and other services etc. sufficient space is also to be provided for free movement of workers.
12. ***Characteristics of the building :*** Shape of building, covered and open area, number of storeys, facilities of elevators, parking area and so on also

influence the layout plan. In most of the cases where building is hired, layout is to be adjusted within the spaces available in the building. Although minor modification may be done to suit the needs of the plants and equipment. But if any building is to be constructed, proper care should be given to construct it according to the layout plan drawn by experts. Special type of construction is needed to accommodate huge or technical or complex or sophisticated machines and equipment.

Costs Associated With Plant Layout

The costs associated with a decision on plant layout are :

- Cost of movement of material from one work area to another.
- Cost of space.
- Cost of production delay, if any, which are indirect costs.
- Cost of spoilage of material, if any, when the materials are staged or stored in condition which determine the quality of the material.
- Cost of labor dissatisfaction and health risks.
- Cost of changes required, if the operational conditions changed in the future. This is the long- term cost.

A good layout should minimize all these costs put together.

Techniques of Plant Layout

In designing or improving the plan of plant layout, certain techniques or tools are developed and are in common use today. The techniques or tools are as follows :

(1)Charts and diagrams

In order to achieve work simplification, production engineers make use of several charts and diagrams for summarizing and analyzing production process and procedure. These include

Operation process chart :— It subdivides the process into separate operations and inspection. When a variety of parts and products are manufactured which follow a different path across several floor areas, an operation process chart may be necessary for the important material items or products. The flow lines of the charts indicate the sequence of all operation in the manufacturing cycle.

Flow process chart :— This chart is the graphic summary of all the activities taking place on the production floor of an existing plant. By preparing this type of chart, it can be found out as to where operations can be eliminated , rearranged, combined, simplified or subdivided for greater economy.

Process flow diagram :— The diagram is both supplement and substitute of process flow chart. It helps in tracing the movement of material on a floor plan or layout drawing. A diagram may be drawn to scale on the original floor plan to show the

movement of work. It is a good technique to show long materials hauls and backtracking of present layouts, thereby indicating how the present layout may be improved. Colored lines can show the flow of several standards products.

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Layouts, thereby indicating how the present layout may be improved. Colored lines can show the flow of several standard products.

This diagram can be used to analyze the effectiveness of the arrangement of the plant activities, the location of specific machines, and the allocation of space. It shows how a more logical arrangement and economical flow of work can be devised.

(2) Machines data card: This card provides full information necessary for the placement and layout of equipment. The cards are prepared separately for each machine. The information generally given on these cards include facts about the machine such as capacity of the machines, scape occupied, power requirements, handling devices required and dimensions.

(3) Templates: Template is the drawing of a machine or tool cut out from the sheet of paper. Cutting to scale shows the area occupied by a machine. The plant layout engineer prepares a floor plan on the basis of reel vent information made available to him. The template technique is an important technique because *(i)* it eliminates unnecessary handlings, *(ii)* minimize backtracking of materials, *(iii)* it makes the mechanical handling possible, *(iv)* it provides a visual picture of proposed or existing plan of layout at one place, *(v)* it offers flexibility to meet future changes in the production requirements.

(4) Scale models : Though the two-dimensional templates are now in extensive use in the fields of layout engineering but it is not much use to executives who cannot understand and manipulate them. One important drawback of template technique is that it leaves the volume, depth, height and clearance of the machines to the imaginations of the reader of the drawing. These drawbacks of the template technique have been removed through the development of miniature scale models of machinery and equipment cast in metal.

With scale models, it has now become possible to move tiny figures of men and machines around in miniature factory. The miniature machines and models of material handling equipment are placed in a miniature plant and moved around in pawn on a chessboard.

(5) Layout drawings : Completed layouts are generally represented by drawings of the plant showing wall, columns, stairways, machines and other equipments, storage areas and office areas.

The above techniques and tools are used for the planning of layout for the new plant.

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1.13 MATERIAL HANDLING SYSTEMS

According to 'American Handling Society' Materials Handling is the art and science involving the movement, packing and storing of substances in any form'.

Material Handling includes :

1. Lifting, moving, dropping, positioning, holding, releasing, stacking etc.
2. Single or in lot movement.
3. Vertical, horizontal or combination of both.
4. Fluid, semi-fluid and discrete items.
5. Attribute to 20% of production cost.

Analysis of material handling problem

1. The reduction of material handling cost.
2. Collection of factual data *e.g.*, type, weight of goods, transportation area, type of material handling.
3. Analyzing the data so that cost advantage can be taken.
4. Application of principles of material handling.
5. The formulation of solution.

Factors affecting 'material handling'

1. Type of product- bulk, shape, weight, fragility, liquidity etc.
2. Plant layout- sequence of movement of materials depends on layout
3. Type of production system.
4. Factory building- Floor strength, ceiling heights, type and strength of roofs, door locations and sizes.
5. Production planning and control- Routing and scheduling are closely related to material handling.
6. Packaging.
7. Material handling equipment- Available and proposed.

Principles of material handling

1. Least movement,
2. Type of each move should be minimized,
3. Distance of each move should be short route,
4. Movement in lots rather than on individual basis,
5. Gravity should be used,
6. Rehandling and back tracking should be avoided,
7. Appropriate material handling which is safe, efficient and flexible should be used,
8. Material handling service should not interrupt production flow,

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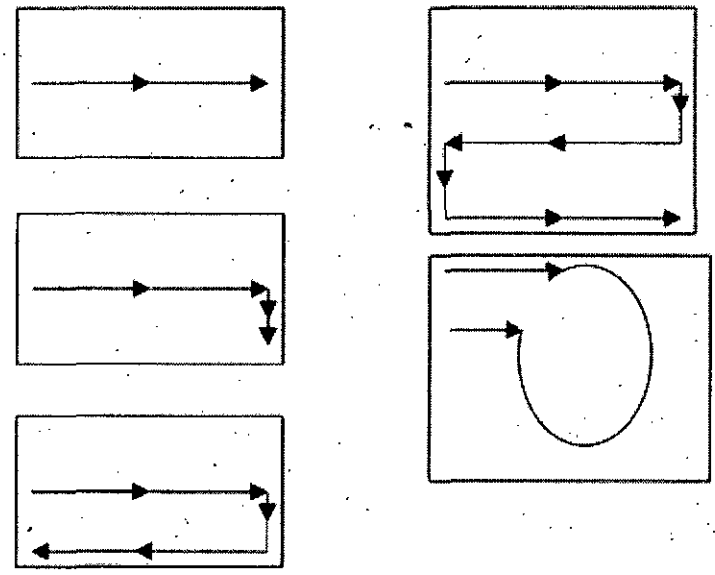
9. Safety of people,
10. Provision of stand-by facilities,
11. Repair and maintenance-periodically,
12. Periodical review of material handling system.

Typical Flow Pattern of Material



Types of equipment

1. Cranes and Hoists
2. Conveyors
3. Chutes
4. Trucks, Tractors
5. Rails
6. Rope ways
7. Pipelines

Features of good material handling equipment

1. Minimizes movement of material
2. Avoids unproductive handling
3. Reduces idle machine capacity
4. Reduces factory hazards
5. Effective production control
6. Better customer services
   i. Reduced operating cost
   ii. Better quality of products

iii. Timely production

TYPES OF MATERIAL HANDLING SYSTEMS

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The material handling systems can be classified according to the type of handling equipment used, type of material handled and the methods ,need or function performed.

1. *Equipment Oriented Systems depending upon the type of equipment used are:-*

(a) Overhead systems

(b) Conveyor systems

(c) Tractor transfer system

(d) Fork-lift truck and pallet truck system

(e) Industrial truck system

(f) Underground truck system

2. *Material Oriented Systems Consisting of:-*

(a) Unit Handling Systems

(b) Bulk Handling System

(c) Liquid Handling System

3. *Method Oriented Systems are of following types:-*

(a) Manual System

(b) Mechanized or automated system

(c) Job Shop handling system

(d) Mass-production handling system

4. *Function Oriented Systems such as:-*

(a) Transportation Systems

(b) Transferring Systems

(c) Elevating Systems

Steps to be followed in the selection and design of material handling system.

1. Identification of the appropriate Systems.
2. Review of design criteria and objectives of handling systems.
3. Collection of data regarding flow pattern and flow requirement.
4. Identification of activity relationship between departments.
5. Determination of space requirement and establishment of material flow pattern.
6. Analysis of material and building characteristic.
7. Preliminary selection of basic handling system and generation of alternative system considering feasibility of mechanization and equipment capabilities.
8. Evaluation of alternatives with respect to optimal material flow, utilizing

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gravity minimum cost, flexibility, case of maintenance and capacity utilization.

9. Selection of the best suitable alternative system and checking it for compatibility with the layout.
10. Specification of the system.
11. Procurement of the equipment and installation of the system.

Types of Materials Handling Equipment

Conveyors

These are gravity or powered devices, commonly used for moving loads from point to point over fixed paths. The various types of conveyors are :

(a) ***Belt conveyor***- Motor driven belt, usually made of rubberized fabric or metal fabric on a rigid frame.

(b) ***Chain Conveyor***- Motor driven chain that drags material along a metal slide base.

(c) ***Roller conveyor***- Boxes, large parts or unit loads roll on top of a series of roller mounted on a rigid frame

(d) ***Pneumatic conveyor:***- High volume of air flows through a tube, carrying material along with the air flow.

Cranes, Elevators and Hoists

These are overhead devices used for moving varying loads intermittently between points within an area, fixed by supporting and binding rails.

1. Graves are devices mounted on overhead rails or ground level wheels or rails.
2. Elevator are a type of graves that lift material usually between floors of building
3. Hoists are devices, which move materials vertically and horizontally in a limited area.

Industrial Trucks

These devices are used for moving mined or uniform loads intermittently over variable paths. They are electric, diesel, gasoline or liquefied petroleum, gas-powered vehicle equipped with lead, forklift truck, pallet trucks, tractor with trailers, hand trucks and power trolleys.

Miscellaneous Handling Equipment

1. Pipelines, which are closed tubes that transport liquids by means of pumps or gravity.
2. Automatic transfer devices, which automatically grasp material, hold them firmly while operation are being performed and move them to other location.

3. Automated guided vehicle are the devices, which do not require operators and provide a great deal of flexibility in the path they travel and the function they perform.
4. Industrial robots are the devices, which has a movable arm like projection with a gripper on the end that can perform a variety of repetitive tasks.

1.14 SUMMARY

- Production/operations management is the process, which combines and transforms various resources used in the production/operations subsystem of the organization into value added product/services in a controlled manner as per the policies of the organization.
- Production function is that part of an organization, which is concerned with the transformation of a range of inputs into the required outputs (products) having the requisite quality level.
- The traditional view of manufacturing management began in eighteenth century when Adam Smith recognised the economic benefits of specialisation of labour. F.W. Taylor implemented Smith's theories and developed scientific management. From then till 1930, many techniques were developed prevailing the traditional view.
- Operating system converts inputs in order to provide outputs which are required by a customer. It converts physical resources into outputs, the function of which is to satisfy customer wants *i.e.*, to provide some utility for the customer.
- Materials management is that aspect of management function which is primarily concerned with the acquisition, control and use of materials needed and flow of goods and services connected with the production process having some predetermined objectives in view.
- Plant layout means the disposition of the various facilities (equipments, material, manpower etc.) within the areas of the site selected. Plant layout begins with the design of the factory building and goes up to the location and movement of work.

1.15 REVIEW QUESTIONS

1. What do you mean by 'Production'?
2. What do you mean by production system?
3. Mention any four advantages of mass production.
4. Mention any four limitations of mass production.
5. Define production management.
6. Mention any four objectives of production management.

7. Define operating system.
8. Explain the different types of production systems.
9. Explain the framework of managing operations.
10. Explain the scope of production and operations management.
11. Discuss the techniques of plant layout.

1.16 FURTHER READINGS

- Prof K Shridhara Bhat, ***Text Book of Production Management (Text and Cases)***, Himalaya Publication, New Delhi.
- Keith Lockyer, Alan Muhlemann and J.S. Oakland; ***Production and Operations Management***; Financial Times/ Prentice Hall Publisher; 6th edition (5 May 1992).
- Halevi, Gideon; ***Handbook of Production Management Methods***, A Butterworth-Heinemann Title Publisher, (22 Oct 2001).

UNIT – II

CAPACITY PLANNING AND WORK DESIGN

STRUCTURE

2.1 LEARNING OBJECTIVES

After going through this unit, students will be able to :

- state the fundamental concept of capacity planning;
- explain the methods of measurement of capacity;
- discuss various important aspects of work design.

2.2 INTRODUCTION

Capacity planning has seen an increased emphasis due to the financial benefits of the efficient use of capacity plans within material requirements planning systems and other information systems. Insufficient capacity can quickly lead to deteriorating delivery performance, unnecessarily increase work-in-process, and frustrate sales personnel and those in manufacturing. However, excess capacity can be costly and unnecessary. The inability to properly manage capacity can be a barrier to the achievement of maximum firm performance. In addition, capacity is an important factor in the organization's choice of technology.

Capacity is usually assumed to mean the maximum rate at which a transformation system produces or processes inputs. Sometimes, this rate may actually be "all at once"—as with the capacity of an airplane. A more usable definition of capacity would be the volume of output per elapsed time and the production capability of a facility.

Capacity planning is the process used to determine how much capacity is needed (and when) in order to manufacture greater product or begin production of a new product. A number of factors can affect capacity—number of workers, ability of workers, number of machines, waste, scrap, defects, errors, productivity, suppliers, government regulations, and preventive maintenance. Capacity planning is relevant in both the long term and the short term. However, there are different issues at stake for each.

2.3 MEANING OF CAPACITY PLANNING

The long-range operations strategy of an organization is expressed by capacity plans. Following issues must be considered in capacity planning: -

1. Market trend in terms of market size, location, & technology innovation.
2. Effect of new product.
3. Variation (seasonal) in demand.
4. Review of existing policies for using overtime & multiple shifts.
5. Should we expand existing facilities or build new capacities.
6. Should we add small units or big units?

The above issues should be resolved as a part of capacity planning.

In assessing alternatives, the revenues, capital costs, & operating costs may be compared, but managers should strike a trade off between possible effects of the strategic issues against economic advantages & disadvantages.

2.4 MEASUREMENT OF CAPACITY

A production planning and control system comprises two activities: planning/control of materials and planning/control of capacities. These two activities must be coordinated based on marketplace requirements. Capacity planning techniques are designed to estimate capacity requirements far enough into the future to fulfill market requirements. Capacity plans should be implemented carefully to avoid unpleasant surprises.

