Production and Operation Management

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DIRECTOR

PRODUCTION AND OPERATION MANAGEMENT

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UNIT 1 INTRODUCTION TO PRODUCTION MANAGEMENT

Structure

1.0 OBJECTIVES

After completing this unit, you will be able to learn about:

- Meaning of product and its function.
- Introduction of production management.
- Scope of production management.
- Production system.
- Types of production.
- Benefits of production management.
- Responsibilities of production manager.
- Decisions of production management.

1.1 INTRODUCTION

Product is the primary factor for all consumers in a market. Product means want satisfying capacity of an element. If a consumer is not satisfied with the product it becomes meaningless for the producer who produces the product. So product should have want satisfaction capacity in a market for the consumers otherwise the marketing procedure will be meaningless. The production function of a business is concerned with creation of either a product or a service required to satisfy a consumer need in the market. It is impossible to have a product for the consumers without its production. So production management is a separate branch of management which deals with the production of goods and services for the effective utilisation of consumers in the market.

Production Function: Any process which involves conversion of raw material into finished product for satisfaction of human wants is called as production. Production function refers to creation of goods and services in order to satisfy human needs by converting resources into outputs. Otherwise it is the process of conversion of raw materials into finished product. Production function can be effective when it satisfy the (A) the consumer demand relating to quality, quantity and price (B) permit the production activity in an economical manner so that return in investment can be possible. It may be concluded that production function not only limited

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to conversion of input to output but also deals with transportation, storage, preservation and quality assurance for the consumers in the market.

1.2 PRODUCTION MANAGEMENT

Production management is called upon to develop and establish relationship between market demand and production capability of an enterprise. It ensures accomplishment of twin organisational objectives of production and satisfaction. Both these objectives can be fulfilled with planning, organising, directing, and controlling and inventory management. Production management is the process of effectively coordinating and controlling the factors of production such as man, machine, material, money and management in order to get satisfaction out of the product.

Production management is the process of transforming the input into output by creating various utility which can add value to those created output. While the input is transferred into output various types of utility are created. Some of the utilities are:

1. ***Form Utility:*** When the input is changed in size, weight, colour, shape and form while converting into output for the benefit of the customers in the market it has form utility. (Cotton changed into different dress materials).
2. ***Place Utility:*** When the input is changed from the place of its availability to the place of their use to be converted into output through transportation is known as place utility.(Sugarcane to the factory for sugar production)
3. ***Time Utility:*** When either the input or the output is preserved for storage purpose in order to be utilised when there is a scarcity of that product to be utilised by the consumers.(Potato & Tomato in cold storage)
4. ***Service Utility:*** When some utility is created by rendering some service to the customer either directly or indirectly for a definite time period it is called as service utility of the product.(Doctors for the patient , lawyers for the clients, teachers for the students)
5. ***Knowledge Utility:*** When some information is communicated to the customer by imparting some knowledge about the product through presentation or advertisement. (Advertisement for a product or service)

1.3 SCOPE OF PRODUCTION MANAGEMENT

Production Management has the following scopes:

1. ***Production Planning and Development:*** It is related to the activity of evolution of new product and design it according to the specification of department in order to satisfy large number of consumers in the market.
2. ***Production Administration:*** It deals with basic three activities that is (A) Production planning, (B) production engineering,(C) production control. All the above functions under production management have its own value and importance. Production management system directly depends on this scope.
3. ***Implementation Function:*** It refers to the activity of execution of plan, policies and decisions. It is a continuous activity in production management system which requires motivation of employees who are in charge of production so that the things can be produced in time.
4. ***Other Allied Activity:*** These are some of the other activity related to standardisation, simplification, specialisation, quality control, inventory control, research and development.

1.4 PRODUCTION SYSTEM

Production system deals with functions of input, process, output, demand forecast and manufacturing control system. Where input refers to utilisation of men, material, machine, money,

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minute and methods. Process refers to manufacturing activity like semi finished product, by-product, finished product. Output is the product service which in other means the final product as per specifications. Demand forecast means consumer demand and the change in consumer demand in the market depend on the market competition. Manufacturing control system is the inventory and plant location measures for an effective and in time production system.

Production system is the application of management functions in production process through planning, organising, directing and controlling managerial functions in the process of converting input into desired output in an efficient and effective manner.

Production system includes all those operations by which the input can be converted into output for a desired product or a service. The service may be tangible or intangible it is the system which generates consumer satisfaction. Hence according to some authors production system is otherwise known as operation system so as production management can be referred as operations management.

1.5 TYPES OF PRODUCTION

Production can be divided into three categories. All the production process is related to conversion of input into output and services for the better use of mankind. Considering this type of production can be:

1. ***Flow Production:*** This is a type of production which is otherwise known as mass production. Under this category production is running in a sequence. There will be no gap in between two production processes. Time taken in each operation can be maintained by utilising update and more machines in order to have steady flow of operation. This type of production is more suitable for high demand products. The merit of this production is in each production operation there can be strict check and measure in input and output too. Maximum attention can be made towards supply of raw material, machine capacity and quality standards so that any defect in production process can be identified easily to have qualitative production in each process.

   Example: Motor Car.

2. ***Batch Production:*** Where there is less scope of flow production that is sequence of production is not available in those production organisations batch production is more suitable type of production. In this category each production is divided into small components. This is called batch production. Under this type of production process the entire production system is divided into various batch or components according to the need of the specification of the product. In order to smooth the production process different machines can be used for each batch and the quality in each batch can be measured properly. On the other hand a product can be available in different functional areas.

   Example: Pressing in one area, milling in other area, colour in other area etc.

3. ***Unit Production:*** This is a type of production where there is a specific order from the customer. Generally this type of production is for a specific period and not repetitive in character. This type of production undertaken by the organisation considering the demand of the customers for that product. This type of production has specific standard, quality, specification in size, colour, weight as well as packing also. Most of the production organisation does not prefer unit production due to its cost and in most of the cases it is not a regular production process.

   Example: Designed ornament, size foot wear etc.

1.6 BENEFITS OF PRODUCTION MANAGEMENT

Production management is essential and beneficial different parties like:

1. ***The Consumer:*** The benefit of production goes primarily to the customer. All the goods and services are meant for the use of customers. A good production management system helps the

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customer from higher productivity, better and reliable quality, reasonable price, satisfactory service and timely delivery of goods and services. So the benefit of production management system goes to the consumer in the society.

2. ***The Employee:*** A good production management system benefits the employees of an organisation. Higher remuneration, job security, stable employment opportunity, better working condition as well as job satisfaction can be possible when there is more and more production in a systematic manner. It is said that productivity and satisfaction are inter relate to each other. On the other hand high employee morale due to job satisfaction provides higher output.
3. ***The Investor:*** Maximum return on investment is the objective of each and every investor. Enterprise having good production management system ensures higher productivity which attracts the investors to invest more in this prosperous enterprise. More productivity ensures higher value in market in terms of security and asset value which is one of the benefits for the investors.
4. ***The Supplier:*** Most of the large, small and medium companies depend on the suppliers in terms of raw material, machine components, and allied services during the course of production. So the role of a supplier is crucial in production management system. A good production management system ensures that intercommunication and mutual confidence among the producer and supplier can be better. More is the production better is the partnership satisfaction of both the parties.
5. ***The Society:*** A better production management system will benefit the society as a whole. More timely production of goods and services in better quality ensures community satisfaction which leads to the society will benefit out of that. More productivity means better economic prosperity. Economic prosperity leads to social prosperity and social prosperity leads to all round development in the society.

1.7 RESPONSIBILTY OF A PRODUCTION MANAGER

Generally a production manger is in charge of a production organisation. The responsibility of a production manager is to look into five "P"s namely (1) product (2) plant (3) process (4) programs (5) people. The responsibilities are mentioned below:

1. ***Product:*** Product is the direct interface between the production and market. It is meant f or the customers in the market. All the production organisations are looking after the product. A product should be qualitative, low price, reliable, easy availability, smooth delivery, easy handling, after sales service and have good and long performance. It is the responsibility of a production manager to look into the above mentioned characteristics of a product while producing it in the organisation.
2. ***Plant:*** The primary responsibility of a production manager is to look into the plant of the organisation. While dealing with the plant it includes building, equipments, machinery and the other related aspects of the plant. The production manager should ensure that the plant must have the capacity to meet the present needs of the organisation as well as to meet the future requirements also. While dealing with the plant the production manager should be cautious about the maintenance of the machinery and equipments, safety in installation of machinery, operational efficiency of the equipments and environmental protection.
3. ***Process:*** It includes the manufacturing process. Transformation of input into output is the responsibility of a production manager. A finished product can be available with input converted into semi finished product and a semi finished product can be converted into finished product. Hence it is responsibility of a production manager is to look into all the processes so that the product can be available in time. In this process it is the duty of the production manager is look into the type of production, the number of process it needs, layout of the product, safety in each operation and the cost involved in each operation.
4. ***Programs:*** It includes the production schedule. Each and every product should be produced with a schedule. The schedule of production can be decided in advance so that the production

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process will continue smoothly. The production program refers to time for each process of production, the date of final product to be produced, the date of delivery in each process, the process of assembling, packing, despatch and payment after despatch of the product.

5. ***People:*** This is one of the major responsibilities of a production manager. The people aspect of a production manager is the skill, knowledge and expertise of the workmen, intelligence of the managerial personnel which is crucial and critical for a qualitative product. It is the responsibility of a production manger is to look into the efficient an effective utilisation of people who are engaged in production of final product as well as in each production process. Both labour and managerial people must be effective in delivering the product in time so that the financial viability of the production organisation can be sustainable.

Besides the above responsibility a production manger has the responsibility of:

(a) To meet the demand of the customers in the market in terms of quantity and quality of the product for a specified time period.

(b) To ensure the exact date and time of delivery of the product of the consumers in the market.

(c) To apply and select most economic method of production process in the organisation in order to reduce the cost of production.

(d) To ensure the desired quality of the product by taking into liking and disliking of the customers in the market.

(e) To have a balance between the production process and marketing process of the organisation.

(f) To maintain desirable level of raw material so that the production process will not hamper.

(g) To look into the grievances of the people who are engaged in production process so that maximum utilisation of man power can be possible.

(h) To look into maximum return on profit for the organisation.

(i) To have maximum productivity in each level of production.

(j) To ensure environmental protection in production of the product.

(k) To look into the rules and regulation of the government.

(l) To maintain good relation with the competitors in the market in terms of quality of the product.

1.8 DECISIONS OF PRODUCTION MANAGEMENT

The decisions of a production management system have been classified into three basic categories. They are:

1. ***Strategic Decisions:*** When a decision related to long term importance of a production organisation it is called as strategic decision. Under this decision it is necessary to look into the future capability of the production unit in terms of product, production process and the facilities available to meet the probable demand of the consumers in the market. This type of decision is concerned for a long range production strategy relating to product and production process so that maximum product can be available in minimum time period with a low cost of production. Some of the strategic decisions are:

   (a) Launching of a new product in future for the production unit.

   (b) Decision to change the production process of the product.

   (c) Decide to change the utilisation of labour force and the machine.

   (d) Establishment of new facility in production unit for the future.

2. ***Operating Decisions:*** When the decisions are made to meet the day to day operations of the production unit in order to meet the demands of consumers in the market it is regarded as operating decision. Under this decision the production managers have to look into the day to

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day operation of the production unit and suggest how to improve the condition so that there can be maximum production in the unit. Some of the operational decisions are:

(a) Decision to maintain desired level of raw material for each production process.

(b) Decide the production schedule for the next month according to the order.

(c) Deployment of skilled and unskilled labour force for the production purpose in each unit.

(d) Decision for the engagement of supplier for the coming production process.

(e) Decision for the terms and conditions of payment of finished product.

3. ***Control Decision:*** This is a managerial decision of production unit. Under this decision it is necessary to take control measures regarding financial soundness of the production organisation. When some measures are taken for the use of men, machine, material and money for an effective use of resources so that the cost of production can be minimum at a particular time period. Generally the control decisions are taken by a production manager when the production unit face the conditions of financial shortage. Some of the control decisions are:

   (a) Decide the action to be taken for the failures of a particular department.

   (b) Decision for the improved labour cost and the measures to reduce them for more profitability.

   (c) Decision for a changed quality control measure in order to improve the quality of the product according to the demand of the consumers.

   (d) Preventive measures to be undertaken in order to increase the operating efficiency of the plant and machinery.

   (e) Steps to be taken in order to increase quality of the product so that the cost of the product can be competitive in market.

   In nutshell it can be concluded that all the above mentioned decisions are taken in order to improve the production capacity as well as the quality of the product so that more and more revenue can be generated in the production unit. The primary aim of the above decisions is to produce maximum product with a minimum cost in order to increase profitability.

1.9 SUMMARY

Production and operations management can be defined as conversion of input into output according to demand of the consumers in the market. The purpose of production management is to produce maximum product with a minimum cost. Production function refers to creation of various utility in order to satisfy large number of consumers in the market. Production system refers to optimum utilisation of production elements like men, material, machine, money and management in production process so that qualitative production can be possible with a minimum cost. There are different type of production which can be utilised by the production unit in order to have quantitative and qualitative production.

Production management system ensures benefit to the consumers, suppliers, employees, organisation and society. The duties and responsibilities of a production manager is to look after plant, product, process, program and people so that the product can be available in time in a desirable cost. It is necessary to take different decisions during production system. The decisions are strategic decisions, operational decisions and controlled decisions which can help the production manager in order to produce qualitative product with a low cost.

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1.10 SELF ASSESSMENT QUESTIONS

Short Type Questions

1. Define production management system.
2. What is production process?
3. What do you mean by place utility?
4. Justify the concept of knowledge utility.
5. Explain the benefits of production management to the investor.
6. Explain how society is benefited out of production management.
7. Mention the responsibility of production manager towards a product.
8. Describe the responsibility of people for a production manager.
9. How strategic decisions are helpful for a production unit.
10. Mention some of the important responsibility of a production manager.

Essay Type Questions

1. Explain various types of production for a production unit.
2. Describe the benefits of production management.
3. A production manger has some responsibility, Elucidate the statement.
4. Production management is the act of converting raw material into finished product. Do you agree? Justify your statement.
5. Narrate the different types of decisions taken by a production manager.

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UNIT 2 PRODUCTION PLANNING AND CONTROL

Structure

2.0 OBJECTIVES

After completing this unit, you will be able to learn about:

- Define Production Planning and Control.
- Identify the functions of Production Planning and Control (PPC).
- Understand the factors affecting Production Planning and Control (PPC).
- Understand the role of PPC in manufacturing Industry.
- Understand the process of making production plan.

2.1 MEANING

Production planning and control is concerned with implementing the plans, i.e. the detailed scheduling of jobs, assigning of workloads to machines (and people), and the actual flow of work through the system. Production is an organized activity of converting raw materials into useful products. Production planning and control is an important task of Production Manager. It has to see that production process is properly decided in advance and it is carried out as per the plan. Production is related to the conversion of raw materials into finished goods. This conversion process involves a number of steps such as deciding what to produce, how to produce, when to produce, etc. These decisions are a part, of production planning. Merely deciding about the task is not sufficient.

The whole process should be carried out in a best possible way and at the lowest cost. Production Manager will have to see that the things proceed as per the plans. This is a control function and has to be carried as meticulously as planning. Both planning and control of production are necessary to produce better quality goods at reasonable prices and in a most systematic manner.

Production planning is the function of looking ahead, anticipating difficulties to be faced and the likely remedial steps to remove them. It may be said to be a technique of forecasting ahead every

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step in the long process of production, taking them at a right time and in the right degree and trying to complete the operations at maximum efficiency. Production control, on the other hand, guides and directs flow of production so that products are manufactured in a best way and conform to a planned schedule and are of the right quality. Control facilitates the task of manufacturing and sees that everything goes as per the plans.

Goldon B. Carson: "Production planning and control involves generally the organization and planning of the manufacturing process. Specifically, it consists of the planning of the routing, scheduling, dispatching and inspection, co-ordination and the control of materials, methods, and machines, tooling and operating times. The ultimate objective is the organization of the supply and movement of materials and labour, machine utilization and related activities, in order to bring about the desired manufacturing results in terms of quantity, time and place."

James L. Lundy: "Basically, the production control function involves the co-ordination and integration of the factors of production for optimum efficiency. Overall sales orders or plans must be translated into specific schedules and assigned so as to occupy all work centers but overload none. The job can be done formally in which case elaborate charting and filing techniques are used; or it can be done informally, with individuals' thoughts and retention there of supplanting tangible aids."

Charles A. Koepke: "Production planning and control is the coordination of a series of functions according to a plan which will economically utilize the plant facilities and regulate the orderly movement of goods through the entire manufacturing cycle, from the procurement of all materials to the shipping of finished goods at a predetermined rate."

2.1.1 Characteristics of Production Planning and Control

The forgoing discussion brings out the following characteristics of production planning and control:

1. It is the planning and control of manufacturing process in an enterprise. The questions like—what is to be manufactured? When it is to be manufactured? How to keep the schedule of production etc.? —are decided and acted upon for getting good results.
2. All types of inputs like materials, men, machines are efficiently used for maintaining efficiency of the manufacturing process.
3. Various factors of production are integrated to use them efficiently and economically.
4. The manufacturing process is organized in such a way that none of the work centre is either overworked or under worked. The division of work is undertaken very carefully so that every available element is properly utilized.
5. The work is regulated from the first stage of procuring raw materials to the stage of finished goods.

2.2 OBJECTIVES OF PRODUCTION PLANNING AND CONTROL

Planning of production precedes control. Whatever is planned needs to be controlled. The ultimate objective of both planning and control is to use various inputs in an efficient way.

The following points will bring out the objectives of production planning and production control:

Production Planning

1. Making most economical use of various inputs.
2. To determine the requirements for men, materials and machines.
3. Production of various inputs at a right time and in right quantity and of right quality.
4. Arranging production schedules according to the needs of marketing department.
5. Providing for adequate stocks to meet contingencies.
6. Keeping up-to-date information processes.

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Production Control

1. Making efforts to adhere to the production schedules.
2. Issuing necessary instructions to the staff for making the plans effective.
3. To ensure that goods produced according to the prescribed standards and quality norms.
4. To ensure that various inputs are made available in right quantity and at proper time.
5. To ensure that work progresses according to the predefined plans.

2.3 STAGES OF PRODUCTION PLANNING AND CONTROL

The stages of Production planning and control has three phases namely as follows:

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

Planning Phase

Planning is an exercise of intelligent anticipation in order to establish how an objective can be achieved or a need fulfilled in restrictive circumstances. It has two categories of planning namely

1. Prior planning
2. Active planning.

Prior Planning

Prior planning means pre-production planning. This includes all the planning efforts, which are taking place prior to the active planning.

Modules

The modules of prior planning are as follows:

1. Product development and design is the process of developing a new product with all the features, which are essential for effective use in the field, and designing it accordingly. At the design stage, one has to take several aspects of design like, design for selling, design for manufacturing and design for usage.
2. Forecasting is an estimate of demand, which will happen in future. Since, it is only an estimate based on the past demand, proper care must be taken while estimating it. Given the sales forecast, the factory capacity, the aggregate inventory levels and size of the work force, the manager must decide at what rate of production to operate the plant over an intermediate planning horizon.
3. Aggregate planning aims to find out a product wise planning over the intermediate planning horizon.
4. Material requirement planning is a technique for determining the quantity and timing for the acquisition of dependent items needed to satisfy the master production schedule.

Active Planning

The modules of active planning are: Process planning and routing, Materials planning. Tools planning, Loading, Scheduling etc.

1. Process planning and routing is a complete determination of the specific technological process steps and their sequence to produce products at the desired quality, quantity and cost. It determines the method of manufacturing a product selects the tools and equipments, analyses how the manufacturing of the product will fit into the facilities. Routing in particular

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prescribes the flow of work in the plant and it is related to the considerations of layout, temporary locations for raw materials and components and materials handling systems.

2. A material planning is a process which determines the requirements of various raw materials/subassemblies by considering the trade-off between various cost components like, carrying cost, ordering cost, shortage cost, and so forth.
3. Tools' planning determines the requirements of various tools by taking process specification (surface finish, length of the job, overall depth of cut etc.), material specifications (type of material used, hardness of the material, shape and size of the material etc.) and equipment specifications (speed range, feed range, depth of cut range etc.).
4. Loading is the process of assigning jobs to several machines such that there is a load balance among the machines. This is relatively a complex task, which can be managed with the help of efficient heuristic procedures.
5. Scheduling is the time phase of loading and determines when and in what sequence the work will be carried out. This fixes the starting as well as the finishing time for each job.

Action--Phase

Action phase has the major step of dispatching. Dispatching is the transition from planning phase to action phase. In this phase, the worker is ordered to start manufacturing the product. The tasks which are included in dispatching are job order, store issue order, tool order, time ticket, inspection order, move order etc.

The job order number is the key item which is to be mentioned in all other reports/orders. Stores issue order gives instruction to stores to issue materials for manufacturing the product as per product specifications. As per tooling requirements for manufacturing the product, the tool Order instruct the tool room to issue necessary tools. Time ticket is nothing but a card which is designed to note down the actual time taken at various processes. This information is used for deciding the costs for future jobs of similar nature and also for performing variance analysis.

Control Phase

The control phase has the following two major modules:

1. ***Progress Reporting:*** In progress reporting, the data regarding what is happening with the job is collected. Also, it helps to make comparison with the present level of performance. The various data pertaining to materials rejection, process variations, equipment failures, operator efficiency, operator absenteeism, tool life, etc., are collected and analyzed for the purpose of progress reporting.
2. ***Corrective Action:*** The tasks under corrective action primarily make provisions for an unexpected event. Some examples of corrective actions are creating schedule flexibility, schedule modifications, capacity modifications, make or buy decisions, expediting the work, pre-planning, and so on. Due to unforeseen reasons such as, machine breakdown, labour absenteeism, too much rejection due to poor material quality etc., it may not be possible to realize the schedule as per the plan. Under such condition, it is better to reschedule the whole product mix so that we get a clear picture of the situation to progress further.

2.4 FUNCTIONS/SCOPE OF PRODUCTION PLANNING & CONTROL

The following points explains the scope of Production Planning and Control

1. ***Materials:*** Materials should be made available at the right quality, right quantity, right price & right price. Inventory control & regular supply of materials should be guaranteed.
2. ***Manpower:*** It is important to carry out manpower planning to maintain operational & managerial staff possessing requisite skills & expertise.
3. ***Methods:*** It is always desirable to consider all the available alternatives & select the best method of processing.