- When outputs are relatively homogenous, capacity units are rather obvious. For *e.g.*, an Auto plant uses number of autos, beer plant uses cases of beer etc.
- When the output units are diverse, it is common to use the measure of the availability. For *e.g.*, airlines use seat available i.e. seat miles as a measure instead of seats.

- When different types of equipment are used for performing a wide variety of machinery operation, & the output may be unique parts. The value of the labor & material of the output could vary widely. Thus the capacity of the shop is normally stated as the capacity of the limiting resources, *e.g.*, the labour hours.
- Measure of capacity of different organizations.

Type of Organisation	*Capacity Measures*
Auto Plant	Number Of Autos
Beer Plant	Cases Of Beer
Power Plant	Mw
Airlines	Available Seat Miles
Hospital	Available Bed Days
Restaurant	Available Seat Turns

Industry Capacity & Competitive Dynamics

"Should any capacity be added with in the industry ". is an important question. In answering this question, one has to take care of long-term projections of demand & competitors capacity too.

For further discussion we assume decision to add capacity already taken for industry & in principle for organisation.

Capacity Decision for Mature Products with Stable Demand

Many products enjoy mature stable markets *e.g.*, steel, aluminum, and fertilizer, cement, and airline services, health care services.

Many products & services are also affected by recession but their trend in demand is relatively stable. The casual/normal sales forecasting methods are used for these products are common methods for estimating future demands. In addition to formal perspective methods, executive opinion & extrapolation are also used.

Given long-range predictions of demand, we must generate capacity requirements. First of all we find out individual capacity of each sub-unit— *e.g.*, M/C shop, assembling, shipping etc. identifying the size & timing of projected capacity gaps provides input for the generation of alternative plans. We may plan to meet demand either by providing the expected required capacity or by partially utilizing alternative sources or we may enlarge existing facilities, establish new producing; locations for the additional capacity; or relocate the entire operation.

Capacity Decision for New Products & Risky Situations

It is difficult to predict capacity requirements for new products initially or in the rapid development phase of product life cycles. There are also situations

involving mature, stable products, such as oil, in which the capacity planning environment is risky owing to unstable political factors. The prediction of capacity requirements in these kinds of situation must place greater emphasis on the distribution of the expected demand. Optimistic & pessimistic predictions can have a profound effect on capacity requirements.

There are widely different capacity needs for the optimistic & pessimistic predictions. If we accept the optimistic schedule, we need capacity additions & huge capacity addition within 10 years (approx). If we fail to provide the capacity, we may miss the market & lost sales could be an important opportunity cost. On the other hand, if we assume the pessimistic schedule, we need only modest amounts of capacity within 5 years that might be provided by multiple shifts & overtime.

Decision tree analysis is used to incorporate uncertainties in the evaluation of alternative capacity plans.

Generation of Alternative Capacity Plans

When capacity gaps have been identified alternative plans should be considered. These alternatives may involve the size & timing of added capacity, the use of overtime & multiple shifts, the use of outside capacity resources, the absorption of lost sales, or the location of new capacity.

Economies of Scale

For a given facility there should be an optimum output that minimizes fixed plus variable costs.

Optimum output is that output for which the total cost/unit is minimum.

Economies of Scale by Successively Larger Plants

There are economies of scales that may come from two basic sources: lower fixed cost/unit & variable cost/unit.

The lower fixed cost accrues because plant & equipment costs of larger plants are lower in proportion to capacity. Larger plants are likely to have a better balance of sub units with less slack capacity in sub units.

Lower variable cost may also accrue with the larger plant because larger volume may justify more mechanization and automation. The result is that minimum unit costs are less for larger plants.

Economic evaluation of capacity :-

1. Mature products with stable demand —

Capacity plan alternative may involve various size units that differ in their productivity reflecting economies to scale.

Capacity plan alternative may include different size (different investment) & locations.

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All the costs involved in capacity planning are future costs & the time span may be long, a discounted cash flow (DCF) analysis is appropriate for comparing alternatives. DCF is based on investment & operating costs.

2. *New products & risky situations* —

Capacity planning in case of new products requires an assessment of risks. The effect of the probability that risky events will occur must be accounted for. If the market is uncertain a probabilistic prediction of the market provides basic data. Suppose that we are planning future capacity for a product that is in the rapid development phase.

The probability of optimistic demand = 0.25

The probability of expected demand = 0.50

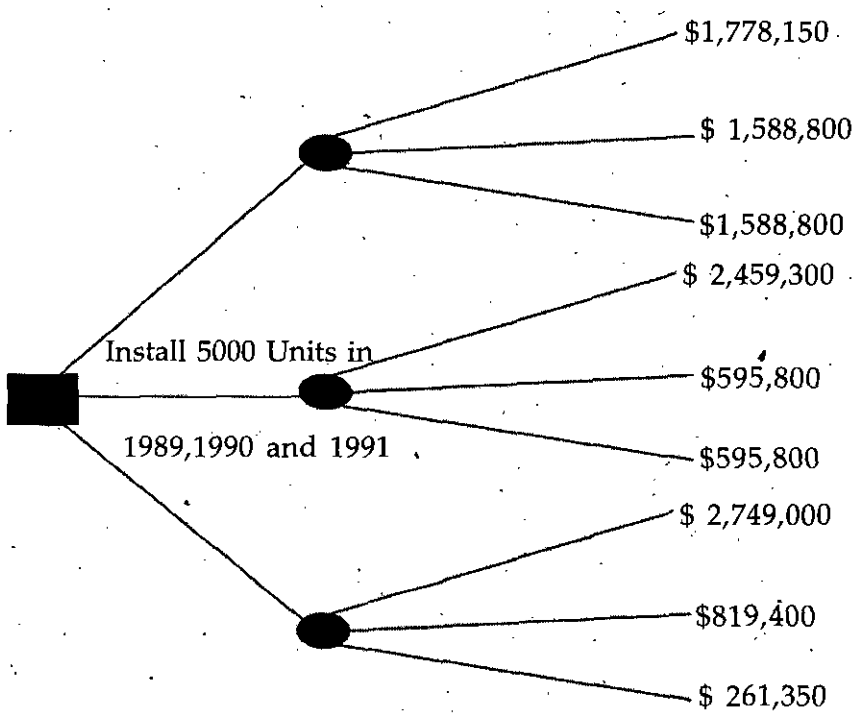
The probability of pessimistic demand = 0.25

Alternatives of capacity expansion are: existing capacity 17000 items

Install 15000 units -

Install 5000 units every year for three years.

No capacity addition.



The above e.g., can be represented in the form of decision tree.

Expected value of decision

Installation of 15000 units

= 1778150+1588800+1588800

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= 4955750

Installation of 5000 units

= 2459300+595800+595800

= 3650900

No capacity addition

= 2749000+819400+261350

= 3829750

Framework for analyzing capacity planning decision.

1. Structuring alternatives.

Capacity expansion involves extremely important strategic issues that must be addressed before the balance of the planning process can proceed. These issues involve existing industry capacity, where it is located, the nature & strength of competition, the status of the technology in the industry including the potential for influence on whether or not to pursue an expansion at all as well as on the structuring for alternatives for expansion.

Given a 'go' signal for the capacity planning process, alternatives need to be structured around different locations that may have the competitive advantages, the process technology that can be used, & the nature of the product & its market. One of the outcomes will be in terms of the riskiness of the situation, with regard to both the product & its markets (mature or new & risky) & the anticipation of chance occurrences or developments usually involving technological choices.

2. Choice Of Criteria For Decision

Capacity expansion invariably means the criteria of assets that have value over long periods. The building & the process equipment normally involve the largest assets of an enterprise, & since the alternatives may involve expenditures & revenues with different timings, present values should be used to place all of the monetary values on a common basis for comparison. But if we are dealing with risky situations that require decision-tree analysis, then probabilities must be taken into account, & the expected monetary values become the criteria.

3. Evaluation Of Alternatives & Decisions.

Although the economic criteria are of great significance in the basic decision to expand capacity they may yield to qualitative differences in the selection of an alternative. Questions of location & timing may depend on qualitative criteria that can't be reflected in the economic analysis.

Competitor factors among the alternatives may be of extreme importance and may outweigh economic differences among the alternatives in the minds of the decision makers. As with the analysis of technological alternatives, decision

makers can make trade-offs between economic & subjective values, thereby pricing the subjective advantages.

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2.5 CAPACITY PLANNING TECHNIQUES AND CLASSIFICATION

There are four procedures for capacity planning; capacity planning using overall factors (CPOF), capacity bills, resource profiles, and capacity requirements planning (CRP). The first three are rough-cut approaches (involving analysis to identify potential bottlenecks) that can be used with or without manufacturing resource planning (MRP) systems. CRP is used in conjunction with MRP systems.

Capacity using overall factors is a simple, manual approach to capacity planning that is based on the master production schedule and production standards that convert required units of finished goods into historical loads on each work center. Bills of capacity is a procedure based on the MPS. Instead of using historical ratios, however, it utilizes the bills of material and routing sheet (which shows the sequence or work centers required to manufacture the part, as well as the setup and run time). Capacity requirements can then be determined by multiplying the number of units required by the MPS by the time needed to produce each. Resource profiles are the same as bills of capacity, except lead times are included so that workloads fall into the correct periods.

Capacity requirements planning (CRP) is only applicable in firms using MRP or MRP II. CRP uses the information from one of the previous rough-cut methods, plus MRP outputs on existing inventories and lot sizing. The result is a tabular load report for each work center or a graphical load profile for helping plan-production requirements. This will indicate where capacity is inadequate or idle, allowing for imbalances to be corrected by shifts in personnel or equipment or the use of overtime or added shifts. Finite capacity scheduling is an extension of CRP that simulates job order stopping and starting to produce a detailed schedule that provides a set of start and finish dates for each operation at each work center.

A failure to understand the critical nature of managing capacity can lead to chaos and serious customer service problems. If there is a mismatch between available and required capacity, adjustments should be made. However, it should be noted that firms cannot have perfectly-balanced material and capacity plans that easily accommodate emergency orders. If flexibility is the firm's competitive priority, excess capacity would be appropriate.

Long-term Capacity Planning

Over the long term, capacity planning relates primarily to strategic issues involving the firm's major production facilities. In addition, long-term capacity issues are interrelated with location decisions. Technology and transferability of

the process to other products is also intertwined with long-term capacity planning. Long-term capacity planning may evolve when short-term changes in capacity are insufficient. For example, if the firm's addition of a third shift to its current two-shift plan still does not produce enough output, and subcontracting arrangements cannot be made, one feasible alternative is to add capital equipment and modify the layout of the plant (long-term actions). It may even be desirable to add additional plant space or to construct a new facility (long-term alternatives).

Short-term Capacity Planning

In the short term, capacity planning concerns issues of scheduling, labor shifts, and balancing resource capacities. The goal of short-term capacity planning is to handle unexpected shifts in demand in an efficient economic manner. The time frame for short-term planning is frequently only a few days but may run as long as six months.

Alternatives for making short-term changes in capacity are fairly numerous and can even include the decision to not meet demand at all. The easiest and most commonly-used method to increase capacity in the short term is working overtime. This is a flexible and inexpensive alternative. While the firm has to pay one and one half times the normal labor rate, it foregoes the expense of hiring, training, and paying additional benefits. When not used abusively, most workers appreciate the opportunity to earn extra wages. If overtime does not provide enough short-term capacity, other resource-increasing alternatives are available. These include adding shifts, employing casual or part-time workers, the use of floating workers, leasing workers, and facilities subcontracting.

Firms may also increase capacity by improving the use of their resources. The most common alternatives in this category are worker cross training and overlapping or staggering shifts. Most manufacturing firms inventory some output ahead of demand so that any need for a capacity change is absorbed by the inventory buffer. From a technical perspective, firms may initiate a process design intended to increase productivity at work stations. Manufacturers can also shift demand to avoid capacity requirement fluctuation by backlogging, queuing demand, or lengthening the firm's lead times. Service firms accomplish the same results through scheduling appointments and reservations.

A more creative approach is to modify the output. Standardizing the output or offering complimentary services are examples. In services, one might allow customers to do some of the process work themselves (*e.g.*, self-service gas stations and fast-food restaurants). Another alternative—reducing quality—is an undesirable yet viable tactic.

Finally, the firm may attempt to modify demand. Changing the price and promoting the product are common. Another alternative is to partition demand

by initiating a yield or revenue management system. Utilities also report success in shifting demand by the use of "off-peak" pricing.

2.6 AGGREGATE PLANNING

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Aggregate planning is the process of developing, analyzing, and maintaining a preliminary, approximate schedule of the overall operations of an organization. The aggregate plan generally contains targeted sales forecasts, production levels, inventory levels, and customer backlogs. This schedule is intended to satisfy the demand forecast at a minimum cost. Properly done, aggregate planning should minimize the effects of shortsighted, day-to-day scheduling, in which small amounts of material may be ordered one week, with an accompanying layoff of workers, followed by ordering larger amounts and rehiring workers the next week. This longer-term perspective on resource use can help minimize short-term requirements changes with a resulting cost savings.

In simple terms, aggregate planning is an attempt to balance capacity and demand in such a way that costs are minimized. The term "aggregate" is used because planning at this level includes all resources "in the aggregate;" for example, as a product line or family.

Aggregate resources could be total number of workers, hours of machine time, or tons of raw materials. Aggregate units of output could include gallons, feet, pounds of output, as well as aggregate units appearing in service industries such as hours of service delivered, number of patients seen, etc.

Aggregate planning does not distinguish among sizes, colors, features, and so forth. For example, with automobile manufacturing, aggregate planning would consider the total number of cars planned for not the individual models, colors, or options. When units of aggregation are difficult to determine (for example, when the variation in output is extreme) equivalent units are usually determined. These equivalent units could be based on value, cost, worker hours, or some similar measure.

Aggregate planning is considered to be intermediate-term (as opposed to long- or short-term) in nature. Hence, most aggregate plans cover a period of three to 18 months. Aggregate plans serve as a foundation for future short-range type planning, such as production scheduling, sequencing, and loading. The master production schedule (MPS) used in material requirements planning (MRP) has been described as the aggregate plan "disaggregated."

Steps taken to produce an aggregate plan begin with the determination of demand and the determination of current capacity. Capacity is expressed as total number of units per time period that can be produced (this requires that an average number of units be computed since the total may include a product mix utilizing distinctly different production times). Demand is expressed as total

number of units needed. If the two are not in balance (equal), the firm must decide whether to increase or decrease capacity to meet demand or increase or decrease demand to meet capacity. In order to accomplish this, a number of options are available.