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4. ***Machines & equipments:*** The choices of manufacturing methods depend on available production facilities & utilization of plant, machines equipments.
5. ***Routing:*** The routing function specifies what work is to be done where & when it is to be performed.
6. ***Estimating:*** it involves establishing performance standard of each work after duly analyzing operation sheets. These sheets indicate feeds, speeds, depth of cuts, use of special attachments & methods.
7. ***Loading & scheduling:*** Loading & scheduling machines have to be made as per the production requirements. Machine loading generates accurate information on work standard, scrap allowances, machine-time requirements & machine capacities. Scheduling is a time-table for performing the job on the available machines so that delivery dates are maintained.
8. ***Dispatching:*** Dispatching is the release of orders & instructions to start production as per the route sheets & schedule charts.
9. ***Expediting:*** It refers to follow-up which is done after the dispatching function.
10. ***Inspection:*** It is related to maintenance of quality in production & processes, methods labour so that improvements can be made to achieve the quality standards.
11. ***Evaluating:*** It provides a feedback mechanism on a long term basis so that past experience can be used to improve upon use of methods, facilities & resources in future period.
12. ***Cost control:*** In manufacturing products, costs can be kept within control through wastage reduction, value analysis, inventory control & efficient use of resources.

2.5 CHALLENGES IN PRODUCTION PLANNING AND CONTROL

The following points explains Challenges in Production Planning and Control

(a) ***Combining Functions:*** It is desirable that a minimum changes be made after schedules are established. This objective can be approached if the amount of work scheduled for the factory or department is equal or slightly greater than the production cycle.

(b) ***Follow-up:*** When jobs are started and completed on schedule, there should be very little concern about the meeting of commitments. Optimum operation of the plant is attained only if the original plan has been carefully prepared to utilize the manufacturing facilities fully and effectively.

(c) ***Re-planning:*** Often required in manufacturing. Changes in market conditions, manufacturing methods, etc. affecting the plant will often indicate that a new manufacturing plan is required.

2.6 FACTORS AFFECTING PRODUCTION PLANNING AND CONTROL

The following points explains Factors Affecting Production Planning and Control

1. ***Market Forecast:*** It will indicate future trends in demand for manufactured products. Work shift policies, plans for an increase or decrease in manufacturing activity are based upon the market forecast and in turn affect the production planning and control.
2. ***Sales Order:*** It is a rewrite of the customer order specifying what has been purchased (product, quantity and authorizing shipment of the goods to the customer). Variation or changes in sales order will drastically affect production planning and control.
3. ***Standard Process Sheet:*** It is prepared by process engineering group or process owner and it is the source of basic data which may include type of machine to be used, time required for processing, etc. For e.g. if any machine is under breakdown, the standard process sheet will be disturbed which in turn affect production planning and control.
4. ***Load Charts:*** These charts are prepared for each workstation or machine in the plant or may be for groups of machines or departments.

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5. ***Project Planning Method:*** The product to be produced are manufactured in quantities and their total processing time can be measured. The best known methods are Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT).

Planning is the process of selecting and sequencing activities such that they achieve one or more goals and satisfy a set of domain constraints. Schedules should reflect the temporal relationships between activities and the capacity limitations of a set of shared resources. Master Production Schedule is main driver and information source for further material requirements planning and accompanying calls or supplies and allows making detailed production schedules for production system. The high re-planning frequency in order to overcome the uncertainty induces the system nervousness. The system nervousness can be defined as – State of a system when a minor changes in Master Production Schedule creates significant changes in Materials Requirement Planning (MRP).

The following critical points can be considered in Master Production Schedule:

- Frequent changes in MPS result in due-date changes in open orders, quantity and timing for planned order of end products.
- Mentioned changes are translated into gross requirements changes for products and timing of their delivery.
- Unexpected changes in MPS effect that materials, needed for a particular order may not be available. The availability of materials is often limited due to the fact that suppliers have similar bottlenecks and schedules variations transmitted from sub-tier suppliers.

The following questions can be considered while scheduling MPS:

- How to make initial MPS that is as feasible as possible?
- How to limit the number of re-planning activities?
- How to be reactive to disturbances in materials flow?
- How to provide planners with accurate information about material resources available which often lead to bloated inventory and in accurately promised delivery dates to the customers?

2.7 PRODUCTION PLANNING SYSTEM

- A good planning system must answer four questions of priority and capacity: What are we going to make? What does it take to make it? What do we have? What do we need?
- Priority, as established by the marketplace, relates to what products are needed, how many are needed, and when they are needed.
- Capacity is the capability of manufacturing to produce goods and services (deliverables). It depends on company resources and the availability of material from suppliers.

2.8 MAKING THE PRODUCTION PLAN

The following points explains how to make a production plan:

(a) Based on the market plan and available resources, the production plan sets the limits or levels of manufacturing activity for some time in the future. The production plan sets the general levels of production and inventories over the planning horizon. Its prime purpose is to establish production rates that will accomplish the objective of the strategic business plan, including inventory levels, backlogs (unfilled customer orders), market demand, customer service, low-cost plant operation, labour relations, and so on. The plan must extend far enough in the future to plan for the labour, equipment, facilities, and material needed to accomplish it.

(b) For planning purposes, a common unit or small number of product groups based on similarity of manufacturing processes is what is needed. Manufacturing is concerned more with the

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demand for the specific kinds of capacity needed to make the products than with the demand for the product.

(c) Capacity is the ability to produce goods and services. It means having the resources available to satisfy demand. Capacity can be expressed as the time available or as the number of units or dollars produced in a given period. The demand for goods must be translated into the demand for capacity. This requires identifying product groups, or families, of individual products based on the similarity of manufacturing process. Usually the following can be varied to adjust capacity:

People can be hired and laid off, overtime and short time can be worked, and shifts can be added or removed. Inventory can be built up in slack periods and sold or consumed during high demand. Work can be subcontracted or extra equipment leased. Manufacturing management is responsible for determining the least-cost alternative consistent with the goals and objectives of the business.

(d) Three or four basic strategies can be used in developing a production plan:

- Chase (demand matching) strategy – producing the amount demanded at any given time. Inventory levels remain stable while production varies to meet demand.
- Production levelling – continually producing an amount equal to the average demand. Companies calculate their total demand over the time span of the plan and, on the average, produce enough to meet it. Production levelling means the company will use its resources at a level rate and produce the same amount each day it is operating. The advantage is that it results in a smooth level of operation that avoids the costs of changing production levels. The disadvantage is that inventory builds up during periods of low demand.
- Subcontracting – means producing at the level of minimum demand and meeting any additional demand through subcontracting. Costs associated with excess capacity are avoided, and because production is levelled, there are no costs associated with changing production levels. The main disadvantage is that the cost of purchasing may be greater than if the item were made in the plant.
- Hybrid strategy – is a combination of the other three strategies. Production management is responsible for finding the combination of strategies that minimizes the sum of all costs involved, providing the level of service required, and meeting the objectives of the finance and marketing plans.

(e) The objective in developing a production plan is to minimize the costs of carrying inventory, changing production levels, and stocking out (not supplying the customer what is wanted when it is wanted). The information needed to make a production plan is as follows: forecast by period for the planning horizon, opening inventory, desired ending inventory, and any past-due customer orders (back orders).

(f) ***Make-to-Stock Production Plan:*** Products are made and put into inventory before an order is received. Sale and delivery are made from inventory. Make to stock when demand is fairly constant and predictable, there are few product options, delivery times demanded by the marketplace are much shorter than the time needed to make the product, and product has a long shelf life.

(g) ***Level production plan:*** The general procedure for developing a plan for level production is total the forecast demand for the planning horizon, determine the opening inventory and the desired ending inventory, calculate the total production required (Total Production = total forecast + back orders + ending inventory – opening inventory), calculate the production required each period by dividing the total production by the number of periods, and calculate the ending inventory for each period.

(h) ***Make-to-Order Production Plan:*** Wait until an order is received from a customer before starting to make the goods. Make to order environment has backlog of unfilled customer orders instead of an inventory of finished goods. The backlog will be for delivery in the future

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and does not represent orders that are late or past due. Firms make to order when: goods are produced to customer specification; the customer is willing to wait while the order is being made, the product is expensive to make and to store, and several product options are offered.

(i) ***Assemble to order:*** Where several product options exist and where the customer is not willing to wait until the product is made, manufacturers produce and stock standard component parts. When an order is received, they assemble the component parts from inventory. Since the components are stocked, the firm needs only time to assemble before delivering the product. Assemble to order is a subset of make to order. To make a production plan, one will need a forecast by period for the planning horizon, an opening backlog of customer orders and desired ending backlog.

(j) To develop a level production plan, total forecast demand for the planning horizon, determine the opening backlog and the desired ending backlog, calculate total production required (Total production = total forecast + opening backlog – ending backlog), calculate the production required each period, and spread the existing backlog over the planning horizon according to due date per period.

(k) ***Resource Planning:*** Once the preliminary production plan is established, it must be compared to the existing resources of the company. If enough capacity to meet the production plan cannot be made available, the plan must be changed.

(l) Resource bill shows the quantity of critical resources (materials, labor, and "bottleneck" operations) needed to make one average unit of the product group.

2.9 PROCESS PLANNING

Well, one can say it is the process of planning for manufacturing and the realization of a product according to a product specification. The product specification (it may also be referred to as Product Design Specification) is a document describing the product; it's features, design, tolerances and what kind of specific behaviour certain components should have etc. Basically it should describe the product in great detail. This document is usually the final thing when having designed the product. This product specification is needed because you may want to send it to manufacturing companies that should produce parts of the product. However it is equally important if you want to produce parts or the entire product within your own company.

The process plan is basically a plan of how your parts will be produced, what machines to use and in what order, to achieve the correct tolerances etc. It involves strategic decisions and careful analysis with production engineers and expertise in order to plan and adapt the production of every single component that you wish to build yourself. Process planning is often seen as the interface between design and manufacturing stages.

Process planning becomes more and more important depending on the number of components and also the total number of products that are going to be produced. If you only produce a small quantity of the final product you perhaps can put down very much detail and perhaps create very fine tolerances on the components since you have time to do it, basically you can check and recheck the important components until they are perfect. However of you have large quantities of your product you cannot check every component but perhaps every 100 or so, then it becomes important that you have very high repeatability within you manufacturing processes so that you know that the products/parts are produced within tolerances.

2.10 MANUFACTURING PLANNING AND CONTROL SYSTEM

- The five major levels in the manufacturing planning and control system are: strategic business plan, production plan (sales and operations plan), master production schedule, material requirements plan, and purchasing and production activity control. Each level varies in purpose, time span (planning horizon), level of detail, and planning cycle (frequency). At each level, three questions must be answered:
  - What are the priorities — how much of what is to be produced and when?

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- ❑ What is the available capacity — what resources do we have?
- ❑ How can differences between priorities and capacity be resolved?