Options for situations in which demand needs to be increased in order to match capacity include :

1. ***Pricing.*** Varying pricing to increase demand in periods when demand is less than peak. For example, matinee prices for movie theaters, off-season rates for hotels, weekend rates for telephone service, and pricing for items that experience seasonal demand.
2. ***Promotion.*** Advertising, direct marketing, and other forms of promotion are used to shift demand.
3. ***Back ordering.*** By postponing delivery on current orders demand is shifted to period when capacity is not fully utilized. This is really just a form of smoothing demand. Service industries are able to smooth demand by taking reservations or by making appointments in an attempt to avoid walk-in customers. Some refer to this as "partitioning" demand.
4. ***New demand creation.*** A new, but complementary demand is created for a product or service. When restaurant customers have to wait, they are frequently diverted into a complementary (but not complimentary) service, the bar. Other examples include the addition of video arcades within movie theaters, and the expansion of services at convenience stores.

Options which can be used to increase or decrease capacity to match current demand include :

1. ***Hire/lay off.*** By hiring additional workers as needed or by laying off workers not currently required to meet demand, firms can maintain a balance between capacity and demand.
2. ***Overtime.*** By asking or requiring workers to work extra hours a day or an extra day per week, firms can create a temporary increase in capacity without the added expense of hiring additional workers.
3. ***Part-time or casual labor.*** By utilizing temporary workers or casual labor (workers who are considered permanent but only work when needed, on an on-call basis, and typically without the benefits given to full-time workers).
4. ***Inventory.*** Finished-goods inventory can be built up in periods of slack demand and then used to fill demand during periods of high demand. In this way no new workers have to be hired, no temporary or casual labor is needed, and no overtime is incurred.
5. ***Subcontracting.*** Frequently firms choose to allow another manufacturer or service provider to provide the product or service to the subcontracting

firm's customers. By subcontracting work to an alternative source, additional capacity is temporarily obtained.

6. ***Cross-training.*** Cross-trained employees may be able to perform tasks in several operations, creating some flexibility when scheduling capacity.
7. ***Other methods.*** While varying workforce size and utilization, inventory buildup/backlogging, and subcontracting are well-known alternatives, there are other, more novel ways that find use in industry. Among these options are sharing employees with counter-cyclical companies and attempting to find interesting and meaningful projects for employees to do during slack times.

Aggregate Planning Strategies

There are two pure planning strategies available to the aggregate planner: a level strategy and a chase strategy. Firms may choose to utilize one of the pure strategies in isolation, or they may opt for a strategy that combines the two.

Level Strategy

A level strategy seeks to produce an aggregate plan that maintains a steady production rate and/or a steady employment level. In order to satisfy changes in customer demand, the firm must raise or lower inventory levels in anticipation of increased or decreased levels of forecast demand. The firm maintains a level workforce and a steady rate of output when demand is somewhat low. This allows the firm to establish higher inventory levels than are currently needed. As demand increases, the firm is able to continue a steady production rate/steady employment level, while allowing the inventory surplus to absorb the increased demand.

A second alternative would be to use a backlog or backorder. A backorder is simply a promise to deliver the product at a later date when it is more readily available, usually when capacity begins to catch up with diminishing demand. In essence, the backorder is a device for moving demand from one period to another, preferably one in which demand is lower, thereby smoothing demand requirements over time.

A level strategy allows a firm to maintain a constant level of output and still meet demand. This is desirable from an employee relations standpoint. Negative results of the level strategy would include the cost of excess inventory, subcontracting or overtime costs, and backorder costs, which typically are the cost of expediting orders and the loss of customer goodwill.

Chase Strategy

A chase strategy implies matching demand and capacity period by period. This could result in a considerable amount of hiring, firing or laying off of employees; insecure and unhappy employees; increased inventory carrying costs; problems with labor unions; and erratic utilization of plant and equipment. It

also implies a great deal of flexibility on the firm's part. The major advantage of a chase strategy is that it allows inventory to be held to the lowest level possible, and for some firms this is a considerable savings. Most firms embracing the just-in-time production concept utilize a chase strategy approach to aggregate planning.

Most firms find it advantageous to utilize a combination of the level and chase strategy. A combination strategy (sometimes called a hybrid or mixed strategy) can be found to better meet organizational goals and policies and achieve lower costs than either of the pure strategies used independently.

Techniques of Aggregate Planning

Techniques for aggregate planning range from informal trial-and-error approaches, which usually utilize simple tables or graphs, to more formalized and advanced mathematical techniques. William Stevenson's textbook Production/Operations Management contains an informal but useful trial-and-error process for aggregate planning presented in outline form. This general procedure consists of the following steps :

1. Determine demand for each period.
2. Determine capacity for each period. This capacity should match demand, which means it may require the inclusion of overtime or subcontracting.
3. Identify company, departmental, or union policies that are pertinent. For example, maintaining a certain safety stock level, maintaining a reasonably stable workforce, backorder policies, overtime policies, inventory level policies, and other less explicit rules such as the nature of employment with the individual industry, the possibility of a bad image, and the loss of goodwill.
4. Determine unit costs for units produced. These costs typically include the basic production costs (fixed and variable costs as well as direct and indirect labor costs). Also included are the costs associated with making changes in capacity. Inventory holding costs must also be considered, as should storage, insurance, taxes, spoilage, and obsolescence costs. Finally, backorder costs must be computed. While difficult to measure, this generally includes expediting costs, loss of customer goodwill, and revenue loss from cancelled orders.
5. Develop alternative plans and compute the cost for each.
6. If satisfactory plans emerge, select the one that best satisfies objectives. Frequently, this is the plan with the least cost. Otherwise, return to step 5.

2.7 JOB DESIGN

"We can say that the that assembly-line workers are fairly highly involved in the work, even through they have little autonomy." Thomas M. Lodah

There are two basics ways in which work is organized. The first related to the flow of authority and is known as organization structure or merely organization. The second relates to flow of work itself from one operation to another and is known as procedure. Synonyms are method, system, and work flow. Alert managers usually recognize the behavioral aspects of organization structure because of the superiorsubordinate relationship which it establishes, but more often than not they ignore or overlook the behavioral aspects of work flow. The reason that work flow and the lay out over which it flows are engineering factors, which are to be distinguished from human factors. In the usual case however, work flow has many behavioral aspects because it sent people interaction as they perform their work.

One management's most fundamental idea is systems and method improvement, by which it seeks to make optimum use of division of labor, and specialization and to achieve order and balance in the performance of work. However, as indicated in the quotation introducing this chapter, workers do not like to be "engineered" in methods improvement. They perceive that improvement is measure in technical terms and that the human dissatisfaction caused by the "improvement" are generally overlooked. The goal of methods improvement is greater productivity, but sometimes it brings human compilations which reduce effectiveness and offset the technical advantages gained.

This part discusses different aspects of work methods. Emphasis is upon the flow of work among people, rather than the personal work methods of an isolated individual. Subjects discussed are flow of work and different work systems.

2.8 WORK DESIGN

In organizational development (OD), work design is the application of Socio-Technical Systems principles and techniques to the humanization of work.

The aims of work design to improved job satisfaction, to improved throughput, to improved quality and to reduced employee problems, e.g., grievances, absenteeism.

(a) Initiation of Action. One important aspect of work flow is that it determines who will "initiate" an activity and who will "receive" it. At each point in the flow of work one person gives material to the next person who will work on it. Along the way, staff experts give ideas and instruction. This process of sending work to another is an initiation of action on another person. When an initiation results from work flow, it is called a procedural initiation to distinguish it from an authority initiation, which comes from formal authority of a informal organization. The receiver of any initiation is psychological secondary, but the receiver of a procedural initiation is especially so because he may receive from a worker who is neither his supervisor nor an informal leader – from someone who "just shouldn't be pushing him around."

When procedural initiation comes from someone of distinctly less skill, someone much younger, or someone inferior by any measure of status, human problems can become serious. These problems tend to be compounded if any relationship involves pressure on the receiver, as in the following example from Whyte's study of restaurants.

Large restaurants sometimes use young boys as runners to communicate the needs of the serving pantry to the kitchen. This place the runner in the position of "telling" the cooks to prepare and send particular types of food. The result is that a young boy imitates action on high-status cooks. In essence, he is telling them what to do. Whyte found that this relationship was typically a trouble spot in the restaurants he studied.

Cooks resented the control exercised on them by young boys of inferior status.

Practical solutions included,

(1) using a mechanical voice system which eliminated face-to-face contact, and

(2) changing the initiator to someone of more status.

Further problems tend to arise when a procedural initiation affects "sensitive" areas such as how much work a man does (e.g., time study) and his conclusion that procedural initiations which are from low-status to high-status person, place heavy pressures on the receiver, or affect sensitive parts of the receiver's work tend to be trouble spots. Management's responsibility is to discover these situations in its work processes and, if they cannot be avoided to plan them carefully.

Procedural, authority, and informal initiation of action come from person however, not all work imitations are identifiable as coming directly from some wherein people respond t cues implicit in the operation situation. For example, a ceramic glaze has finished its baking cycle and the operator acts to remove it from the furnace, or the cellophane ribbon creases on cellophane machines and men act as a team to correct it.

In this instance, one cannot determine who initiates an event because it arises from the work itself. This kind of initiation not identifiable with persons is called a situational interactions. There is some evidence that persons get satisfaction from working in harmony with situational initiations and that teams have better moral when their teamwork primarily involves situational initiations instead of personal ones. The reasons appears to be what workers are less likely to resent and feel subordinate the impersonal requirements of the work itself.

(b) Systems Design for better Teamwork. Another important aspect of work procedure is that it should permit people to work together as a team whenever the work flow requires it. Teamwork can be engineered out of a work situation

by means of layouts and job assignments which separate people so that it is impractical for them to work together, even though the work flow requirement teamwork. In one instance two operators, functionally interdependent, was unnecessarily on separate shifts, which prevented the operator fed parts to two spiral lines which were in competition, and each line regularly claimed that is favored the other. In another situation the operator of a continuous bottle forming machine was so far separated from the first inspection station on this line that he could never be sure whether his machine was producing satisfactory quality. The problem was met by continuously reporting inspection result from the inspector to an information panel in front of the operator. One of the best illustrations of teamwork engineered out of a job is Rice's study of textile mill in India.

The evidence is clear that work systems and layout have a substantial effect on human behaviour. They do this by :

(1) Determining who initiates procedural action on whom, and some of the conditions in which the initiations occurs.

(2) Influencing the degree to which employees performing interdependent functions can work together as a team.

(3) Affecting the communication patterns of employees.

The general conclusion for management is that relationships among workers in a system can be just as important as relationships of the work in that system. In the design of any system it is folly to spend all time planning work relationships but ignoring worker relationships.

(c) Control of Red Tape. One aspect of procedure which is universally known as respected for its effect on people is red tape. It is the unnecessary procedure which delays and harasses people everywhere. The term originated from real red tape used to tie official government documents, many of which having long been challenged as unnecessary by those who prepare them. No doubt some of the work in government and in business as well is true red tape, but some is in reality "fictions red tape." It exists when those who perform the procedure do not know why they are doing it. They, consequently, think it is red tape, but from a broader viewpoint the work is both necessary and worthwhile. The remedy for fictitious red tape is improved communication and development of a broader perspective among those who perform the work.

Genuine red tape arises primarily because (1) managers are afraid to delegate and consequently set up all sorts of unnecessary approvals and checks, and (2) procedures, even through once useful, tend to persist long after their usefulness has passed. The first reason can be eliminated through good leadership and second reason deserves further attention at this point.

One cause of the "stickiness" of red tape is normal resistance to change. A procedure tends to become a habit, and people resist changing it. Since it as, in a

sense, set up to eliminate thinking by giving its followers a routine to use without having to decide each step, they-seldom think about changing it. They get "stuck in a rut." Another cause of useless procedure is that it is often determined by a higher authority who does not understand work problems, but his personnel hesitate to challenge the procedure because they did not participate in establishing it. In other cases, people do not know why they are performing a procedure; consequently they cannot know whether it is useless or not, and they do not date to expose their "ignorance" by questioning a procedure with their boss may be able to prove essential beyond a shadow of a doubt. People do not like to get caught not knowing something about their work.

Another reason for useless procedures is that most of them cross lines of authority, jumping from one chain of command else worry about. " they know about this procedure, too – and it originates with them – so let them change it." An additional reason why procedures tend to outlive their usefulness is that the persons who created them are often supervisors all out of proportion to their real significance. Very often he focuses extremes attention on one or two of them. They become an obsession with him and this condition is known as obsessive thinking.

Where conditions permit obsessive thinking and the conditions cannot be changed, employee effectiveness is increased through the use of activities which occupy the mind and crowd out obsessive thinking. The more a worker's mind is kept busy, the less should be his obsessive thinking. This is one reason management provides music in routine and monotonous situations. For this same reason management permits –even encourages – talking across the aisle or workbench. Contests and recreational programs are other activities which occupy the mind, drive out obsessive thinking, and provide additional group solidarity.

In order to escape some of the human effects of poorly designed systems more companies are insisting that their systems experts and industrial engineers have human relations training. Where the stakes are high, even more stringent requirements may be set. One company which employed many persons with advanced degrees in its offices and in small lot of production established the policy of having all job design and systems work performed by a team of two men. On each team one person was an industrial engineer concerned with technical requirements, and the other was a human relations specialist dealing with human aspects of the work.

Different Work Systems

The way in which work is organized leads to different work systems. The following systems will be discussed because of their significant influence on employee behaviour: produced and functional work systems, labor pools, and assembly lines.

From the social point of view, we need to design systems which are as appropriate for people as possible, considering economic and other factors the situation. Regardless of what kind of system is developed, workers and their supervisors will try to adjust to it. In nearly all cases they will adjust reasonable well, because people have a remarkable sense of adaptability. Following is a example of employee adaptability.

An air-conditioning manufacturer required his three final assembly departments to complete a specific daily quota of air conditioners. Supervisors soon learned that the ordinary uncertainties of production caused them to produce over their quota on some days and under their quota on other days. However, management was quite insistent that they must meet the quota every day that shipping schedules could be met. In response to this system established by management, each of the supervisors began his own, "system." Each started keeping a store of ten to fifty "almost-finished" air conditioners under starpaulin in his department. When he saw that he was running short for the day, he took from this store a nearly finished air conditioner and ran it through final assembly steps in order to meet his standard of 7—air conditioners for each eight hours day. Then, when he produced over the standard on another day, he worked some of his production back into the store.

If a supervisor had a series of bad days, the other supervisors lent to him from their stores, if necessary, or they lent him a man from their group to help him catch up. In this way, management's needs for a standard output were met and supervisors' needs for acceptance by management were met.

(a) Product and Functional Work Systems. Two somewhat opposing work systems are product and functional organization of worm. Manufacturing affords an interesting example. The product system is organized around a complete product to be made. The functional system is organized on the basis of specialized work activities rather than products. The two type of work systems in a pharmaceutical firm are as follow.