- ***Strategic Business Plan:*** It is senior management's statement of the broad direction of the firm, major goals and objectives the company expects to achieve over the next two to ten years or more. It is based on long-range forecasts and provides a framework that sets the goals and objectives for further planning by marketing, finance, engineering and production/operations. The level of detail is not high. It is concerned with general market and production requirements. It is often stated in dollars rather than units.
- ***Production Plan:*** Given the objectives set by the strategic business plan, production management is concerned with the quantities of each product group or family that must be produced in each period, the desired inventory levels, the resources of equipment, labour, and material needed in each period, and the availability of the resources needed. For effective planning, there must be a balance between priority and capacity. The planning horizon is usually six to 18 months and is reviewed perhaps each month or quarter.
- ***Master Production Schedule (MPS):*** is a plan for the production of individual end items. It breaks down the production plan to show, for each period, the quantity of each end item to be made. Inputs to the MPS are the production plan, the forecast for individual end items, sales orders, inventories, and existing capacity. The level of detail for the MPS is higher than for the production plan. The planning horizon usually extends from three to 18 months but primarily depends on the purchasing and manufacturing lead times. Master scheduling describes the process of developing a master production schedule; the term master production schedule is the end result of the process. Plans are reviewed and changed weekly or monthly.
- ***Material Requirements Plan (MRP):*** is a plan for the production and purchase of the components and/or services used in making the items in the MPS. The MRP establishes when the components and services are needed to make each end item. The level of detail is high. The planning horizon is similar to MPS, extending from 3 to 18 months.
- ***Purchasing and Production Activity Control (PAC):*** represents the implementation and control phase (execution phase). Purchasing is responsible for establishing and controlling the flow of raw materials into the factory. PAC is responsible for planning and controlling the flow of work through the factory. The planning horizon is very short and the level of detail is high.
- ***Capacity Management:*** At each level in the manufacturing planning and control system, the priority plan must be tested against the available resources and capacity of the manufacturing system. The basic process is one of calculating the capacity needed to manufacture the priority plan and of finding methods to make that capacity available. If the capacity cannot be made available when needed then the plans must be changed.
- ***Sales and Operations Planning (SOP):*** is a process for continually revising the strategic business plan and coordinating plans of the various departments. SOP is a cross-functional business plan that involves sales and marketing, product development, operations, and senior management. Operations represents supply, marketing represents demand. The SOP is the forum in which the production plan is developed and a dynamic process in which the company plans are updated on a regular basis, at least monthly. (See figure 2.5 and the benefits listed above.)
- ***Manufacturing Resource Planning (MRP II):*** The manufacturing planning and control system described here, is a master game plan for all departments in the company and works from the top down with feedback from the bottom. This fully integrated planning and control system is called a manufacturing resource planning, or MRP II, system. The phrase "MRP II" is used to distinguish the "manufacturing resource plan" (MRP II) from the "materials requirement plan" (MRP).
- ***Enterprise Resource Planning (ERP):*** is an accounting oriented information system for identifying and planning the enterprise---wide resources needed to make, ship, and account for customer orders. ERP encompasses the total company and MRP II is manufacturing.

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2.11 ROLE OF PRODUCTION PLANNING AND CONTROL IN MANUFACTURING INDUSTRY

Every production system should have systematic way to gain its goal of production. Production system is basically concerned with taking inputs of capital, labour, order, materials and using the first two to transform material to satisfy orders. To attain success without planned work. Without planning nothing is completed within the required time. So planning has its own importance which is intolerable, "Planning" gives a scheduled task and "Control" completes it successfully. Production Planning and Control (PPC) department in any industry has to do all planned responsibility. But production planning and control is not an easy task. So every textile and apparel company should have a self-sufficient and high-performance department called "Production Planning & Control". Basic roles of PPC is as follows:

1. Taking orders from marketing division.
2. Analyzing the orders & feeling the requirements of customer.
3. Planning for production.
4. Cost analysis & lead time.

It is only a basic procedure. It may change according to the type of order. Sometimes, order is places only for finishing the material or only for dyeing the white goods. Then some steps are omitted from the planning procedure.

1. ***Taking orders from marketing division:*** Order collect from the buyer with the details information (Art work, technical sheet) is the first and principle task in textile and apparel industry. After getting the order from marketing division then other process start.
2. ***Analyzing the orders:*** There are various key points of garment which should be analyze before confirming order. This section analyzes the orders according to buyers, Order Quantity, type of orders (i.e. type of fabric, colour to be dyed etc.), delivery date etc., Cost of garments per dozen, Determination of production time and delivery date. Then it selects which M/C. to use, no of M/C. to use, time required for production etc. This section plans for required quantity of fabric need to be dyed. Dyeing balance, RFD (Ready for delivery), RFD balance, delivered fabric and delivery balance.
3. ***Production Planning:*** Main role of PPC is to smooth production. Every functions of production are includes in planning. Such as planning for dyeing the yarn, planning for weaving the fabric, planning for finishing the fabric etc. The quality objectives are defined at organizational and functional levels in measurable term. Review is conducted at a suitable time interval with proper recording system.

   The Quality Objectives of an industry is defined to develop the following areas:

   - To feel the desires of the customers.
   - To implement the required systems.
   - To assign resources for training & place of work improvements.
   - To maintain infrastructural tasks accurately.
   - To build quality into every product at every stages of production line.
   - To obtain a production-line with minimal errors & corrective actions.
4. ***Cost-analysis:*** Cost analysis is another important role for production planning. Cost Analysis worksheet will help you to determine how to price your products. The cost of production should be as minimum as we already gave a price to customer while taking order.

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2.12 SUMMARY

Production planning and control practices will vary widely from plant to plant/organization to organization. Though no production control function can be entirely eliminated, the least control that results in effective operation of the factory is the best control. It must be remembered that production planning and control systems should be tools of management. The objective is not an elaborate and detailed system of controls and records, but rather, the optimum operation of the plant for maximum profits. PPC places an emphasis on the control of work-in-process, the system will be in effect tie together all previous records and forms developed in all planning for the manufacture of the products.

2.13 SELF ASSESSMENT QUESTIONS

Short Type Questions

1. Define production planning system.
2. What is production planning and control?
3. What do you mean by production plan?
4. Explain the benefits of production planning and control to a manufacturer.
5. Explain how society is benefited out of production planning and control.

Essay Type Questions

1. Explain various stages of production planning and control.
2. Describe the functions of production planning and control.
3. Explain various factors affecting production planning and control.
4. Narrate the different types of decisions taken by a production manager while formulating a production plan.
5. Describe the role of production planning and control in a manufacturing unit.

2.14 REFERENCES

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UNIT 3 PROJECT MANAGEMENT

Structure

3.0 OBJECTIVES

After completing this unit, you will be able to learn about:

- Define Production Planning and Control.
- Identify the functions of Production Planning and Control (PPC).
- Understand the factors affecting Production Planning and Control (PPC).
- Understand the role of PPC in manufacturing Industry.
- Understand the process of making production plan.

3.1 INTRODUCTION

As a discipline, project management developed from several fields of application including civil construction, engineering, and heavy defence activity. Two forefathers of project management are Henry Gantt, called the father of planning and control techniques, who is famous for his use of the

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Gantt chart as a project management tool and Henri Fayol for his creation of the five management functions that form the foundation of the body of knowledge associated with project and program management. Both Gantt and Fayol were students of Frederick Winslow Taylor's theories of scientific management. His work is the forerunner to modern project management tools including work breakdown structure (WBS) and resource allocation.

The development of software for an improved business process, the construction of a building or bridge, the relief effort after a natural disaster, the expansion of sales into a new geographic, market, manufacturing an aircraft or building a ship etc. - all are examples of projects.

3.2 MEANING OF PROJECT MANAGEMENT

A project is an organized endeavour to accomplish a specified non-repetitive task. The project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements.

Project Life Cycle

A project passes through a life cycle that depends on the size and complexity of the project. Generally a project passes through the following phases.

1. ***The Concept Phase:*** In this stage the organization thinks whether a project is needed or not. The organization is requested to propose a plan to perform a project for a customer.
2. ***Project Initiation:*** Initiation is the second phase of the project lifecycle. This is where the project's value and feasibility are measured. Project managers typically use two evaluation tools to decide whether or not to pursue a project:

   Business Case Document: This document justifies the need for the project, and it includes an estimate of potential financial benefits.

   Feasibility Study: This is an evaluation of the project's goals, timeline and costs to determine if the project should be executed. It balances the requirements of the project with available resources.
3. ***Project Planning****:* Once the project receives the green light, it needs a solid plan to guide the team, as well as keep them on time and on budget. A well-written project plan gives guidance for obtaining resources, acquiring financing and procuring required materials. The project plan gives the team direction for producing quality outputs, handling risk, creating acceptance, communicating benefits to stakeholders and managing suppliers.

   The project plan also prepares teams for the obstacles they might encounter over the course of the project, and helps them understand the cost, scope and timeframe of the project.
4. ***Project Execution****:* This is the phase that is most commonly associated with project management. Execution is all about building deliverables that satisfy the customer. Team leaders make this happen by allocating resources and keeping team members focused on their assigned tasks.

   Execution relies heavily on the planning phase. The work and efforts of the team during the execution phase are derived from the project plan.
5. ***Project Monitoring and Control****:* Monitoring and control are sometimes combined with execution because they often occur at the same time. As teams execute their project plan, they must constantly monitor their own progress.

   To guarantee delivery of what was promised, teams must monitor tasks to prevent scope creep, calculate key performance indicators and track variations from allotted cost and time. This constant vigilance helps keep the project moving ahead smoothly.
6. ***Project Closure****:* Teams close a project when they deliver the finished project to the customer, communicating completion to stakeholders and releasing resources to other projects. This vital step in the project lifecycle allows the team to evaluate and document the project and

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move on the next one, using previous project mistakes and successes to build stronger processes and more successful teams.

Although project management may seem overwhelming at times, breaking it down into these five distinct cycles can help your team manage even the most complex projects and use time and resources more wisely.

Project management knowledge draws on ten areas:

1. Integration
2. Scope
3. Time
4. Cost
5. Quality
6. Procurement
7. Human resources
8. Communications
9. Risk management
10. Stakeholder management

All management is concerned with these, of course. But project management brings a unique focus shaped by the goals, resources and schedule of each project. The value of that focus is proved by the rapid, worldwide growth of project management:

- as a recognized and strategic organizational competence
- as a subject for training and education
- as a career path

3.3 APPROACHES

There are a number of approaches to organizing and completing project activities, including: phased, lean, iterative, and incremental. There are also several extensions to project planning, for example based on outcomes (product-based) or activities (process-based)A 2017 study suggested that the success of any project depends on how well four key aspects are aligned with the contextual dynamics affecting the project, these are referred to as the *four P's*:

- ***Plan:*** The planning and forecasting activities.
- ***Process***, the overall approach to all activities and project governance.
- ***People***, and the dynamics of how they collaborate and communicate.
- ***Power***, Projects are which describes all lines of authority, decision-makers, organisations, policies for implementation and the likes.

Regardless of the methodology employed, careful consideration must be given to the overall project objectives, timeline, and cost, as well as the roles and responsibilities of all participants and stakeholders.

Phased Approach

The phased (or staged) approach breaks down and manages the work through a series of distinct steps to be completed, and is often referred to as "traditional or "waterfall". Although it can vary, it typically consists of five process areas, four phases plus control:

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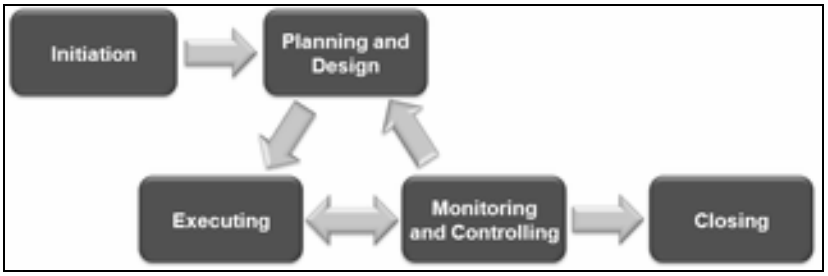

Typical development phases of an engineering project:

- Initiation
- Planning and design
- Construction
- Monitoring and controlling
- Completion or closing

Many industries use variations of these project stages and it is not uncommon for the stages to be renamed in order to better suit the organization. For example, when working on a brick-and-mortar design and construction, projects will typically progress through stages like pre-planning, conceptual design, schematic design, design development, construction drawings (or contract documents), and construction administration.

While the phased approach works well for small, well-defined projects, it often results in challenge or failure on larger projects, or those that are more complex or have more ambiguities, issues and risk.

Project planning generally consists of

- determining the project management methodology to follow (e.g. whether the plan will be defined wholly up front, iteratively, or in rolling waves);
- developing the scope statement;
- selecting the planning team;
- identifying deliverables and creating the product and work breakdown structures;
- identifying the activities needed to complete those deliverables and networking the activities in their logical sequence;
- estimating the resource requirements for the activities;
- estimating time and cost for activities;
- developing the schedule;
- developing the budget;
- risk planning;
- developing quality assurance measures;
- Gaining formal approval to begin work.

Additional processes, such as planning for communications and for scope management, identifying roles and responsibilities, determining what to purchase for the project and holding a kick-off meeting are also generally advisable.

For new product development projects, conceptual design of the operation of the final product may be performed concurrent with the project planning activities, and may help to inform the planning team when identifying deliverables and planning activities.

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Project Documentation

Documenting everything within a project is key to being successful. In order to maintain budget, scope, effectiveness and pace a project must have physical documents pertaining to each specific task. With correct documentation, it is easy to see whether or not a project's requirement has been met. To go along with that, documentation provides information regarding what has already been completed for that project. Documentation throughout a project provides a paper trail for anyone who needs to go back and reference the work in the past. In most cases, documentation is the most successful way to monitor and control the specific phases of a project. With the correct documentation, a project's success can be tracked and observed as the project goes on. If performed correctly documentation can be the backbone to a project's success.

Monitoring and Controlling

Monitoring and controlling consists of those processes performed to observe project execution so that potential problems can be identified in a timely manner and corrective action can be taken, when necessary, to control the execution of the project. The key benefit is that project performance is observed and measured regularly to identify variances from the project management plan.

Monitoring and controlling includes:

- Measuring the ongoing project activities ('where we are');
- Monitoring the project variables (cost, effort, scope, etc.) against the project management plan and the project performance baseline (*where we should be*);
- Identifying corrective actions to address issues and risks properly (*How can we get on track again*);
- Influencing the factors that could circumvent integrated change control so only approved changes are implemented.

In multi-phase projects, the monitoring and control process also provides feedback between project phases, in order to implement corrective or preventive actions to bring the project into compliance with the project management plan.

Project maintenance is an ongoing process, and it includes

- Continuing support of end-users
- Correction of errors
- Updates to the product over time

Monitoring and Controlling Cycle

In this stage, auditors should pay attention to how effectively and quickly user problems are resolved. When changes are introduced to the project, the viability of the project has to be re-assessed. It is important not to lose sight of the initial goals and targets of the projects. When the changes accumulate, the forecasted result may not justify the original proposed investment in the

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project. Successful project management identifies these components, and tracks and monitors progress so as to stay within time and budget frames already outlined at the commencement of the project.

Closing

Closing process includes the formal acceptance of the project and the ending thereof. Administrative activities include the archiving of the files and documenting lessons learned.

This phase consists of.

- ***Contract closure:*** Complete and settle each contract (including the resolution of any open items) and close each contract applicable to the project or project phase.
- ***Project close:*** Finalize all activities across all of the process groups to formally close the project or a project phase

Also included in this phase is the Post Implementation Review. This is a vital phase of the project for the project team to learn from experiences and apply to future projects. Normally a Post Implementation Review consists of looking at things that went well and analyzing things that went badly on the project to come up with lessons learned.

3.4 PROJECT CONTROLLING AND PROJECT CONTROL SYSTEMS

Project controlling (also known as Cost Engineering) should be established as an independent function in project management. It implements verification and controlling function during the processing of a project in order to reinforce the defined performance and formal goals. The tasks of project controlling are also:

- the creation of infrastructure for the supply of the right information and its update
- the establishment of a way to communicate disparities of project parameters
- the development of project information technology based on an intranet or the determination of a project key performance indicator system (KPI)
- divergence analyses and generation of proposals for potential project regulations
- the establishment of methods to accomplish an appropriate project structure, project workflow organization, project control and governance
- creation of transparency among the project parameters

Fulfillment and implementation of these tasks can be achieved by applying specific methods and instruments of project controlling. The following methods of project controlling can be applied:

- investment analysis
- cost–benefit analysis
- value benefit analysis
- expert surveys
- simulation calculations
- risk-profile analysis
- surcharge calculations
- cost trend analysis
- target/actual-comparison

Project control is that element of a project that keeps it on track, on-time and within budget. Project control begins early in the project with planning and ends late in the project with post-implementation review, having a thorough involvement of each step in the process. Projects may be audited or reviewed while the project is in progress. Formal audits are generally risk or

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compliance-based and management will direct the objectives of the audit. An examination may include a comparison of approved project management processes with how the project is actually being managed. Each project should be assessed for the appropriate level of control needed: too much control is too time consuming, too little control is very risky. If project control is not implemented correctly, the cost to the business should be clarified in terms of errors and fixes.

Control systems are needed for cost, risk, quality, communication, time, change, procurement, and human resources. In addition, auditors should consider how important the projects are to the financial statements, how reliant the stakeholders are on controls, and how many controls existing. Auditors should review the development process and procedures for how they are implemented. The process of development and the quality of the final product may also be assessed if needed or requested. A business may want the auditing firm to be involved throughout the process to catch problems earlier on so that they can be fixed more easily. An auditor can serve as a controls consultant as part of the development team or as an independent auditor as part of an audit.

Businesses sometimes use formal systems development processes. These help assure systems are developed successfully. A formal process is more effective in creating strong controls, and auditors should review this process to confirm that it is well designed and is followed in practice. A good formal systems development plan outlines:

- A strategy to align development with the organization's broader objectives
- Standards for new systems
- Project management policies for timing and budgeting
- Procedures describing the process
- Evaluation of quality of change

Characteristics of Projects

There are five important characteristics of a project.

1. It should always have a specific start and end dates.
2. They are performed and completed by a group of people.
3. The output is delivery on unique product or service.
4. They are temporary in nature.
5. It is progressively elaborated. *Example:* Designing a new car, writing a book.

Project Complexity

Complexity and its nature play an important role in the area of project management. Despite having number of debates on this subject matter, studies suggest lack of definition and reasonable understanding of complexity in relation to management of complex projects. As it is considered that project complexity and project performance are closely related, it is important to define and measure complexity of the project for project management to be effective.

By applying the discovery in measuring work complexity descried in Requisite Organization and Stratified Systems Theory, Dr Elliott Jaques classifies projects and project work (stages, tasks) into basic 7 levels of project complexity based on such criteria as time-span of discretion and complexity of a project's output:

- Level 1 Project – improve the direct output of an activity (quantity, quality, time) within a business process with targeted completion time up to 3 months.
- Level 2 Project – develop and improve compliance to a business process with targeted completion time from 3 months to 1 year.
- Level 3 Project – develop, change and improve a business process with targeted completion time from 1 to 2 years.

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- Level 4 Project – develop, change and improve a functional system with targeted completion time from 2 to 5 years.
- Level 5 Project – develop, change and improve a group of functional systems / business function with targeted completion time from 5 to 10 years.
- Level 6 Project – develop, change and improve a whole single value chain of a company with targeted completion time from 10 to 20 years.
- Level 7 Project – develop, change and improve multiple value chains of a company with target completion time from 20 to 50 years.

Benefits from measuring Project Complexity are to improve project people feasibility by:

- Match the level of a project's complexity with effective targeted completion time of a project
- Match the level of a project's complexity with the respective capability level of the project manager
- Match the level of a project task's complexity with the respective capability of the project members

Project Managers

A project manager is a professional in the field of project management. Project managers are in charge of the people in a project. People are the key to any successful project. Without the correct people in the right place and at the right time a project cannot be successful. Project managers can have the responsibility of the planning, execution, controlling, and closing of any project typically relating to the construction industry, engineering, architecture, computing, and telecommunications. Many other fields of production engineering, design engineering, and heavy industrial have project managers.

A project manager needs to understand the order of execution of a project to schedule the project correctly as well as the time necessary to accomplish each individual task within the project. A project manager is the person accountable for accomplishing the stated project objectives. Project Managers tend to have multiple years' experience in their field. A project manager is required to know the project in and out while supervising the workers along with the project. A project manager normally reports directly to someone of higher stature on the completion and success of the project.

A project manager is often a client representative and has to determine and implement the exact needs of the client, based on knowledge of the firm they are representing. The ability to adapt to the various internal procedures of the contracting party, and to form close links with the nominated representatives, is essential in ensuring that the key issues of cost, time, quality and above all, client satisfaction, can be realized.

3.5 TYPES OF PROJECT MANAGEMENT

Project management can apply to any project, but it is often tailored to accommodate the specific needs of different and highly specialized industries. For example, the construction industry, which focuses on the delivery of things like buildings, roads, and bridges, has developed its own specialized form of project management that it refers to as *construction project management* and in which project managers can become trained and certified. The information technology industry has also evolved to develop its own form of project management that is referred to as *IT project management* and which specializes in the delivery of technical assets and services that are required to pass through various lifecycle phases such as planning, design, development, testing, and deployment. *Biotechnology project management* focuses on the intricacies of biotechnology research and development. *Localization project management* includes many standard project management practices even though many consider this type of management to be a very different discipline. It focuses on three important goals: time, quality and budget. Successful projects are completed on schedule, within budget, and according to previously agreed quality standards.

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For each type of project management, project managers develop and utilize repeatable templates that are specific to the industry they're dealing with. This allows project plans to become very thorough and highly repeatable, with the specific intent to increase quality, lower delivery costs, and lower time to deliver project results.

Lean Project Management

Lean project management uses the principles from lean manufacturing to focus on delivering value with less waste and reduced time.

Iterative and Incremental Project Management

In critical studies of project management it has been noted that phased approaches are not well suited for projects which are large-scale and multi-company, with undefined, ambiguous, or fast-changing requirements, or those with high degrees of risk, dependency, and fast-changing technologies. The cone of uncertainty explains some of this as the planning made on the initial phase of the project suffers from a high degree of uncertainty. This becomes especially true as software development is often the realization of a new or novel product.

These complexities are better handled with a more exploratory or iterative and incremental approach. Several models of iterative and incremental project management have evolved, including agile project management, dynamic systems development method, extreme project management, and Innovation Engineering. Critical chain project management (CCPM) is an application of the theory of constraints (TOC) to planning and managing projects, and is designed to deal with the uncertainties inherent in managing projects, while taking into consideration limited availability of resources (physical, human skills, as well as management & support capacity) needed to execute projects.

The goal is to increase the flow of projects in an organization (throughput). Applying the first three of the five focusing steps of TOC, the system constraint for all projects, as well as the resources, are identified. To exploit the constraint, tasks on the critical chain are given priority over all other activities. Finally, projects are planned and managed to ensure that the resources are ready when the critical chain tasks must start, subordinating all other resources to the critical chain.

Product-based Planning

Product-based planning is a structured approach to project management, based on identifying all of the products (project deliverables) that contribute to achieving the project objectives. As such, it defines a successful project as output-oriented rather than activity- or task-oriented.

Process-based Management

The incorporation of process-based management has been driven by the use of maturity models such as the OPM3 and the CMMI (capability maturity model integration; and ISO/IEC 15504 (SPICE – software process improvement and capability estimation). Unlike SEI's CMM, the OPM3 maturity model describes how to make project management processes capable of performing successfully, consistently, and predictably in order to enact the strategies of an organization.

Project Production Management

Project production management is the application of operations management to the delivery of capital projects. The Project production management framework is based on a project as a production system view, in which a project transforms inputs (raw materials, information, labour, plant & machinery) into outputs (goods and services).