The two types of work systems create different employee environments. In the product system the persons who work together are a conglomerate mix of skills. They lack a mutual occupational interest because their associates performing similar work are located throughout the plant. There are persons mixing formulas in all three departments – tablets, liquid and vaccines. Though product employees lack a mutual occupational interest, they do see a whole product made in their work area, so their role in the work process becomes more meaningful to them. Promotion in the product system usually is gained by learning a different occupation, such as moving from tablet packager to tablet presser to tablet coater; therefore the route of promotion is less certain and requires more versatility of skill. As a result, the workers become broader in experience and outlook.

The foreman in the product system cannot master all the skills in his department, so he is unable to comment respect of the workers through superior's ability in their specialty. He maintains leadership by means of skilled management and human motivation. He tends to be a broader, more versatile supervisor than the supervisor of a functional system. His supervision tends to be less punitive and directive, because natural team work develops as each man sees that his contribution is needed to make this whole product.

Look now at the functional work system. In the mixing department of the pharmaceutical firm the foreman probably is the senior man or is the mixed with greatest skill or knowledge of formulas. Emphasis is on technical skill rather than human skills. Workers in a functional system no longer are direct involved in the whole product and tend to feel less responsible for it. Since their work goes to one department and then another, potential conflict is increased. Bickering develops over whether work is done on time and with proper quality, because a breakdown in one department slows the work of all other departments. Disputes arise concerning who caused a mistake and at what point a department assumed control of a particular batch of work in process.

In the functional system, top management needs to devote extra attention to maintaining interdepartmental cooperation and developing broad, human-oriented supervisors. Both tend to be lacking.

(b) Labour Pools. Labour pools are also a special way of organizing work. Depending upon their objectives and manner of organization, different relationships develop. An example of this is discussed below.

(c) Assembly Lines. Assembly lines are a type of product work system, because work is organized and simplified in terms of the product manufactured. An assembly line is based on the following concepts: (1) standardization (2) interchangeability of parts, (3) breakdown of jobs into simple motions, (4) an orderly progression of the product through a series of operations, and (5) mechanical movement of the product to and from workers.

2.9 SUMMARY

- Capacity planning has seen an increased emphasis due to the financial benefits of the efficient use of capacity plans within material requirements planning systems and other information systems.
- A production planning and control system comprises two activities: planning/control of materials and planning/control of capacities. These two activities must be coordinated based on marketplace requirements.
- Many products enjoy mature stable markets *e.g.*, steel, aluminum, and fertilizer, cement, and airline services, health care services. Many products

& services are also affected by recession but their trend in demand is relatively stable.

- Aggregate planning is the process of developing, analyzing, and maintaining a preliminary, approximate schedule of the overall operations of an organization. The aggregate plan generally contains targeted sales forecasts, production levels, inventory levels, and customer backlogs.
- One management's most fundamental idea is systems and method improvement, by which it seeks to make optimum use of division of labor, and specialization and to achieve order and balance in the performance of work.

2.10 REVIEW QUESTIONS

1. State the important points need to be taken under consideration during capacity planning.
2. How is capacity measured?
3. What is aggregate planning?
4. Classify capacity planning.
5. What do you mean by job design?

2.11 FURTHER READINGS

- Prof K Shridhara Bhat, ***Text Book of Production Management (Text and Cases)***, Himalaya Publication, New Delhi.
- Keith Lockyer, Alan Muhlemann and J.S. Oakland; ***Production and Operations Management***; Financial Times/ Prentice Hall Publisher; 6th edition (5 May 1992).
- Bemis, S.E., Belenky, A.H. & Soder, D.A. (1983) ***Job analysis: An effectiveness management tool***, Washington DC: Bureau of National Affairs.

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UNIT– III

MATERIALS MANAGEMENT

STRUCTURE

3.1 LEARNING OBJECTIVES

After going through this unit, students will be able to :

- know the fundamental concept of material management;
- explain the fundamentals of purchasing;
- discuss various important aspects of material management.

3.2 INTRODUCTION

Materials management is the branch of logistics that deals with the tangible components of a supply chain. Specifically, this covers the acquisition of spare parts and replacements, quality control of purchasing and ordering such parts, and the standards involved in ordering, shipping, and warehousing the said parts.

3.3 MEANING, SCOPE AND IMPORTANCE OF MATERIAL MANAGEMENT

Materials management is part of logistics and refers to the location and movement of the physical items or products. There are three main processes associated with materials management: spare parts, quality control, and inventory management. Materials management is important in large manufacturing and distribution environments, where there are multiple parts, locations, and significant money invested in these items.

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The first process in materials management is related to spare parts. A detailed business process is required to determine the order point for the spare parts, identify the ideal quantity to order, process receipt of the parts, and then make sure they are in the correct place. Spare parts are integral to the continuing operation of production lines and related equipment. Poor management of this process can cause downtime and loss of production.

Quality control is a large part of materials management. The creation of material standards, inspections, and returns process is a primary responsibility of the materials management group. All parts and materials must be tested to ensure that a specific level of quality is met. This is typically completed before a purchase order is issued to a supplier, to ensure that the supplier has met the conditions of their contract.

Inventory management is the accurate tracking of all materials in the company's inventory. The company has purchased these items from another supplier. There are three possible areas of loss that are reduced through effective inventory management: shrinkage, misplacement, and short shipments.

Shrinkage is a general materials management term used to describe the loss of materials once they have reached the companies property. This type of loss can be due to theft or damage. There are several strategies that can be used to reduce the risk through loss prevention, such as itemized product inventory, bar coding, and security cameras.

Loss through misplacement is most commonly found in very large organizations or warehouses. Material is received by the shipper and then moved to another location by the distribution staff. However, if it is moved to the wrong location, it is as if the product had not been received at all. This issue can be reduced through bar code scanning to confirm product placement and a tracking system, which records when items are stored and where.

Short shipments occur when the quantity received is less that the quantity on the packing slip. This must be identified and corrected as soon as possible, preferably before the shipper receives the package. The more time that passes before it is realized, the greater the risk the supplier will insist that the product was shipped correctly, and the loss occurred within the customer's warehouse.

Scope

The goal of materials management is to consolidate and efficiently handle core services. It creates truck deliveries and service vehicle routes that reduce conflicts for vehicles and pedestrians. Delivery sites and loading docks are more effective and reduce redundancy. Cost is reduced when it comes to solid and hazardous waste removal, storage, and recycling. Utility infrastructure and service equipment relocation can improve aesthetics.

Quality Assurance

A large component of materials management is ensuring that parts and materials used in the supply chain meet minimum requirements by performing quality assurance (QA). While most of the writing and discussion about materials management is on acquisition and standards, much of the day to day work conducted in materials management deals with QA issues. Parts and material are tested, both before purchase orders are placed and during use, to ensure there are no short or long term issues that would disrupt the supply chain. This aspect of material management is most important in heavily automated industries, since failure rates due to faulty parts can slow or even stop production lines, throwing off timetables for production goals.

Standards

The other major component of materials management will be gradual movement toward compliance. There are standards that are followed in supply chain management that are important to a supply chain's function. For example, a supply chain that uses just-in-time or lean replenishment requires clarity. in the shipping of parts and material from purchasing agent to warehouse to place of destination. Systems reliant on vendor-managed inventories may begin to acquire up-to-date computerized inventories and begin to explore robust ordering systems for outlying vendors to place orders on.

Promoting Sustainability

Many business and institutional campuses have cluttered, noisy, and oftentimes inefficient service environments. Delivery trucks compete with pedestrians, loading docks are in plain sight, trash dumpsters sprout up, and lobbies, hallways, and stairwells are cluttered with unplanned storage. With forethought and creativity, these systems can reduce energy use and carbon emissions, minimize traffic congestion, streamline operational flows, and enhance esthetics.

Improving Circulation Infrastructure

Redundancy can be reduced and effectiveness is increased when service points are clustered to reduce the amount of redundancy. An effective materials management program can also resolve "island" approaches to shipping, receiving, and vehicle movement. Solutions can include creating a new central loading location, as well consolidating service areas and docks from separate buildings into one. Developing better campus circulation infrastructure also means re-evaluating truck delivery and service vehicle routes. Vehicle type, size, and schedules are studied to make these more compatible with surrounding neighborhoods. This will reduce truck traffic, creating a safer environment for pedestrians and a more attractive environment for other uses.

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BENEFITS

An effective materials management plan builds from and enhances an institutional master plan by filling in the gaps and producing an environmentally responsible and efficient outcome. An institutional campus, office, or housing complex can expect a myriad of benefits from an effective materials management plan. For starters, there are long-term cost savings, as consolidating, reconfiguring, and better managing a campus' core infrastructure reduces annual operating costs. An institutional campus, office, or housing complex will also get the highest and best use out of campus real estate.

An effective materials management plan also means a more holistic approach to managing vehicle use and emissions, solid waste, hazardous waste, recycling, and utility services. As a result, this means a "greener," more sustainable environment and a manifestation of the many demands today for institutions to become more environmentally friendly.

And finally, an effective materials management plan can improve aesthetics. Removing unsafe and unsightly conditions, placing core services out of sight, and creating a more pedestrian-friendly environment will improve the visual and physical sense of place for those who live and work there.

Dredged Material Management

Three management alternatives may be considered for dredged material: open-water disposal, confined (diked) disposal, and beneficial use. Open-water disposal is the placement of dredged material in rivers, lakes, estuaries, or oceans via pipeline or release from hopper dredges or barges. Confined disposal is placement of dredged material within diked nearshore or upland confined disposal facilities via pipeline or other means.

Potential environmental impacts resulting from dredged material disposal may be physical, chemical, or biological in nature. Because many of the waterways are located in industrial and urban areas, sediments often contain contaminants from these sources. Unless properly managed, dredging and disposal of contaminated sediment can adversely affect water quality and aquatic or terrestrial organisms. Sound planning, design, and management of projects are essential if dredged material disposal is to be accomplished with appropriate environmental protection and in an efficient manner.

Beneficial Use

Ten broad categories of beneficial uses have been identified, based on the functional use of the dredged material or site. They are :

- Habitat restoration/enhancement (wetland, upland, island, and aquatic sites including use by waterfowl and other birds).

- Beach nourishment.
- Aquaculture.
- Parks and recreation (commercial and noncommercial).
- Agriculture, forestry, and horticulture.
- Strip mine reclamation and landfill cover for solid waste management.
- Shoreline stabilization and erosion control (fills, artificial reefs, submerged berms, etc.).
- Construction and industrial use (including port development, airports, urban, and residential).
- Material transfer (fill, dikes, leaves, parking lots, and roads).
- Multiple purpose.

Importance of Materials Management

Material Management is all about purchashing mix. It involves the the procurment of material of in store and and the ability to know the total number of available goods that are to be issued out on request. All the functions are primarily carried out by the store manager whose mission is to ensure that goods are not below average as to satisfy the demands of customers.

The primary and general importance of material management is to ensure that he/she streamlined the issues/demand/sales of the company as to enable him/her to be aware of when the management is short goods and will not go to the extemt of making use of their buffer stock.

3.4 SUPPLY CHAIN MANAGEMENT

Supply chain management (SCM) is the management of a network of interconnected businesses involved in the ultimate provision of product and service packages required by end customers (Harland, 1996). Supply Chain Management spans all movement and storage of raw materials, work-in-process inventory, and finished goods from point of origin to point of consumption (supply chain).

More common and accepted definitions of Supply Chain Management are:

- Supply Chain Management is the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole (Mentzer et. al., 2001).
- A customer focused definition is given by Hines (2004: p76) "Supply chain strategies require a total systems view of the linkages in the chain that work together efficiently to create customer satisfaction at the end point

of delivery to the consumer. As a consequence costs must be lowered throughout the chain by driving out unnecessary costs and focusing attention on adding value. Throughput efficiency must be increased, bottlenecks removed and performance measurement must focus on total systems efficiency and equitable reward distribution to those in the supply chain adding value. The supply chain system must be responsive to customer requirements."

- Global Supply Chain Forum - Supply Chain Management is the integration of key business processes across the supply chain for the purpose of creating value for customers and stakeholders (Lambert, 2008).

A supply chain, as opposed to supply chain management, is a set of organizations directly linked by one or more of the upstream and downstream flows of products, services, finances, and information from a source to a customer. Managing a supply chain is 'supply chain management' (Mentzer et. al., 2001).

Activities/Functions

Supply chain management is a cross-function approach including managing the movement of raw materials into an organization, certain aspects of the internal processing of materials into finished goods, and the movement of finished goods out of the organization and toward the end-consumer. As organizations strive to focus on core competencies and becoming more flexible, they reduce their ownership of raw materials sources and distribution channels. These functions are increasingly being outsourced to other entities that can perform the activities better or more cost effectively. The effect is to increase the number of organizations involved in satisfying customer demand, while reducing management control of daily logistics operations. Less control and more supply chain partners led to the creation of supply chain management concepts. The purpose of supply chain management is to improve trust and collaboration among supply chain partners, thus improving inventory visibility and the velocity of inventory movement.

Strategic

- Strategic network optimization, including the number, location, and size of warehousing, distribution centers, and facilities.
- Strategic partnerships with suppliers, distributors, and customers, creating communication channels for critical information and operational improvements such as cross docking, direct shipping, and third-party logistics.
- Product life cycle management, so that new and existing products can be optimally integrated into the supply chain and capacity management activities.
- Information technology chain operations.

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- Where-to-make and make-buy decisions.
- Aligning overall organizational strategy with supply strategy.
- It is for long term and needs resource commitment.

Tactical

- Sourcing contracts and other purchasing decisions.
- Production decisions, including contracting, scheduling, and planning process definition.
- Inventory decisions, including quantity, location, and quality of inventory.
- Transportation strategy, including frequency, routes, and contracting.
- Benchmarking of all operations against competitors and implementation of best practices throughout the enterprise.
- Milestone payments.
- Focus on customer demand.

Operational

- Daily production and distribution planning, including all nodes in the supply chain.
- Production scheduling for each manufacturing facility in the supply chain (minute by minute).
- Demand planning and forecasting, coordinating the demand forecast of all customers and sharing the forecast with all suppliers.
- Sourcing planning, including current inventory and forecast demand, in collaboration with all suppliers.
- Inbound operations, including transportation from suppliers and receiving inventory.
- Production operations, including the consumption of materials and flow of finished goods.
- Outbound operations, including all fulfillment activities, warehousing and transportation to customers.
- Order promising, accounting for all constraints in the supply chain, including all suppliers, manufacturing facilities, distribution centers, and other customers.
- From production level to supply level accounting all transit damage cases & arrange to settlment at customer level by maintaining company loss through insurance company.