Benefits Realization Management

Benefits realization management (BRM) enhances normal project management techniques through a focus on outcomes (benefits) of a project rather than products or outputs, and then measuring the

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degree to which that is happening to keep a project on track. This can help to reduce the risk of a completed project being a failure by delivering agreed upon requirements/outputs but failing to deliver the *benefits* of those requirements. In addition, BRM practices aim to ensure the alignment between project outcomes and business strategies. The effectiveness of these practices is supported by recent research evidencing BRM practices influencing project success from a strategic perspective across different countries and industries.

Earned Value Management

Earned value management (EVM) extends project management with techniques to improve project monitoring. It illustrates project progress towards completion in terms of work and value (cost). Earned Schedule is an extension to the theory and practice of EVM.

Project Management Success Criteria

There is a tendency to confuse the project success with project management success. They are two different things. Project management success criteria are different from project success criteria. The project management is said to be successful if the given project is completed within the agreed upon time, met the agreed upon scope and within the agreed upon budget. Meanwhile, a project is said to be successful, when it succeeds in achieving the expected business case.

The United States Department of Defense states; "Cost, Schedule, Performance, and Risk," are the four elements through which Department of Defense acquisition professionals make trade-offs and track program status. There are also international standards. Risk management applies proactive identification of future problems and understanding of their consequences allowing predictive decisions about projects.

Work Breakdown Structure

The work breakdown structure (WBS) is a tree structure that shows a subdivision of the activities required to achieve an objective—for example a program, project, and contract. The WBS may be hardware-, product-, service-, or process-oriented A WBS can be developed by starting with the end objective and successively subdividing it into manageable components in terms of duration, size, and responsibility (e.g., systems, subsystems, components, tasks, sub-tasks, and work packages), which include all steps necessary to achieve the objective.

The work breakdown structure provides a common framework for the natural development of the overall planning and control of a contract and is the basis for dividing work into definable increments from which the statement of work can be developed and technical, schedule, cost, and labor hour reporting can be established. The work breakdown structure can be displayed in two forms, as a table with subdivision of tasks or as an organizational chart whose lowest nodes are referred to as "work packages".

It is an essential element in assessing the quality of a plan, and an initial element used during the planning of the project. For example, a WBS is used when the project is scheduled, so that the use of work packages can be recorded and tracked.

International Standards

There have been several attempts to develop project management standards, such as:

- ISO 21500:2012 – Guidance on project management. This is the first project management ISO.
- ISO 31000:2009 – Risk management. Risk management is 1 of the 10 knowledge areas of either ISO 21500 or PMBoK5 concept of project management.
- ISO/IEC/IEEE 16326:2009 – Systems and Software Engineering—Life Cycle Processes—Project Management.
- Capability Maturity Model from the Software Engineering Institute.

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- GAPPS, Global Alliance for Project Performance Standards – an open source standard describing COMPETENCIES for project and program managers.
- A Guide to the Project Management Body of Knowledge from the Project Management Institute (PMI)
- HERMES method, Swiss general project management method, selected for use in Luxembourg and international organizations.
- The ISO standards ISO 9000, a family of standards for quality management systems, and the ISO 10006:2003, for Quality management systems and guidelines for quality management in projects.
- PRINCE2 (Projects in Controlled Environments).
- Association for Project Management Body of Knowledge
- Team Software Process (TSP) from the Software Engineering Institute.
- Total Cost Management Framework, AACE International's Methodology for Integrated Portfolio, Program and Project Management.
- V-Model, an original systems development method.
- The logical framework approach, which is popular in international development organizations.
- Australian Institute of Project Management (AIPM) has 4 levels of certification; CPPP, CPPM, CPPD & CPPE for Certified Practicing Project ... Partner, Manager, Director and Executive.

Project Portfolio Management

An increasing number of organizations are using what is referred to as project portfolio management (PPM) as a means of selecting the right projects and then using project management techniques as the means for delivering the outcomes in the form of benefits to the performing private or not-for-profit organization. PPM is usually performed by a dedicated team of managers organized by within a Project Management Office (PMO), usually based within the organization.

Project Management Software

Project management software is software used to help plan, organize, and manage resource pools, develop resource estimates and implement plans. Depending on the sophistication of the software, functionality may include estimation and planning, scheduling, cost control and budget management, resource allocation, collaboration software, communication, decision-making, workflow, risk, quality, documentation and/or administration systems.

Virtual Project Management

Virtual program management (VPM) is management of a project done by a virtual team, though it rarely may refer to a project implementing a virtual environment. It is noted that managing a virtual project is fundamentally different from managing traditional projects, combining concerns of telecommuting and global collaboration (culture, time zones, language).

3.6 ROLE TECHNIQUE

Basically, CPM (Critical Path Method) and PERT (Programme Evaluation Review Technique) are project management techniques, which have been created out of the need of Western industrial and military establishments to plan, schedule and control complex projects.

3.6.1 Brief History of CPM/PERT

CPM/PERT or Network Analysis as the technique is sometimes called, developed along two parallel streams, one industrial and the other military.

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CPM was the discovery of M.R.Walker of E.I.Du Pont de Nemours & Co. and J.E.Kelly of Remington Rand, circa 1957. The computation was designed for the UNIVAC-I computer. The first test was made in 1958, when CPM was applied to the construction of a new chemical plant. In March 1959, the method was applied to maintenance shut-down at the Du Pont works in Louisville, Kentucky. Unproductive time was reduced from 125 to 93 hours.

PERT was devised in 1958 for the POLARIS missile program by the Program Evaluation Branch of the Special Projects office of the U.S.Navy, helped by the Lockheed Missile Systems division and the Consultant firm of Booz-Allen & Hamilton. The calculations were so arranged so that they could be carried out on the IBM Naval Ordinance Research Computer (NORC) at Dahlgren, Virginia.

Definition of PERT

PERT is an acronym for Program (Project) Evaluation and Review Technique, in which planning, scheduling, organizing, coordinating and controlling of uncertain activities take place. The technique studies and represents the tasks undertaken to complete a project, to identify the least time for completing a task and the minimum time required to complete the whole project. It was developed in the late 1950s. It is aimed to reduce the time and cost of the project.

PERT uses time as a variable which represents the planned resource application along with performance specification. In this technique, first of all, the project is divided into activities and events. After that proper sequence is ascertained, and a network is constructed. After that time needed in each activity is calculated and the critical path (longest path connecting all the events) is determined.

Definition of CPM

Developed in the late 1950's, Critical Path Method or CPM is an algorithm used for planning, scheduling, coordination and control of activities in a project. Here, it is assumed that the activity duration is fixed and certain. CPM is used to compute the earliest and latest possible start time for each activity.

The process differentiates the critical and non-critical activities to reduce the time and avoid the queue generation in the process. The reason behind the identification of critical activities is that, if any activity is delayed, it will cause the whole process to suffer. That is why it is named as Critical Path Method.

In this method, first of all, a list is prepared consisting of all the activities needed to complete a project, followed by the computation of time required to complete each activity. After that, the dependency between the activities is determined. Here, 'path' is defined as a sequence of activities in a network. The critical path is the path with the highest length.

3.6.2 PERT vs CPM

The most important differences between PERT and CPM are provided below:

1. PERT is a project management technique, whereby planning, scheduling, organizing, coordinating and controlling of uncertain activities is done. CPM is a statistical technique of project management in which planning, scheduling, organizing, coordination and control of well-defined activities takes place.
2. PERT is a technique of planning and control of time. Unlike CPM, which is a method to control costs and time?
3. While PERT is evolved as research and development project, CPM evolved as construction project.
4. PERT is set according to events while CPM is aligned towards activities.
5. A deterministic model is used in CPM. Conversely, PERT uses probabilistic model.
6. There are three times estimates in PERT i.e. optimistic time (to), most likely time ™, pessimistic time (tp). On the other hand, there is only one estimate in CPM.

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7. PERT technique is best suited for a high precision time estimate, whereas CPM is appropriate for a reasonable time estimate.
8. PERT deals with unpredictable activities, but CPM deals with predictable activities.
9. PERT is used where the nature of the job is non-repetitive. In contrast to, CPM involves the job of repetitive nature.
10. There is a demarcation between critical and non-critical activities in CPM, which is not in the case of PERT.
11. PERT is best for research and development projects, but CPM is for non-research projects like construction projects.
12. Crashing is a compression technique applied to CPM, to shorten the project duration, along with least additional cost. The crashing concept is not applicable to PERT.

3.6.3 Planning, Scheduling & Control

Planning, Scheduling (or organizing) and Control are considered to be basic Managerial functions, and CPM/PERT has been rightfully accorded due importance in the literature on Operations Research and Quantitative Analysis.

Far more than the technical benefits, it was found that PERT/CPM provided a focus around which managers could brain-storm and put their ideas together. It proved to be a great communication medium by which thinkers and planners at one level could communicate their ideas, their doubts and fears to another level. Most important, it became a useful tool for evaluating the performance of individuals and teams.

There are many variations of CPM/PERT which have been useful in planning costs, scheduling manpower and machine time. CPM/PERT can answer the following important questions:

How long will the entire project take to be completed? What are the risks involved?

Which are the critical activities or tasks in the project which could delay the entire project if they were not completed on time?

Is the project on schedule, behind schedule or ahead of schedule?

If the project has to be finished earlier than planned, what is the best way to do this at the least cost?

3.6.4 The Framework for PERT and CPM

Essentially, there are six steps which are common to both the techniques. The procedure is listed below:

1. Define the Project and all of it’s significant activities or tasks. The Project (made up of several tasks) should have only a single start activity and a single finish activity.
2. Develop the relationships among the activities. Decide which activities must precede and which must follow others.
3. Draw the "Network" connecting all the activities. Each Activity should have unique event numbers. Dummy arrows are used where required to avoid giving the same numbering to two activities.
4. Assign time and/or cost estimates to each activity
5. Compute the longest time path through the network. This is called the critical path.
6. Use the Network to help plan, schedule, monitor and control the project.

The Key Concept used by CPM/PERT is that a small set of activities, which make up the longest path through the activity network control the entire project. If these "critical" activities could be identified and assigned to responsible persons, management resources could be optimally used by concentrating on the few activities which determine the fate of the entire project.

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Non-critical activities can be replanned, rescheduled and resources for them can be reallocated flexibly, without affecting the whole project.

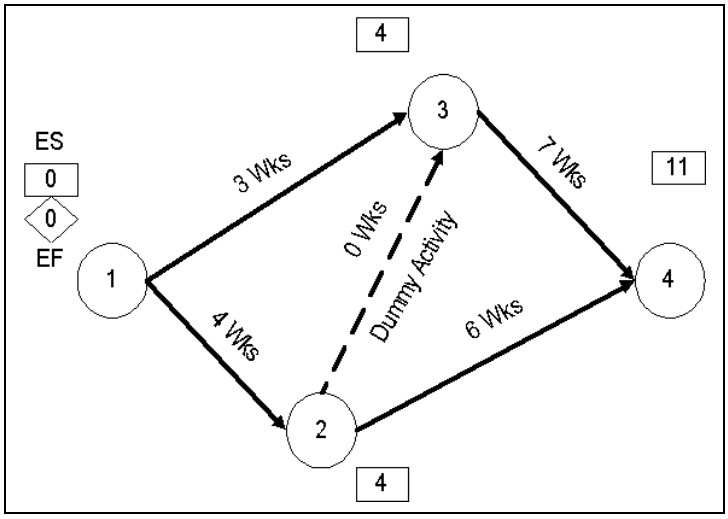
Five useful questions to ask when preparing an activity network are:

- Is this a Start Activity?
- Is this a Finish Activity?
- What Activity Precedes this?
- What Activity Follows this?
- What Activity is Concurrent with this?

Some activities are serially linked. The second activity can begin only after the first activity is completed. In certain cases, the activities are concurrent, because they are independent of each other and can start simultaneously. This is especially the case in organizations which have supervisory resources so that work can be delegated to various departments which will be responsible for the activities and their completion as planned. When work is delegated like this, the need for constant feedback and co-ordination becomes an important senior management pre-occupation.

3.6.5 Drawing the CPM/PERT Network

Each activity (or sub-project) in a PERT/CPM Network is represented by an arrow symbol. Each activity is preceded and succeeded by an event, represented as a circle and numbered.



At Event 3, we have to evaluate two predecessor activities – Activity 1-3 and Activity 2-3, both of which are predecessor activities. Activity 1-3 gives us an Earliest Start of 3 weeks at Event 3. However, Activity 2-3 also has to be completed before Event 3 can begin. Along this route, the Earliest Start would be 4 + 0 = 4. The rule is to take the longer (bigger) of the two Earliest Starts. So the Earliest Start at event 3 is 4.

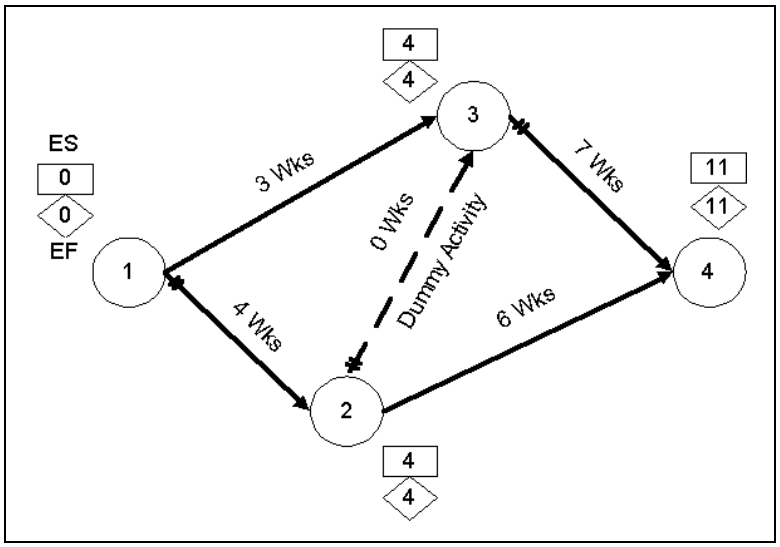
Similarly, at Event 4, we find we have to evaluate two predecessor activities – Activity 2-4 and Activity 3-4. Along Activity 2-4, the Earliest Start at Event 4 would be 10 wks, but along Activity 3-4, the Earliest Start at Event 4 would be 11 wks. Since 11 wks is larger than 10 wks, we select it as the Earliest Start at Event 4.

We have now found the longest path through the network. It will take 11 weeks along activities 1-2, 2-3 and 3-4. This is the Critical Path.

3.6.6 The Backward Pass – Latest Finish Time Rule

To make the Backward Pass, we begin at the sink or the final event and work backwards to the first event.

Notes



At Event 3 there is only one activity, Activity 3-4 in the backward pass, and we find that the value is 11-7 = 4 weeks. However at Event 2 we have to evaluate 2 activities, 2-3 and 2-4. We find that the backward pass through 2-4 gives us a value of 11-6 = 5 while 2-3 gives us 4-0 = 4. We take the **smaller value** of 4 on the backward pass.

3.6.7 Tabulation & Analysis of Activities

We are now ready to tabulate the various events and calculate the Earliest and Latest Start and Finish times. We are also now ready to compute the SLACK or TOTAL FLOAT, which is defined as the difference between the Latest Start and Earliest Start.

Event	Duration (Weeks)	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Total Float
1-2	4	0	4	0	4	0
2-3	0	4	4	4	4	0
3-4	7	4	11	4	11	0
1-3	3	0	3	1	4	1
2-4	6	4	10	5	11	1

- The Earliest Start is the value in the rectangle near the tail of each activity
- The Earliest Finish is = Earliest Start + Duration
- The Latest Finish is the value in the diamond at the head of each activity
- The Latest Start is = Latest Finish – Duration

There are two important types of Float or Slack. These are Total Float and Free Float.

TOTAL FLOAT is the spare time available when all preceding activities occur at the earliest possible times and all succeeding activities occur at the latest possible times.

Total Float = Latest Start – Earliest Start

Activities with zero Total float are on the Critical Path

FREE FLOAT is the spare time available when all preceding activities occur at the earliest possible times and all succeeding activities occur at the earliest possible times.

When an activity has zero Total float, Free float will also be zero.

Notes

There are various other types of float (Independent, Early Free, Early Interfering, Late Free, Late Interfering), and float can also be negative. We shall not go into these situations at present for the sake of simplicity and be concerned only with Total Float for the time being.

Having computed the various parameters of each activity, we are now ready to go into the scheduling phase, using a type of bar chart known as the Gantt Chart.

There are various other types of float (Independent, Early Free, Early Interfering, Late Free, Late Interfering), and float can also be negative. We shall not go into these situations at present for the sake of simplicity and be concerned only with Total Float for the time being. Having computed the various parameters of each activity, we are now ready to go into the scheduling phase, using a type of bar chart known as the Gantt Chart.

Exercise 3.1

A Social Project manager is faced with a project with the following activities:

Activity-ID	Description	Duration
1-2	Social Work Team to live in Village	5 Weeks
1-3	Social Research Team to do survey	12 Weeks
3-4	Analyze results of survey	5 Weeks
2-4	Establish Mother & Child Health Program	14 Weeks
3-5	Establish Rural Credit Programme	15 Weeks
4-5	Carry out Immunizations of Under Fives	4 Weeks

- Draw the arrow diagram, using the helpful numbering of the activities, which suggests the following logic:
- Unless the Social Work team lives in the village, the Mother and Child Health Programme cannot be started due to ignorance and superstition of the villagers
- The Analysis of the survey can obviously be done only after the survey is complete.
- Until rural survey is done, the Rural Credit Programme cannot be started
- Unless Mother and Child Programme is established, the Immunisation of Under Fives cannot be started
  - ❑ Calculate the Earliest and Latest Event Times
  - ❑ Tabulate and Analyse the Activities
  - ❑ Schedule the Project Using a Gantt Chart

3.6.8 The PERT (Probabilistic) Approach

So far we have talked about projects, where there is high certainty about the outcomes of activities. In other words, the cause-effect logic is well known. This is particularly the case in engineering projects. However, in Research & Development projects, or in Social Projects which are defined as “Process Projects”, where learning is an important outcome, the cause-effect relationship is not so well established. In such situations, the PERT approach is useful, because it can accommodate the variation in event completion times, based on an expert’s or an expert committee’s estimates.

For each activity, three time estimates are taken

- The Most Optimistic
- The Most Likely
- The Most Pessimistic

Notes

The Duration of an activity is calculated using the following formula:

$$t_e = \frac{t_0 + 4t_m + t_p}{6}$$

Where t_e is the Expected time, t_o is the Optimistic time, t_m is the most probable activity time and t_p is the Pessimistic time.

It is not necessary to go into the theory behind the formula. It is enough to know that the weights are based on an approximation of the Beta distribution.

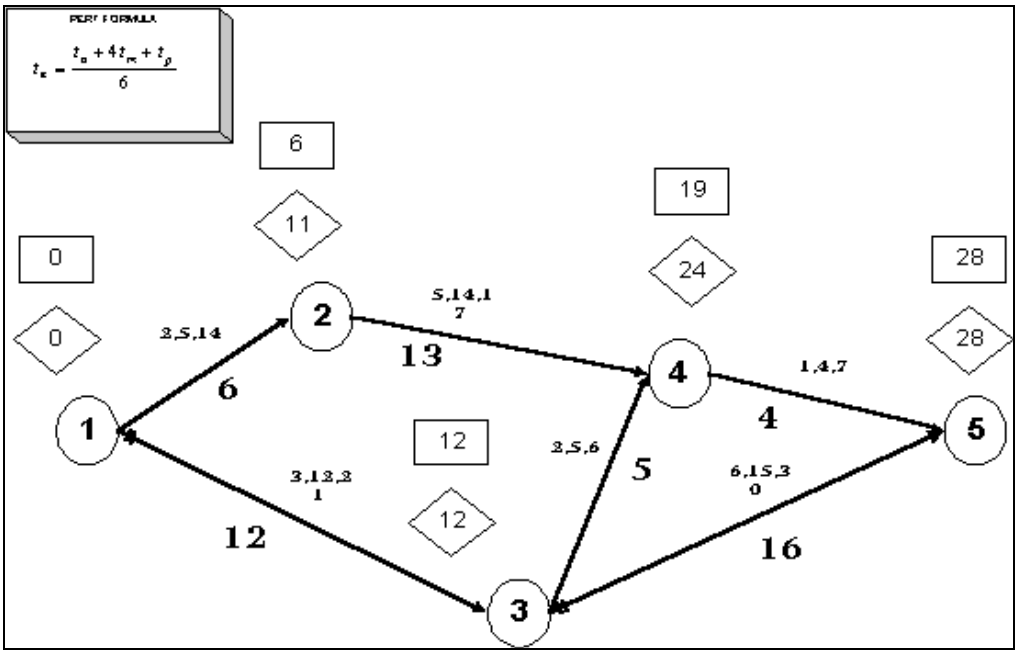
The Standard Deviation, which is a good measure of the variability of each activity is calculated by the rather simplified formula:

$$S_1 = \frac{t_p + t_0}{6}$$

The Variance is the Square of the Standard Deviation.

3.6.9 PERT Calculations for the Social Project

In our Social Project, the Project Manager is now not so certain that each activity will be completed on the basis of the single estimate he gave. There are many assumptions involved in each estimate, and these assumptions are illustrated in the three-time estimate he would prefer to give to each activity.



In Activity 1-3, the time estimates are 3, 12 and 21. Using our PERT formula, we get:

$$t_e = \frac{3 + (4 \times 12) + 21}{6} = \frac{72}{6} = 12$$

$$S_1 = \frac{(21 - 3)}{6} = \frac{18}{6} = 3$$

Notes

The Standard Deviation (s.d.) for this activity is also calculated using the PERT formula. We calculate the PERT event times and other details as below for each activity:

Event	t_o	t_m	t_p	t_e	ES	EF	LS	LF	TF	s.d.	Var.
1-3	3	12	21	12	0	12	0	12	0	3	9
3-5	6	15	30	16	12	28	12	28	0	4	16
1-2	2	5	14	6	0	6	5	11	5	2	4
2-4	5	14	17	13	6	19	11	24	5	2	4
3-4	2	5	8	5	12	17	19	24	7	1	1
4-5	1	4	7	4	19	23	24	28	5	1	1

3.6.10 Estimating Risk

Having calculated the s.d. and the Variance, we are ready to do some risk analysis. Before that we should be aware of two of the most important assumptions made by PERT.

The Beta distribution is appropriate for calculation of activity durations.

Activities are independent, and the time required to complete one activity has no bearing on the completion times of it's successor activities in the network. The validity of this assumption is questionable when we consider that in practice, many activities have dependencies.

3.6.11 Expected Length of a Project

PERT assumes that the expected length of a project (or a sequence of independent activities) is simply the sum of their separate expected lengths. Thus the summation of all the t_e's along the critical path gives us the length of the project. Similarly the variance of a sum of independent activity times is equal to the sum of their individual variances.

In our example, the sum of the variance of the activity times along the critical path, VT is found to be equal to (9+16) = 25.