3.5 FUNDAMENTALS OF PURCHASING

Purchasing refers to a business or organization attempting for acquiring goods or services to accomplish the goals of the enterprise. Though there are several organizations that attempt to set standards in the purchasing process,

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processes can vary greatly between organizations. Typically the word "purchasing" is not used interchangeably with the word "procurement", since procurement typically includes Expediting, Supplier Quality, and Traffic and Logistics (T&L) in addition to Purchasing.

Purchasing managers/directors, and procurement managers/directors guide the organization's acquisition procedures and standards. Most organizations use a three-way check as the foundation of their purchasing programs. This involves three departments in the organization completing separate parts of the acquisition process. The three departments do not all report to the same senior manager to prevent unethical practices and lend credibility to the process. These departments can be purchasing, receiving; and accounts payable or engineering, purchasing and accounts payable; or a plant manager, purchasing and accounts payable. Combinations can vary significantly, but a purchasing department and accounts payable are usually two of the three departments involved.

When the receiving department is not involved, it's typically called a two-way check or two-way purchase order. In this situation, the purchasing department issues the purchase order receipt not required. When an invoice arrives against the order, the accounts payable department will then go directly to the requestor of the purchase order to verify that the goods or services were received. This is typically what is done for goods and services that will bypass the receiving department. A few examples are software delivered electronically, NRE work (non reoccuring engineering services), consulting hours, etc.

Historically, the purchasing department issued Purchase Orders for supplies, services, equipment, and raw materials. Then, in an effort to decrease the administrative costs associated with the repetitive ordering of basic consumable items, "Blanket" or "Master" Agreements were put into place. These types of agreements typically have a longer duration and increased scope to maximize the Quantities of Scale concept. When additional supplies are required, a simple release would be issued to the supplier to provide the goods or services.

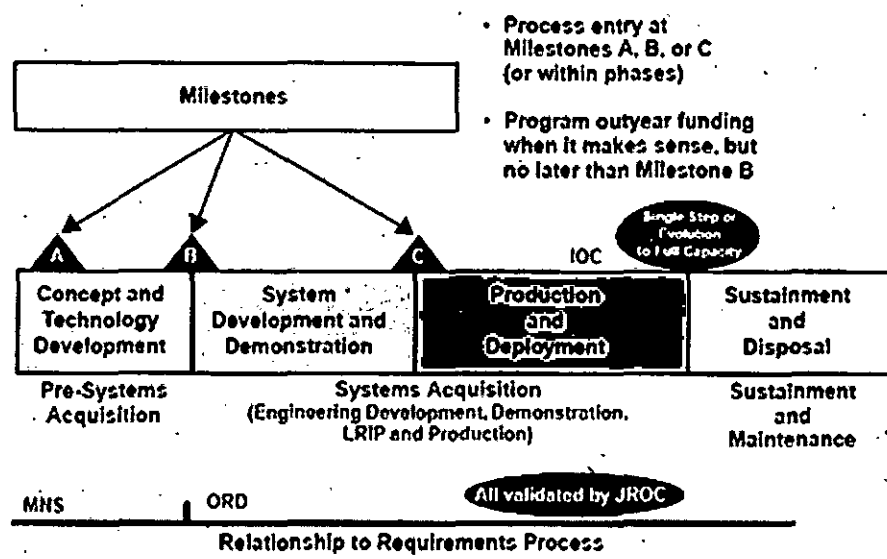
Another method of decreasing administrative costs associated with repetitive contracts for common material, is the use of company credit cards, also known as "Purchasing Cards" or simply "P-Cards". P-card programs vary, but all of them have internal checks and audits to ensure appropriate use. Purchasing managers realized once contracts for the low dollar value consumables are in place, procurement can take a smaller role in the operation and use of the contracts. There is still oversight in the forms of audits and monthly statement reviews, but most of their time is now available to negotiate major purchases and setting up of other long term contracts. These contracts are typically renewable annually.

This trend away from the daily procurement function (tactical purchasing) resulted in several changes in the industry. The first was the reduction of personnel.

Purchasing departments were now smaller. There was no need for the army of clerks processing orders for individual parts as in the past. Another change was the focus on negotiating contracts and procurement of large capital equipment. Both of these functions permitted purchasing departments to make the biggest financial contribution to the organization. A new terms and job title emerged – Strategic sourcing and Sourcing Managers. These professionals not only focused on the bidding process and negotiating with suppliers, but the entire supply function. In these roles they were able to add value and maximize savings for organizations. This value was manifested in lower inventories, less personnel, and getting the end product to the organization's consumer quicker. Purchasing manager's success in these roles resulted in new assignments outside to the traditional purchasing function – logistics, materials management, distribution, and warehousing. More and more purchasing managers were becoming Supply Chain Managers handling additional functions of their organizations operation. Purchasing managers were not the only ones to become Supply Chain Managers. Logistic managers, material managers, distribution managers, etc all rose the broader function and some had responsibility for the purchasing functions now.

Acquisition Process

The revised acquisition process for major systems in industry and defense is shown in the next figure. The process is defined by a series of phases during which technology is defined and matured into viable concepts, which are subsequently developed and readied for production, after which the systems produced are supported in the field.



Model of the Acquisition Process.

The process allows for a given system to enter the process at any of the development phases. For example, a system using unproven technology would

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enter at the beginning stages of the process and would proceed through a lengthy period of technology maturation, while a system based on mature and proven technologies might enter directly into engineering development or, conceivably, even production. The process itself includes four phases of development:

- Concept and Technology Development: is intended to explore alternative concepts based on assessments of operational needs, technology readiness, risk, and affordability.
- Concept and Technology Development phase begins with concept exploration. During this stage, concept studies are undertaken to define alternative concepts and to provide information about capability and risk that would permit an objective comparison of competing concepts.
- System Development and Demonstration phase. This phase could be entered directly as a result of a technological opportunity and urgent user need, as well as having come through concept and technology development.
- The last, and longest, phase is the Sustainment and Disposal phase of the program. During this phase all necessary activities are accomplished to maintain and sustain the system in the field in the most cost-effective manner possible.

Selection of Bidders

This is the process where the organization identifies potential suppliers for specified supplies, services or equipment. These suppliers' credentials (qualifications) and history are analyzed, together with the products or services they offer. The bidder selection process varies from organization to organization, but can include running credit reports, interviewing management, testing products, and touring facilities. This process is not always done in order of importance, but rather in order of expense. Often purchasing managers research potential bidders obtaining information on the organizations and products from media sources and their own industry contacts. Additionally, purchasing might send Request for Information (RFI) to potential suppliers to help gather information.

Engineering would also inspect sample products to determine if the company can produce products they need. If the bidder passes both of these stages engineering may decide to do some testing on the materials to further verify quality standards. These tests can be expensive and involve significant time of multiple technicians and engineers. Engineering management must make this decision based on the cost of the products they are likely to procure, the importance of the bidders' product to production, and other factors. Credit checks, interviewing management, touring plants as well as other steps could all be utilized if engineering, manufacturing, and supply chain managers decide they could help their decision and the cost is justifiable.

Other organizations might have minority procurement goals to consider in selection of bidders. Organizations identify goals in the use of companies owned and operated by certain ethnicities or women owned business enterprises. Significant utilizing of minority suppliers may qualify the firm as a potential bidder for a contract with a company or governmental entity looking to increase their minority supplier programs.

This selection process can include or exclude international suppliers depending on organizational goals and criteria. Companies looking to increase their pacific rim supplier base may exclude suppliers from the Americas, Europe, and Australia. Other organizations may be looking to purchase domestically to ensure a quicker response to orders as well as easier collaboration on design and production.

Organizational goals will dictate the criteria for the selection process of bidders. It is also possible that the product or service being procured is so specialized that the number of bidders are limited and the criteria must be very wide to permit competition. If only one firm can meet the specifications for the product then the purchasing managers must consider utilizing a "Sole Source" option or work with engineering to broaden the specifications if the project will permit alteration in the specifications. The sole source option is the part of the selection of bidders that acknowledges there is sometimes only one reasonable supplier for some services or products. This can be because of the limited applications for the product cannot support more than one manufacturer, proximity of the service provided, or the products are newly designed or invented and competition is not yet available.

Bidding Process

This is the process an organization utilizes to procure goods, services or equipment. Processes vary significantly from the stringent to the very informal. Large corporations and governmental entities are most likely to have stringent and formal processes. These processes can utilize specialized bid forms that require specific procedures and detail. The very stringent procedures require bids to be open by several staff from various departments to ensure fairness and impartiality. Responses are usually very detailed. Bidders not responding exactly as specified and following the published procedures can be disqualified. Smaller private businesses are more likely to have less formal procedures. Bids can be in the form of an email to all of the bidders specifying products or services. Responses by bidders can be detailed or just the proposed amount.

Technical Evaluation

Technical evaluations, evaluations of the technical suitability of the quoted goods or services, if required, are normally performed prior to the commercial evaluation. During this phase of the procurement process, a technical

representative of the company (usually an engineer) will review the proposal and designate each bidder as either technically acceptable or technically unacceptable.

Commercial Evaluation

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Payment Terms

Cost of Money is calculated by multiplying the applicable currency interest rate multiplied by the amount of money paid prior to the receipt of GOODS. If the money were to have remained in the buyer's account, interest would be drawn. That interest is essentially an additional cost associated with such Progress or Milestone payments.

The manufacturing location is taken into consideration during the evaluation stage primarily to calculate freight costs and regional issues which may be considered. For instance, in Europe it is common for factories to close during the month of August for Summer holiday. Labor agreements may also be taken into consideration and may be drawn into the evaluation if the particular region is known to frequent labor unions.

The manufacturing lead-time is the time from the placement of the order (or time final drawings are submitted by the Buyer to the Seller) until the goods are manufactured and prepared for delivery. Lead-times vary by commodity and can range from several days to years.

Transportation time is evaluated while comparing the delivery of goods to the Buyer's required use-date. If Goods are shipped from a remote port, with infrequent vessel transportation, the transportation time could exceed the schedule and adjustments would need to be made.

Delivery Charges - the charge for the Goods to be delivered to a stated point. Bid Validity Packing Bid Adjustments Terms and Conditions Seller's Services Standards Organizations Financial Review Payment Currency Risk Analysis - market volatility, financial stress within the bidders Testing

Negotiating

Negotiating is a key skillset in the Purchasing field. One of the goals of Purchasing Agents is to acquire goods per the most advantageous terms of the buying entity (or simply, the "Buyer").

Purchasing Agents typically attempt to decrease costs while meeting the Buyer's other requirements such as an on-time delivery, compliance to the commercial terms and conditions (including the warranty, the transfer of risk, assignment, auditing rights, confidentiality, remedies, etc).

Good negotiators, those with high levels of documented "cost savings", receive a premium within the industry relative to their compensation. Depending on the employment agreement between the Purchasing Agent (Buyer) and the employer, Buyer's cost savings can result in the creation of value to the business,

and may result in a flat-rate bonus, or a percentage payout to the Purchasing Agent of the documented cost savings.

Post-Award Administration

Post-award administration typically consists of making minor changes, additions or subtractions, that in some way change the terms of the agreement or the Seller's Scope of Supply. Such changes are often minor, but for auditing purposes must be documented into the existing agreement. Examples include increasing the quantity of a Line Item or changing the metallurgy of a particular component.

3.6 QUALITY ASSURANCE

C. D. Lewis defined quality as " the degree to which a specific product satisfies a particular class of consumers or consumers in general or the degree to which it confirms to a design specification or the distinguishing feature of a product's taste, colour, appearance etc".

Product quality has entered the consciousness of the managers with a vengeance. It has become crystal clear that high quality products have a distinct advantage in the marketplace, that market share can be gained or lost over the quality issue. Therefore quality is the competitive priority.

The top management sets basic quality standards and goals based on corporate and market inputs, engineering and R&D express these standards in terms of detailed specifications, purchasing and incoming inspections attempt to ensure that meet specifications, the production system must be designed so that it is capable of meeting quality standards and must then produce the requisite quality; inspection and quality controls establish the procedures to ensure that quality is actually produced maintenance keeps equipment capable of producing the requisite quality and so on.

The slogan, "Quality is everyone's job" is really true. In order to produce quality products everyone should be in on the act. Quality assurance is designed to maintain reliability of the entire productive system to do what it was designed to do.

The following are the typical quality measures of the output of the productive systems : -

Type of System	Measure of Output
Manufacturing	Dimensions, tolerances on dimensions, chemical composition, surface finish, performance tests
Medical service	False positive diagnosis, false negative diagnosis

Postal service	Waiting time at post office, errors in delivery, overall delivery time.
Banks	Waiting time at windows, clerical errors

Produce what consumer wants

Product quality is what is perfect from customers' point of view. There is no point in making chemically pure salt for the consumer market because the customer will not accept it. The goods must be delivered constantly and as per the specifications required by the customers.

Some customers feel that high priced product is of right quality. The idea behind this is that they do not want cheap quality. But they will also not pay too much for their requirements because customer's purchasing power becomes the upper limit for customer's willingness to pay. Hence best quality for a customer is best product at the price he can sacrifice.

Aspects of Quality

1. Quality of design
2. Quality of conformance

Quality of design refers to properties and characteristics acquired by the product at the design and development stage. These properties depend on the type of material used, safety factors allowed, knowledge and skill of design, personnel employed etc. . Quality of design is the fundamental requisite.

Quality of conformance is adherence to the quality of design while the product is being actually produced.

Howsoever successful the production is in achieving quality of conformance; it cannot go beyond quality laid down by design. Design itself should consider the type of manpower available and the equipment used. If design is blind to these aspects, the quality of conformance is likely to drop. Quality is a collaborative effort of the designer and the production engineer.

Importance of Quality

- Existence of manufacturing organization depends on the quality of the product or services it manufactures or supplies.
- Employees feel proud to be associated with a producer of quality product and service.
- Departments and branches in the same organization also feel proud when appreciated for higher quality.
- Customers also like to buy products of high ranked companies.
- A producer of high quality products and services earns high profits and goodwill in the long run.
- Quality is the only tool to compete in today's world.

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- Quality product manufacturer's attract highly skilled and professional people.

Cost of Poor Quality

- Reduction in sales, thus reduction in profits.
- Re-establishment of goodwill lost due to poor quality is difficult and time consuming.
- Cost of rework of the defectives.
- Need of more rigorous inspection and testing.
- People in organisation shift responsibility of defectives on others.
- Indemnity in case of guarantees to customers. ?Replacement of inferior quality products sold. ? Sale of sub- standard products at low price.
- Defective products may cause delays and stoppages in production processes.
- Supplier may have to incur legal cost to face the suits and claim under consumer protection act.
- Forcible withdrawal of substandard product by instruction of the court.
- Wrong use of a product may happen because of improper instructions and labels on the product packing. This may lead to enormous problems.

Two Dimensions of Quality-Positive and Negative

Positive Costs

These costs are attributed to having a spell out optimum quality right from procurement of raw materials to the delivery of the finished product to the final customer.

These costs have two aspects, costs for formulation of strategic policies for total quality. There is an attempt to prevent problems, and solve them when they arise. There are training costs to have a quality culture. Another aspect of positive cost is the inspection cost. Both these aspects are investments, which no organisation can avoid. The positive costs should not exceed 6 p.c. Of total turnover, which is a trivial cost to bear considering the benefits, which accrue therefrom.

Negative Costs

They are three types :

(1) Costs attribute defects creeping in the manufacturing process.

(2) Costs due to rectification of defects like after –sales service costs.

(3) Costs on account of rejection of a consignment by a customer for sub-standard quality goods, especially by an importer.

Many a time, non- production departments contribute a great deal to the negative costs *e.g.*, purchase department, maintenance department, design and engineering department.

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How does the manufacturer decide quality?

The marketing department in terms of quality, quantity and price makes the assessment or study of customer needs. This information is passed on to the design-engineering department. Then a detailed specification is prepared by the design engineer with the help of heads of all departments. The cost of production and ability to produce are also considered while developing the detailed specifications. Thus one can say that specifications are the detailed description of product's design in quantitative terms. Generally three types of specifications are used :

(1) ***Technical specifications***- physical and chemical properties desired in the product. When the desired properties are in the measurable form, they are termed as

(2) ***Performance specifications*** - describe, the performance or use of the products of the products or the services that a product will give. The conformance to the quality can be conformed by using the product.

(3) ***Brand Name***- Performance specification s are extensively used in purchasing highly technical military and space products and also complicated machines and machine tools with sophisticated technology. When it becomes very costly to develop performance or technical specifications or such a practice does prove satisfactory, purchases are made on the basis of brand names.

It should be noted that on the basis of strict specifications, materials parts, and tools etc. may not be available continuously. In such circumstances, if a slight difference in specifications does not affect the quality of the final product or the performance of the product' materials or parts or tools should not be rejected. Considerable judgement should be applied while taking decision of acceptance or otherwise.

3.7 SUMMARY

- Materials management is the branch of logistics that deals with the tangible components of a supply chain. Specifically, this covers the acquisition of spare parts and replacements, quality control of purchasing and ordering such parts.
- Quality control is a large part of materials management. The creation of material standards, inspections, and returns process is a primary responsibility of the materials management group.
- Purchasing refers to a business or organization attempting for acquiring goods or services to accomplish the goals of the enterprise. Though there are several organizations that attempt to set standards in the purchasing process, processes can vary greatly between organizations.

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- C. D. Lewis defined quality as " the degree to which a specific product satisfies a particular class of consumers or consumers in general or the degree to which it confirms to a design specification or the distinguishing feature of a product's taste, colour, appearance etc".

3.8 REVIEW QUESTIONS

1. What do you mean by material management?
2. What is the scope of material management?
3. Discuss the important elements of purchasing.
4. What is quality control?

3.9 FURTHER READINGS

- J.R. Tony Arnold and Stephen N. Chapman, Introduction to Materials Management (5th Edition), Prentice Hall Publication.
- Gopalakrishnan, P., Purchasing and Materials Management, Tata McGraw-Hill Publisher, New Delhi.

UNIT– IV

INVENTORY MANAGEMENT

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STRUCTURE

4.1 LEARNING OBJECTIVES

After going through this unit, students will be able to :

- state the fundamental concept of inventory management;
- know the inventory models and safety;
- discuss various important aspects of inventory management.

4.2 INTRODUCTION

Inventory Management and Inventory Control must be designed to meet the dictates of the marketplace and support the company's strategic plan. The many changes in 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.

Despite the many changes that companies go through, the basic principles of Inventory Management and Inventory Control remain the same. Some of the

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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.

4.3 CONCEPT OF INVENTORY MANAGEMENT

Inventory management, or inventory control, is an attempt to balance inventory needs and requirements with the need to minimize costs resulting from obtaining and holding inventory. There are several schools of thought that view inventory and its function differently. These will be addressed later, but first we present a foundation to facilitate the reader's understanding of inventory and its function.

What is Inventory

Inventory is a quantity or store of goods that is held for some purpose or use (the term may also be used as a verb, meaning to take inventory or to count all goods held in inventory). Inventory may be kept "in-house," meaning on the premises or nearby for immediate use; or it may be held in a distant warehouse or distribution center for future use. With the exception of firms utilizing just-in-time methods, more often than not, the term "inventory" implies a stored quantity of goods that exceeds what is needed for the firm to function at the current time (*e.g.*, within the next few hours).

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4.4 IMPORTANCE OF INVENTORY MANAGEMENT

Why would a firm hold more inventory than is currently necessary to ensure the firm's operation? The following is a list of reasons for maintaining what would appear to be "excess" inventory.

Table 1

	January	*February*	*March*	*April*	*May*	*June*
Demand	50	50	0	100	200	200
Produce	100	100	100	100	100	100
Month-end inventory	50	100	200	200	100	0

Meet Demand

In order for a retailer to stay in business, it must have the products that the customer wants on hand when the customer wants them. If not, the retailer will have to back-order the product. If the customer can get the good from some other source, he or she may choose to do so rather than electing to allow the original retailer to meet demand later (through back-order). Hence, in many instances, if a good is not in inventory, a sale is lost forever.

Keep Operations Running

A manufacturer must have certain purchased items (raw materials, components, or subassemblies) in order to manufacture its product. Running out of only one item can prevent a manufacturer from completing the production of its finished goods.

Inventory between successive dependent operations also serves to decouple the dependency of the operations. A machine or workcenter is often dependent upon the previous operation to provide it with parts to work on. If work ceases at a workcenter, then all subsequent centers will shut down for lack of work. If a supply of work-in-process inventory is kept between each workcenter, then each machine can maintain its operations for a limited time, hopefully until operations resume the original center.

Lead Time

Lead time is the time that elapses between the placing of an order (either a purchase order or a production order issued to the shop or the factory floor) and actually receiving the goods ordered.

If a supplier (an external firm or an internal department or plant) cannot supply the required goods on demand, then the client firm must keep an inventory of the needed goods. The longer the lead time, the larger the quantity of goods the firm must carry in inventory.

A just-in-time (JIT) manufacturing firm, such as Nissan in Smyrna, Tennessee, can maintain extremely low levels of inventory. Nissan takes delivery on truck seats as many as 18 times per day. However, steel mills may have a lead time of up to three months. That means that a firm that uses steel produced at the mill must place orders at least three months in advance of their need. In order to keep their operations running in the meantime, an on-hand inventory of three months' steel requirements would be necessary.

Hedge

Inventory can also be used as a hedge against price increases and inflation. Salesmen routinely call purchasing agents shortly before a price increase goes into effect. This gives the buyer a chance to purchase material, in excess of current need, at a price that is lower than it would be if the buyer waited until after the price increase occurs.

Quality Discount

Often firms are given a price discount when purchasing large quantities of a good. This also frequently results in inventory in excess of what is currently needed to meet demand. However, if the discount is sufficient to offset the extra holding cost incurred as a result of the excess inventory, the decision to buy the large quantity is justified.

Smoothing Requirements

Sometimes inventory is used to smooth demand requirements in a market where demand is somewhat erratic. Consider the demand forecast and production schedule outlined in Table 1.

Notice how the use of inventory has allowed the firm to maintain a steady rate of output (thus avoiding the cost of hiring and training new personnel), while building up inventory in anticipation of an increase in demand. In fact, this is often called anticipation inventory. In essence, the use of inventory has allowed the firm to move demand requirements to earlier periods, thus smoothing the demand.

4.5 CONTROLLING INVENTORY

Firms that carry hundreds or even thousands of different part numbers can be faced with the impossible task of monitoring the inventory levels of each part number.

In order to facilitate this, many firm's use an ABC approach. ABC analysis is based on Pareto Analysis, also known as the "80/20" rule. The 80/20 comes from Pareto's finding that 20 percent of the populace possessed 80 percent of the wealth. From an inventory perspective it can restated thusly: approximately 20 percent

of all inventory items represent 80 percent of inventory costs. Therefore, a firm can control 80 percent of its inventory costs by monitoring and controlling 20 percent of its inventory. But, it has to be the correct 20 percent.

The top 20 percent of the firm's most costly items are termed "A" items (this should approximately represent 80 percent of total inventory costs). Items that are extremely inexpensive or have low demand are termed "C" items, with "B" items falling in between A and C items. The percentages may vary with each firm, but B items usually represent about 30 percent of the total inventory items and 15 percent of the costs. C items generally constitute 50 percent of all inventory items but only around 5 percent of the costs.

By classifying each inventory item as an A, B or C the firm can determine the resources (time, effort and money) to dedicate to each item. Usually this means that the firm monitors A items very closely but can check on B and C items on a periodic basis (for example, monthly for B items and quarterly for C items).

Another control method related to the ABC concept is cycle counting. Cycle counting is used instead of the traditional "once-a-year" inventory count where firms shut down for a short period of time and physically count all inventory assets in an attempt to reconcile any possible discrepancies in their inventory records. When cycle counting is used the firm is continually taking a physical count but not of total inventory.

A firm may physically count a certain section of the plant or warehouse, moving on to other sections upon completion, until the entire facility is counted. Then the process starts all over again.

The firm may also choose to count all the A items, then the B items, and finally the C items. Certainly, the counting frequency will vary with the classification of each item. In other words, A item may be counted monthly, B items quarterly, and C items yearly. In addition the required accuracy of inventory records may vary according to classification, with A items requiring the most accurate record keeping.

4.6 BALANCING INVENTORY AND COSTS

As stated earlier, inventory management is an attempt to maintain an adequate supply of goods while minimizing inventory costs. We saw a variety of reasons companies hold inventory and these reasons dictate what is deemed to be an adequate supply of inventory. Now, how do we balance this supply with its costs? First let's look at what kind of costs we are talking about.

There are three types of costs that together constitute total inventory costs: holding costs, set-up costs, and purchasing costs.

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Holding Costs

Holding costs, also called carrying costs, are the costs that result from maintaining the inventory. Inventory in excess of current demand frequently means that its holder must provide a place for its storage when not in use. This could range from a small storage area near the production line to a huge warehouse or distribution center. A storage facility requires personnel to move the inventory when needed and to keep track of what is stored and where it is stored. If the inventory is heavy or bulky, forklifts may be necessary to move it around.

Storage facilities also require heating, cooling, lighting, and water. The firm must pay taxes on the inventory, and opportunity costs occur from the lost use of the funds that were spent on the inventory. Also, obsolescence, pilferage (theft), and shrinkage are problems. All of these things add cost to holding or carrying inventory.

If the firm can determine the cost of holding one unit of inventory for one year (H) it can determine its annual holding cost by multiplying the cost of holding one unit by the average inventory held for a one-year period. Average inventory can be computed by dividing the amount of goods that are ordered every time an order is placed (Q) by two. Thus, average inventory is expressed as Q /2. Annual holding cost, then, can be expressed as H (Q /2).

Set-up Costs

Set-up costs are the costs incurred from getting a machine ready to produce the desired good. In a manufacturing setting this would require the use of a skilled technician (a cost) who disassembles the tooling that is currently in use on the machine. The disassembled tooling is then taken to a tool room or tool shop for maintenance or possible repair (another cost). The technician then takes the currently needed tooling from the tool room (where it has been maintained; another cost) and brings it to the machine in question.

There the technician has to assemble the tooling on the machine in the manner required for the good to be produced (this is known as a "set-up"). Then the technician has to calibrate the machine and probably will run a number of parts, that will have to be scrapped (a cost), in order to get the machine correctly calibrated and running. All the while the machine has been idle and not producing any parts (opportunity cost). As one can see, there is considerable cost involved in set-up.

If the firm purchases the part or raw material, then an order cost, rather than a set-up cost, is incurred. Ordering costs include the purchasing agent's salary and travel/entertainment budget, administrative and secretarial support, office space, copiers and office supplies, forms and documents, long-distance

telephone bills, and computer systems and support. Also, some firms include the cost of shipping the purchased goods in the order cost.

If the firm can determine the cost of one set-up (S) or one order, it can determine its annual setup/order cost by multiplying the cost of one set-up by the number of set-ups made or orders placed annually. Suppose a firm has an annual demand (D) of 1,000 units. If the firm orders 100 units (Q) every time it places and order, the firm will obviously place 10 orders per year (D / Q). Hence, annual set-up/order cost can be expressed as S (D / Q).

Purching Cost

Purchasing cost is simply the cost of the purchased item itself. If the firm purchases a part that goes into its finished product, the firm can determine its annual purchasing cost by multiplying the cost of one purchased unit (P) by the number of finished products demanded in a year (D). Hence, purchasing cost is expressed as PD.

Now total inventory cost can be expressed as :

Total = Holding cost + Set-up/Order cost + Purchasing cost

or

$$\text{Total} = H (Q /2) + S (D / Q) + PD$$

If holding costs and set-up costs were plotted as lines on a graph, the point at which they intersect (that is, the point at which they are equal) would indicate the lowest total inventory cost. Therefore, if we want to minimize total inventory cost, every time we place an order, we should order the quantity (Q) that corresponds to the point where the two values are equal. If we set the two costs equal and solve for Q we get:

$$H (Q /2) = S (D / Q)$$

$$Q = 2 DS / H$$

The quantity Q is known as the economic order quantity (EOQ). In order to minimize total inventory cost, the firm will order Q every time it places an order. For example, a firm with an annual demand of 12,000 units (at a purchase price of $25 each), annual holding cost of $10 per unit and an order cost of $150 per order (with orders placed once a month) could save $800 annually by utilizing the EOQ. First, we determine the total costs without using the EOQ method:

$$Q = \$10(1000/2) + \$150(12,000/1000) + \$25(12,000) = \$306,800$$

Then we calculate EOQ :

$$EOQ = 2(12,000)(\$150)/\$10= 600$$

And we calculate total costs at the EOQ of 600 :

$$Q = \$10(600/2) + \$150(12,000/600) + \$25(12,000) = \$306,000$$

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Finally, we subtract the total cost of Q from Q to determine the savings :

$306,800 " 306,000 = $800

Notice that if you remove purchasing cost from the equation, the savings is still $800. We might assume this means that purchasing cost is not relevant to our order decision and can be eliminated from the equation. It must be noted that this is true only as long as no quantity discount exists. If a quantity discount is available, the firm must determine whether the savings of the quantity discount are sufficient to offset the loss of the savings resulting from the use of the EOQ.

There are a number of assumptions that must be made with the use of the EOQ. These include :

- Only one product is involved.
- Deterministic demand (demand is known with certainty).
- Constant demand (demand is stable through-out the year).
- No quantity discounts.
- Constant costs (no price increases or inflation).

While these assumptions would seem to make EOQ irrelevant for use in a realistic situation, it is relevant for items that have independent demand. This means that the demand for the item is not derived from the demand for something else (usually a parent item for which the unit in question is a component). For example, the demand for steering wheels would be derived from the demand for automobiles (dependent demand) but the demand for purses is not derived from anything else; purses have independent demand.

2.7 OTHER LOT-SIZING TECHNIQUES

There are a number of other lot-sizing techniques available in addition to EOQ. These include the fixed-order quantity, fixed-order-interval model, the single-period model, and part-period balancing.

Fixed-Order-Quantity Model

EOQ is an example of the fixed-order-quantity model since the same quantity is ordered every time an order is placed. A firm might also use a fixed-order quantity when it is captive to packaging situations. If you were to walk into an office supply store and ask to buy 22 paper clips, chances are you would walk out with 100 paper clips. You were captive to the packaging requirements of paper clips, i.e., they come 100 to a box and you cannot purchase a partial box. It works the same way for other purchasing situations. A supplier may package their goods in certain quantities so that their customers must buy that quantity or a multiple of that quantity.

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Fixed-Order-Interval Model

The fixed-order-interval model is used when orders have to be placed at fixed time intervals such as weekly, biweekly, or monthly. The lot size is dependent upon how much inventory is needed from the time of order until the next order must be placed (order cycle). This system requires periodic checks of inventory levels and is used by many retail firms such as drug stores and small grocery stores.

Single-Period Model

The single-period model is used in ordering perishables, such as food and flowers, and items with a limited life, such as newspapers. Unsold or unused goods are not typically carried over from one period to another and there may even be some disposal costs involved. This model tries to balance the cost of lost customer goodwill and opportunity cost that is incurred from not having enough inventory, with the cost of having excess inventory left at the end of a period.

Part-Time Balancing

Part-period balancing attempts to select the number of periods covered by the inventory order that will make total carrying costs as close as possible to the set-up/order cost.

When a proper lot size has been determined, utilizing one of the above techniques, the reorder point, or point at which an order should be placed, can be determined by the rate of demand and the lead time. If safety stock is necessary it would be added to the reorder point quantity.

Reorder point = Expected demand during lead time + Safety stock

Thus, an inventory item with a demand of 100 per month, a two-month lead time and a desired safety stock of two weeks would have reorder point of 250. In other words, an order would be placed whenever the inventory level for that good reached 250 units.

Reorder point = 100/month × 2 months + 2 weeks' safety stock = 250

2.8 OTHER SCHOOLS OF THOUGHT IN INVENTORY MANAGEMENT

There are a number of techniques and philosophies that view inventory management from different perspectives.

MRP and MRP II

MRP and MRP II are computer-based resource management systems designed for items that have dependent demand. MRP and MRP II look at order quantities period by period and, as such, allow discrete ordering (ordering only

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what is currently needed). In this way inventory levels can be kept at a very low level; a necessity for a complex item with dependent demand.

Just-in-Time (JIT)

Just-in-time (JIT) is a philosophy that advocates the lowest possible levels of inventory. JIT espouses that firms need only keep inventory in the right quantity at the right time with the right quality. The ideal lot size for JIT is one, even though one hears the term "zero inventory" used.

Theory of Constraints (TOC)

Theory of constraints (TOC) is a philosophy which emphasizes that all management actions should center around the firm's constraints. While it agrees with JIT that inventory should be at the lowest level possible in most instances, it advocates that there be some buffer inventory around any capacity constraint (e.g., the slowest machine) and before finished goods.

4.9 THE FUTURE OF INVENTORY MANAGEMENT

The advent, through altruism or legislation, of environmental management has added a new dimension to inventory management-reverse supply chain logistics. Environmental management has expanded the number of inventory types that firms have to coordinate. In addition to raw materials, work-in-process, finished goods, and MRO goods, firms now have to deal with post-consumer items such as scrap, returned goods, reusable or recyclable containers, and any number of items that require repair, reuse, recycling, or secondary use in another product. Retailers have the same type problems dealing with inventory that has been returned due to defective material or manufacture, poor fit, finish, or color, or outright "I changed my mind" responses from customers.

Finally, supply chain management has had a considerable impact on inventory management. Instead of managing one's inventory to maximize profit and minimize cost for the individual firm, today's firm has to make inventory decisions that benefit the entire supply chain.

4.10 INVENTORY TYPES

Inventory is defined as a stock or store of goods. These goods are maintained on hand at or near a business's location so that the firm may meet demand and fulfill its reason for existence. If the firm is a retail establishment, a customer may look elsewhere to have his or her needs satisfied if the firm does not have the required item in stock when the customer arrives. If the firm is a manufacturer, it must maintain some inventory of raw materials and work-in-process in order to keep the factory running. In addition, it must maintain some supply of finished goods in order to meet demand.

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Sometimes, a firm may keep larger inventory than is necessary to meet demand and keep the factory running under current conditions of demand. If the firm exists in a volatile environment where demand is dynamic (i.e., rises and falls quickly), an on-hand inventory could be maintained as a buffer against unexpected changes in demand. This buffer inventory also can serve to protect the firm if a supplier fails to deliver at the required time, or if the supplier's quality is found to be substandard upon inspection, either of which would otherwise leave the firm without the necessary raw materials. Other reasons for maintaining an unnecessarily large inventory include buying to take advantage of quantity discounts (i.e., the firm saves by buying in bulk), or ordering more in advance of an impending price increase.

Generally, inventory types can be grouped into four classifications: raw material, work-in-process, finished goods, and MRO goods.

Raw Materials

Raw materials are inventory items that are used in the manufacturer's conversion process to produce components, subassemblies, or finished products. These inventory items may be commodities or extracted materials that the firm or its subsidiary has produced or extracted. They also may be objects or elements that the firm has purchased from outside the organization. Even if the item is partially assembled or is considered a finished good to the supplier, the purchaser may classify it as a raw material if his or her firm had no input into its production. Typically, raw materials are commodities such as ore, grain, minerals, petroleum, chemicals, paper, wood, paint, steel, and food items. However, items such as nuts and bolts, ball bearings, key stock, casters, seats, wheels, and even engines may be regarded as raw materials if they are purchased from outside the firm.

The bill-of-materials file in a material requirements planning system (MRP) or a manufacturing resource planning (MRP II) system utilizes a tool known as a product structure tree to clarify the relationship among its inventory items and provide a basis for filling out, or "exploding," the master production schedule. Consider an example of a rolling cart. This cart consists of a top that is pressed from a sheet of steel, a frame formed from four steel bars, and a leg assembly consisting of four legs, rolled from sheet steel, each with a caster attached.

Generally, raw materials are used in the manufacture of components. These components are then incorporated into the final product or become part of a subassembly. Subassemblies are then used to manufacture or assemble the final product. A part that goes into making another part is known as a component, while the part it goes into is known as its parent. Any item that does not have a component is regarded as a raw material or purchased item. From the product structure tree it is apparent that the rolling cart's raw materials are steel, bars, wheels, ball bearings, axles, and caster frames.

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Work-in-Process

Work-in-process (WIP) is made up of all the materials, parts (components), assemblies, and subassemblies that are being processed or are waiting to be processed within the system. This generally includes all material—from raw material that has been released for initial processing up to material that has been completely processed and is awaiting final inspection and acceptance before inclusion in finished goods.

Any item that has a parent but is not a raw material is considered to be work-in-process. A glance at the rolling cart product structure tree example reveals that work-in-process in this situation consists of tops, leg assemblies, frames, legs, and casters. Actually, the leg assembly and casters are labeled as subassemblies because the leg assembly consists of legs and casters and the casters are assembled from wheels, ball bearings, axles, and caster frames.

Finished Goods

A finished good is a completed part that is ready for a customer order. Therefore, finished goods inventory is the stock of completed products. These goods have been inspected and have passed final inspection requirements so that they can be transferred out of work-in-process and into finished goods inventory. From this point, finished goods can be sold directly to their final user, sold to retailers, sold to wholesalers, sent to distribution centers, or held in anticipation of a customer order.

Any item that does not have a parent can be classified as a finished good. By looking at the rolling cart product structure tree example one can determine that the finished good in this case is a cart.

Inventories can be further classified according to the purpose they serve. These types include transit inventory, buffer inventory, anticipation inventory, decoupling inventory, cycle inventory, and MRO goods inventory. Some of these also are know by other names, such as speculative inventory, safety inventory, and seasonal inventory. We already have briefly discussed some of the implications of a few of these inventory types, but will now discuss each in more detail.

Transit Inventory

Transit inventories result from the need to transport items or material from one location to another, and from the fact that there is some transportation time involved in getting from one location to another. Sometimes this is referred to as pipeline inventory. Merchandise shipped by truck or rail can sometimes take days or even weeks to go from a regional warehouse to a retail facility. Some large firms, such as automobile manufacturers, employ freight consolidators to pool their transit inventories coming from various locations into one shipping source in order to take advantage of economies of scale. Of course, this can greatly

increase the transit time for these inventories, hence an increase in the size of the inventory in transit.

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Buffer Inventory

As previously stated, inventory is sometimes used to protect against the uncertainties of supply and demand, as well as unpredictable events such as poor delivery reliability or poor quality of a supplier's products. These inventory cushions are often referred to as safety stock. Safety stock or buffer inventory is any amount held on hand that is over and above that currently needed to meet demand. Generally, the higher the level of buffer inventory, the better the firm's customer service. This occurs because the firm suffers fewer "stock-outs" (when a customer's order cannot be immediately filled from existing inventory) and has less need to backorder the item, make the customer wait until the next order cycle, or even worse, cause the customer to leave empty-handed to find another supplier. Obviously, the better the customer service the greater the likelihood of customer satisfaction.

Anticipation Inventory

Oftentimes, firms will purchase and hold inventory that is in excess of their current need in anticipation of a possible future event. Such events may include a price increase, a seasonal increase in demand, or even an impending labor strike. This tactic is commonly used by retailers, who routinely build up inventory months before the demand for their products will be unusually high (i.e., at Halloween, Christmas, or the back-to-school season). For manufacturers, anticipation inventory allows them to build up inventory when demand is low (also keeping workers busy during slack times) so that when demand picks up the increased inventory will be slowly depleted and the firm does not have to react by increasing production time (along with the subsequent increase in hiring, training, and other associated labor costs). Therefore, the firm has avoided both excessive overtime due to increased demand and hiring costs due to increased demand. It also has avoided layoff costs associated with production cut-backs, or worse, the idling or shutting down of facilities. This process is sometimes called "smoothing" because it smoothes the peaks and valleys in demand, allowing the firm to maintain a constant level of output and a stable workforce.

Decoupling Inventory

Very rarely, if ever, will one see a production facility where every machine in the process produces at exactly the same rate. In fact, one machine may process parts several times faster than the machines in front of or behind it. Yet, if one walks through the plant it may seem that all machines are running smoothly at the same time. It also could be possible that while passing through the plant, one notices several machines are under repair or are undergoing some form of

preventive maintenance. Even so, this does not seem to interrupt the flow of work-in-process through the system. The reason for this is the existence of an inventory of parts between machines, a decoupling inventory that serves as a shock absorber, cushioning the system against production irregularities. As such it "decouples" or disengages the plant's dependence upon the sequential requirements of the system (i.e., one machine feeds parts to the next machine).

The more inventory a firm carries as a decoupling inventory between the various stages in its manufacturing system (or even distribution system), the less coordination is needed to keep the system running smoothly. Naturally, logic would dictate that an infinite amount of decoupling inventory would not keep the system running in peak form. A balance can be reached that will allow the plant to run relatively smoothly without maintaining an absurd level of inventory. The cost of efficiency must be weighed against the cost of carrying excess inventory so that there is an optimum balance between inventory level and coordination within the system.

Cycle Inventory

Those who are familiar with the concept of economic order quantity (EOQ) know that the EOQ is an attempt to balance inventory holding or carrying costs with the costs incurred from ordering or setting up machinery. When large quantities are ordered or produced, inventory holding costs are increased, but ordering/setup costs decrease. Conversely, when lot sizes decrease, inventory holding/carrying costs decrease, but the cost of ordering/setup increases since more orders/setups are required to meet demand. When the two costs are equal (holding/carrying costs and ordering/setup costs) the total cost (the sum of the two costs) is minimized. Cycle inventories, sometimes called lot-size inventories, result from this process. Usually, excess material is ordered and, consequently, held in inventory in an effort to reach this minimization point. Hence, cycle inventory results from ordering in batches or lot sizes rather than ordering material strictly as needed.

MRO Goods Inventory

Maintenance, repair, and operating supplies, or MRO goods, are items that are used to support and maintain the production process and its infrastructure. These goods are usually consumed as a result of the production process but are not directly a part of the finished product. Examples of MRO goods include oils, lubricants, coolants, janitorial supplies, uniforms, gloves, packing material, tools, nuts, bolts, screws, shim stock, and key stock. Even office supplies such as staples, pens and pencils, copier paper, and toner are considered part of MRO goods inventory.

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In their book Managing Business Process Flows: Principles of Operations Management, Anupindi, Chopra, Deshmukh, Van Mieghem, and Zemel discuss a final type of inventory known as theoretical inventory. They describe theoretical inventory as the average inventory for a given throughput assuming that no WIP item had to wait in a buffer. This would obviously be an ideal situation where inflow, processing, and outflow rates were all equal at any point in time. Unless one has a single process system, there always will be some inventory within the system. Theoretical inventory is a measure of this inventory (i.e., it represents the minimum inventory needed for goods to flow through the system without waiting). The authors formally define it as the minimum amount of inventory necessary to maintain a process throughput of R, expressed as :

Theoretical Inventory = Throughput × Theoretical Flow Time

$$I_{th} = R \times T_{th}$$

In this equation, theoretical flow time equals the sum of all activity times (not wait time) required to process one unit. Therefore, WIP will equal theoretical inventory whenever actual process flow time equals theoretical flow time.

Inventory exists in various categories as a result of its position in the production process (raw material, work-in-process, and finished goods) and according to the function it serves within the system (transit inventory, buffer inventory, anticipation inventory, decoupling inventory, cycle inventory, and MRO goods inventory). As such, the purpose of each seems to be that of maintaining a high level of customer service or part of an attempt to minimize overall costs.

4.11 SUMMARY

- Inventory Management and Inventory Control must be designed to meet the dictates of the marketplace and support the company's strategic plan. The many changes in market demand, new opportunities due to worldwide marketing, global sourcing of materials, and new manufacturing technology.
- Inventory management, or inventory control, is an attempt to balance inventory needs and requirements with the need to minimize costs resulting from obtaining and holding inventory.
- There are three types of costs that together constitute total inventory costs: holding costs, set-up costs, and purchasing costs.
- There are a number of other lot-sizing techniques available in addition to EOQ. These include the fixed-order quantity, fixed-order-interval model, the single-period model, and part-period balancing.
- Transit inventories result from the need to transport items or material

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from one location to another, and from the fact that there is some transportation time involved in getting from one location to another.

4.12 REVIEW QUESTIONS

1. What is inventory? Why is it called a necessary evil for an organisation?
2. What do you favour —inventory depletion or inventory accumulation ? Explain.
3. Explain various methods of inventory control with a special stress on ABC analysis.
4. Explain selective inventory control and its techniques ?
5. Discuss features of any two type of inventories.

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UNIT– V

MATERIALS REQUIREMENT PLANNING

STRUCTURE

5.1 LEARNING OBJECTIVES

After going through this unit, students will be able to :

- state the fundamental concept of material requirement planning;
- explain the concept of stores management;
- discuss various important aspects of material requirement planning.

5.2 INTRODUCTION

Material requirements planning (MRP) is a production planning and inventory control system used to manage manufacturing processes. Most MRP systems are software-based, while it is possible to conduct MRP by hand as well.

An MRP system is intended to simultaneously meet three objectives :

- Ensure materials and products are available for production and delivery to customers.
- Maintain the lowest possible level of inventory.
- Plan manufacturing activities, delivery schedules and purchasing activities.

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5.3 THE SCOPE OF MRP IN MANUFACTURING

The basic function of MRP system includes inventory control, bill of material processing and elementary scheduling. MRP helps organizations to maintain low inventory levels. It is used to plan manufacturing, purchasing and delivering activities.

"Manufacturing organizations, whatever their products, face the same daily practical problem - that customers want products to be available in a shorter time than it takes to make them. This means that some level of planning is required."

Companies need to control the types and quantities of materials they purchase, plan which products are to be produced and in what quantities and ensure that they are able to meet current and future customer demand, all at the lowest possible cost. Making a bad decision in any of these areas will make the company lose money. A few examples are given below :

- If a company purchases insufficient quantities of an item used in manufacturing, or the wrong item, they may be unable to meet contracts to supply products by the agreed date.
- If a company purchases excessive quantities of an item, money is being wasted - the excess quantity ties up cash while it remains as stock and may never even be used at all. However, some purchased items will have a minimum quantity that must be met, therefore, purchasing excess is necessary.
- Beginning production of an order at the wrong time can cause customer deadlines to be missed.

MRP is a tool to deal with these problems. It provides answers for several questions :

- What items are required?
- How many are required?
- When are they required?

MRP can be applied both to items that are purchased from outside suppliers and to sub-assemblies, produced internally, that are components of more complex items.

The data that must be considered include :

- The end item (or items) being created. This is sometimes called Independent Demand, or Level "0" on BOM (Bill of materials).
- How much is required at a time.
- When the quantities are required to meet demand.
- Shelf life of stored materials.

- ***Inventory status records.*** Records of net materials available for use already in stock (on hand) and materials on order from suppliers.
- ***Bills of materials.*** Details of the materials, components and sub-assemblies required to make each product.
- ***Planning Data.*** This includes all the restraints and directions to produce the end items. This includes such items as: Routings, Labor and Machine Standards, Quality and Testing Standards, Pull/Work Cell and Push commands, Lot sizing techniques (i.e. Fixed Lot Size, Lot-For-Lot, Economic Order Quantity), Scrap Percentages, and other inputs.

5.4 CONCEPT OF MATERIAL REQUIREMENT PLANNING

Material requirements planning (MRP) is a computer-based inventory management system designed to assist production managers in scheduling and placing orders for dependent demand items. Dependent demand items are components of finished goods—such as raw materials, component parts, and subassemblies—for which the amount of inventory needed depends on the level of production of the final product. For example, in a plant that manufactured bicycles, dependent demand inventory items might include aluminum, tires, seats, and derailleurs.

The first MRP systems of inventory management evolved in the 1940s and 1950s. They used mainframe computers to explode information from a bill of materials for a certain finished product into a production and purchasing plan for components. Before long, MRP was expanded to include information feedback loops so that production personnel could change and update the inputs into the system as needed. The next generation of MRP, known as manufacturing resources planning or MRP II, also incorporated marketing, finance, accounting, engineering, and human resources aspects into the planning process. A related concept that expands on MRP is enterprise resources planning (ERP), which uses computer technology to link the various functional areas across an entire business enterprise.

MRP works backward from a production plan for finished goods to develop requirements for components and raw materials. "MRP begins with a schedule for finished goods that is converted into a schedule of requirements for the subassemblies, component parts, and raw materials needed to produce the finished items in the specified time frame," William J. Stevenson wrote in his book Production/Operations Management. "Thus, MRP is designed to answer three questions: what is needed? how much is needed? and when is it needed?"

MRP breaks down inventory requirements into planning periods so that production can be completed in a timely manner while inventory levels—and related carrying costs—are kept to a minimum. Implemented and used properly,

it can help production managers plan for capacity needs and allocate production time. But MRP systems can be time consuming and costly to implement, which may put them out of range for some small businesses. In addition, the information that comes out of an MRP system is only as good as the information that goes into it.

Companies must maintain current and accurate bills of materials, part numbers, and inventory records if they are to realize the potential benefits of MRP.

5.5 MRP INPUTS

According to Stevenson, the information input into MRP systems comes from three main sources: a bill of materials, a master schedule, and an inventory records file. The bill of materials is a listing of all the raw materials, component parts, subassemblies, and assemblies required to produce one unit of a specific finished product. Each different product made by a given manufacturer will have its own separate bill of materials.

The bill of materials is arranged in a hierarchy, so that managers can see what materials are needed to complete each level of production. MRP uses the bill of materials to determine the quantity of each component that is needed to produce a certain number of finished products. From this quantity, the system subtracts the quantity of that item already in inventory to determine order requirements.

The master schedule outlines the anticipated production activities of the plant. Developed using both internal forecasts and external orders, it states the quantity of each product that will be manufactured and the time frame in which they will be needed. As Stevenson explained, the master schedule separates the planning horizon into time "buckets," which are usually calendar weeks. The schedule must cover a time frame long enough to produce the final product. This total production time is equal to the sum of the lead times of all the related fabrication and assembly operations. It is important to note that master schedules are often generated according to demand and without regard to capacity. An MRP system cannot tell in advance if a schedule is not feasible, so managers may have to run several possibilities through the system before they find one that works.

The inventory records file provides an accounting of how much inventory is already on hand or on order, and thus should be subtracted from the material requirements. "The inventory records file is used to store information on the status of each item by time period," Stevenson noted. "This includes gross requirements, scheduled receipts, and expected amount on hand. It also includes other details for each item, such as supplier, lead time, and lot size."

5.6 MRP PROCESSING

Using information culled from the bill of materials, master schedule, and inventory records file, an MRP system determines the net requirements for raw materials, component parts, and subassemblies for each period on the planning horizon. MRP processing first determines gross material requirements, then subtracts out the inventory on hand and adds back in the safety stock in order to compute the net requirements.

As Stevenson explained, the main outputs from MRP include three primary reports and three secondary reports. The primary reports consist of: planned order schedules, which outline the quantity and timing of future material orders; order releases, which authorize orders to be made; and changes to planned orders, which might include cancellations or revisions of the quantity or time frame. The secondary reports generated by MRP include: performance control reports, which are used to track problems like missed delivery dates and stock outs in order to evaluate system performance; planning reports, which can be used in forecasting future inventory requirements; and exception reports, which call managers' attention to major problems like late orders or excessive scrap rates.

Although working backward from the production plan for a finished product to determine the requirements for components may seem like a simple process, it can actually be extremely complicated, especially when some raw materials or parts are used in a number of different products. Frequent changes in product design, order quantities, or production schedule also complicate matters. "The importance of the computer becomes evident when you consider that a typical firm would have not one but many end items for which it needs to develop material requirements plans, each with its own set of components," Stevenson explained. "Differences in timing of demands and quantities needed, revisions caused by late deliveries, high scrap rates, and canceled orders all have an impact on processing."

5.7 BENEFITS AND DRAWBACKS OF MRP

MRP systems offer a number of potential benefits to manufacturing firms. Some of the main benefits include helping production managers to minimize inventory levels and the associated carrying costs, track material requirements, determine the most economical lot sizes for orders, compute quantities needed as safety stock, allocate production time among various products, and plan for future capacity needs. The information generated by MRP systems is useful in other areas as well. "A range of people in a typical manufacturing company are important users of the information provided by an MRP system," Stevenson wrote. "Production planners are obvious users of MRP. Production managers, who must balance work loads across departments and make decisions about scheduling work, and plant foremen, who are responsible for issuing work orders

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and maintaining production schedules, also rely heavily on MRP output. Other users include customer service representatives, who must be able to supply customers with projected delivery dates, purchasing managers, and inventory managers."

MRP systems also have several potential drawbacks, however. First, MRP relies upon accurate input information. If a small business has not maintained good inventory records or has not updated its bills of materials with all relevant changes, it may encounter serious problems with the outputs of its MRP system. The problems could range from missing parts and excessive order quantities to schedule delays and missed delivery dates. At a minimum, an MRP system must have an accurate master production schedule, good lead time estimates, and current inventory records in order to function effectively and produce useful information.

Another potential drawback associated with MRP is that the systems can be difficult, time consuming, and costly to implement. Many businesses encounter resistance from employees when they try to implement MRP. For example, employees who once got by with sloppy record keeping may resent the discipline MRP requires. Or departments that became accustomed to hoarding parts in-case of inventory shortages might find it difficult to trust the system and let go of that habit.

The key to making MRP implementation work is to provide training and education for all affected employees. "It is vital to identify whose power base will be affected by a new system," William J. Sawaya wrote in Industrial Management. "These persons must be converted or the system will fail. Key personnel must be convinced that they personally will be better served by the new system than by any other alternative." One way to improve employee acceptance of MRP systems is to adjust reward systems to reflect production and inventory management goals. "People generally act in their own self-interest," Sawaya noted. "If the performance measures that are used in determining compensation and promotion do not adequately address materials management, then no system in the world can significantly improve the situation."

5.8 MRP II

In the 1980s, MRP technology was expanded to create a new approach called manufacturing resources planning, or MRP II. "The techniques developed in MRP to provide valid production schedules proved so successful that organizations became aware that with valid schedules other resources could be better planned and controlled," Gordon Minty noted in his book Production Planning and Controlling. "The areas of marketing, finance, and personnel were affected by the improvement in customer delivery commitments, cash flow projections, and personnel management projections."

Minty went on to explain that MRP II "has not replaced MRP, nor is it an improved version of it. Rather, it represents an effort to expand the scope of production resource planning and to involve other functional areas of the firm in the planning process," such as marketing, finance, engineering, purchasing, and human resources. MRP II differs from MRP in that all of these functional areas have input into the master production schedule. From that point, MRP is used to generate material requirements and help production managers plan capacity. MRP II systems often include simulation capabilities so managers can evaluate various options.

5.9 STORE MANAGEMENT

A store manager is the person ultimately responsible for the day-to-day operations (or management) of a retail store. All employees working in the store report to the store manager. A store manager reports to a district or general manager.

Roles and Responsibilities

Responsibilities of a store manager may include :

- Human Resources, specifically: recruiting, hiring, training and development, performance management, payroll, and schedule workplace scheduling.
- Store business operations, including managing profit and loss, facility management, safety and security, loss prevention (also called shrink), and banking.
- Product management, including ordering, receiving, price changes, handling damaged products, and returns.
- Team Development, facilitating staff learning and development.
- Problem solving, handling unusual circumstances.

Sales Generation

A store manager must meet monthly, quarterly, or annual sales goals, depending on the company's fiscal cycle. This involves setting individual sales goals (quotas), holding contests for employees, or offering sales promotions. The manager may also receive a monetary incentive (or "bonus") tied to financial performance over a specific period. This incentive may be based on net sales, profitability, or both. Thus, the store manager may be forced to reduce payroll expenditures by decreasing employees' hours, or otherwise reducing operating costs.

Safety and Security

The Store manager is the store's primary key-holder and may be called to the store before, during, or after business hours in the event of an emergency.

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They are also responsible for the safety of all customers and employees on store premises. Store managers may be required to hold safety meetings, especially as dictated by union practices in cases where store employees belong to a union.

Division of Responsibility

A store manager may have several subordinates who have management-level responsibility. These employees may be called assistant managers, supervisors, keyholders, shift leads, or leads.

Hiring, Training and Development

The store manager is responsible for hiring, training, and in some cases, development, of employees. The manager must ensure staffing levels are adequate to effectively operate the store, and ensure employees receive training necessary for their job responsibilities. Managers may be responsible for developing employees so the company can promote employees from within and develop future leaders, potentially for employment at other locations. these kind of roll store manager has to be do according to company to company.

Visual Merchandising and Inventory Control

In retail locations, store managers are responsible for visual merchandising. Many companies communicate how to merchandise their stores using direction such as planograms to indicate product placement. While managers have a varying degree of autonomy in deviating from corporate direction, it is important to ensure that stores are compliant with the company's brand image. Managers must ensure that the proper amount of inventory is displayed for customers to purchase, by ensuring that shelves and racks remain stocked and that product is frequently rotated out of storage areas. Managers are also concerned with shrinkage, and must ensure that merchandising techniques and customer service skills minimize the possibility of product being stolen.

5.10 SUMMARY

- Material requirements planning (MRP) is a production planning and inventory control system used to manage manufacturing processes.
- The basic function of MRP system includes inventory control, bill of material processing and elementary scheduling. MRP helps organizations to maintain low inventory levels. It is used to plan manufacturing, purchasing and delivering activities.
- MRP systems offer a number of potential benefits to manufacturing firms. Some of the main benefits include helping production managers to minimize inventory levels and the associated carrying costs, track material requirements, determine the most economical lot sizes for orders, compute quantities needed as safety stock etc.

- A store manager is the person ultimately responsible for the day-to-day operations (or management) of a retail store. All employees working in the store report to the store manager. A store manager reports to a district or general manager.

5.11 REVIEW QUESTIONS

1. What is material requirement planning?
2. Discuss the scope of MRP in manufacturing sector.
3. Explain the method of MRP processing.
4. Describe the roles and responsibilities of store manager.

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