The square root VT gives us the standard deviation of the project length. Thus, ST=Ö 25=5. The higher the standard deviation, the greater the uncertainty that the project will be completed on the due date. Although the t_e's are randomly distributed, the average or expected project length Te approximately follows a Normal Distribution. Since we have a lot of information about a Normal Distribution, we can make several statistically significant conclusions from these calculations.

A random variable drawn from a Normal Distribution has 0.68 probability of falling within one standard deviation of the distribution average. Therefore, there is a 68% chance that the actual project duration will be within one standard deviation, ST of the estimated average length of the project, t_e.

In our case, the t_e = (12 + 16) = 28 weeks and the ST = 5 weeks. Assuming t_e to be normally distributed, we can state that there is a probability of 0.68 that the project will be completed within 28 ± 5 weeks, which is to say, between 23 and 33 weeks.

Since it is known that just over 95% (.954) of the area under a Normal Distribution falls within two standard deviations, we can state that the probability that the project will be completed within 28 ± 10 is very high at 0.95.

3.6.12 Probability of Project Completion by Due Date

Now, although the project is estimated to be completed within 28 weeks (t_e = 28) our Project Director would like to know what is the probability that the project might be completed within 25 weeks (i.e. Due Date or D = 25).

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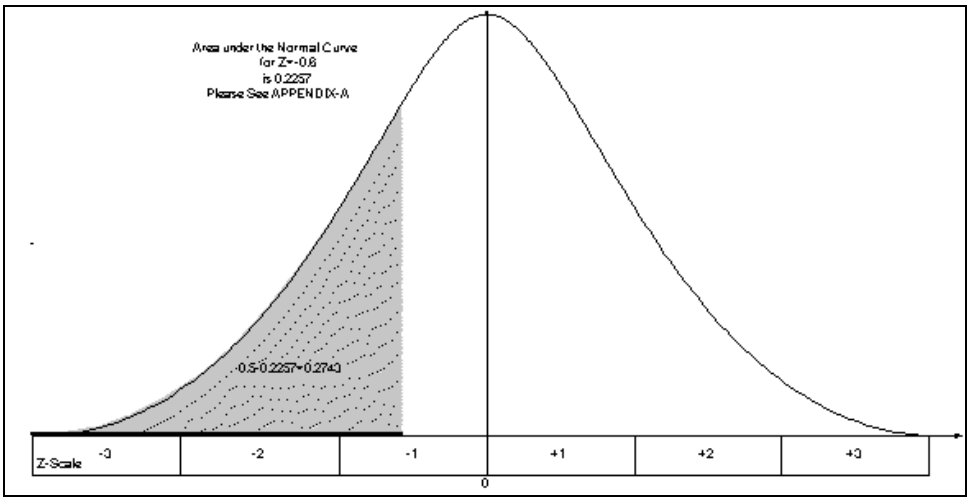
For this calculation, we use the formula for calculating Z, the number of standard deviations that D is away from t_e.

$$Z = \frac{D - t_e}{S_t} = \frac{25 - 28}{5} = \frac{-3}{5} = -0.6$$

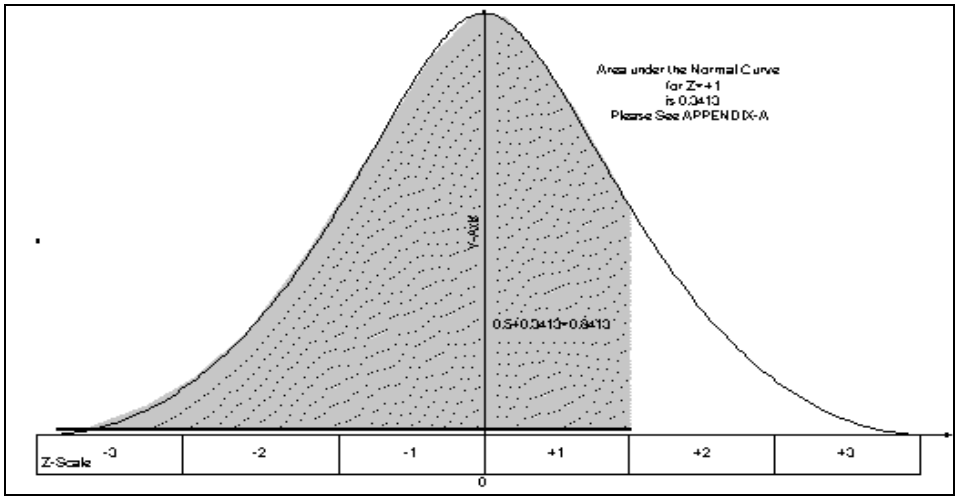
By looking at the following extract from a standard normal table, we see that the probability associated with a Z of -0.6 is 0.274. This means that the chance of the project being completed within 25 weeks, instead of the expected 28 weeks is about 2 out of 7 which is not very encouraging.



On the other hand, the probability that the project will be completed within 33 weeks is calculated as follows:

$$Z = \frac{D - t_e}{S_t} = \frac{33 - 28}{5} = \frac{5}{5} = 1$$

The probability associated with Z= +1 is 0.84134. This is a strong probability, and indicates that the odds are 16 to 3 that the project will be completed by the due date.



If the probability of an event is p, the odds for its occurrence are a to b, where:

$$\frac{a}{b} = \frac{p}{1-p} = \frac{0.84134}{0.15866} \approx \frac{16}{3}$$

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3.7 INNOVATION MANAGEMENT

What is the future of today's companies? Is it a lack of innovation or an inability to cope with change? Or, is it the incompetence that underlines the failure to anticipate change and stay ahead of the curve? Either way, businesses need to identify where they are going wrong because innovation as a business strategy is here to stay. The rules of the game have changed. Traditional practices and concepts do not hold water anymore.

For survival, innovation is almost obligatory (Drucker, 1999). An innovation process "connects upstream idea valuation to downstream production and release to market." Once a well-defined innovation strategy that aligns with business goals is in place, the next step will entail managing it effectively. Like any business function, innovation can be managed.

"Innovation Management is about more than just planning new products, services, brand extensions, or technology inventions. It's about imagining, mobilizing, and competing in new ways," says Idris Mootee, author of *Design Thinking for Strategic Innovation*.

Whereas, Gartner says it is a business discipline that aims to drive a repeatable, sustainable innovation process or culture within an organization. Innovation management initiatives focus on disruptive or step changes that transform the business in some significant way. This discipline of managing the innovation process harnesses creative ideas and uses them to build a steady pipeline of innovations that are reliable, repeatable, consistent, and profitable.

Innovation management programs for different companies will vary significantly. For instance, an emerging business is likely to be focusing on one main product, unlike a mature organization that is looking to fortify its position in the market or find new, disruptive innovations. Rapidly growing firms could be looking for ways to extend their core businesses. Deciding between developing new innovations for the future and revitalizing their existing offerings can be tricky.

3.7.1 Function and Intention of Innovation Management

In a turbulent and rapidly changing economy, organizations must prep themselves to innovate on a continuing basis or else their survival is seriously threatened. Innovation management helps deal with the challenges that stem from the innovation process. Broadly, the benefits of managing innovation include the following:

- Improves efficiency
- Guarantees long-term success
- Increases market success
- Decreases costs
- Reduces processing time
- Initiates the innovation process
- Reduces risk of becoming obsolete due to competitors
- Improves chances of survival due to better solutions spawned from newer technologies

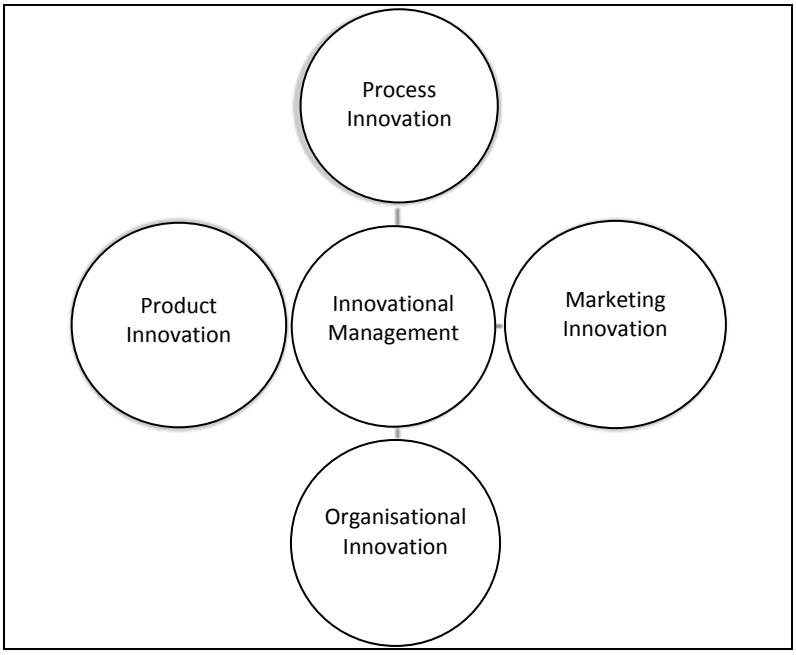
3.7.2 Classifications in Innovation Management

Innovation management is typically designed for these four types:

1. ***Process Innovation:*** A process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. (OECD, 2005) Unlike incremental or continuous innovations that will most likely generate little value, process innovations are typically expected to bring game-changing shifts. Delivery, production, and support services are needed for process innovation. Examples of process innovation would be reducing the cost per service provided or the time taken and increasing the number of products or services provided within a specific time. Henry Ford's assembly line innovation is a groundbreaking example.

Notes

2. ***Product Innovation:*** A product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components, and materials, incorporated software, user-friendliness or other functional characteristics. (OECD, 2005) Finding new products, adding new features or new uses of a product are examples of product innovation. Apple's iPhone, wrinkle-resistant fabrics, Amazon's Kindle, mountain bike suspensions, extreme-action cameras such as GoPro, wearable computers, and dual-clutch transmissions are easily recognizable examples.
3. ***Marketing Innovation:*** A marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. (OECD, 2005) Research shows that it is a consequence of competitiveness; to increase sales, it will address customer needs better, open new markets, and find new ways for positioning. In sustaining innovations, incumbents win. In disruptive innovations, new entrants win. Check out L'Oreal's Makeup Genius app, IKEA's Catalogue app and SBI's YONO app.
4. ***Organizational Innovation:*** Organizational innovation means the implementation of a new organizational method in the undertaking's business practices, workplace organization or external relations. (Official Journal of the EU) The organizational changes could be implementing new ways to create public value and could result from letting go fundamental assumptions and finding consistent predictors of success.



3.7.3 The 8 Phases of an Innovation Management Process

The *innovation management process* has become an important part of the operations of many businesses, as the recognition of the importance of initiatives towards innovation has become much more common. That said, while many companies do attempt to have a solid approach to creativity and innovation, too few actually focus on it as a single function. Instead, they seem to hold many separate activities in isolation, such as brainstorming sessions, pilot projects and campaigns, and vague communication with the market, and simply keep fingers crossed that it will come together in the end. While this has worked for some in the past, it is far from the ideal way of performing this important task. Instead, the best way to accomplish this is to have a set innovation activities which integrates the activity into the regular cycle of your business. The list below shows the phases in innovation management process, which will help your organization to put it all together as one process.

Notes

1. ***Setting the goals for the process:*** Innovation always begins with a goal in mind. It is many times based on finding the solution to a problem. Once you have this goal, it should be discussed among everyone in the problem solving team. This team may consist of you and another person, a group of people, or may even be all of your organization's employees. It may involve others such as your customers (who can provide suggestions and feedback based on their own experience with your product or service) or other stakeholders in the business. When you establish the team for this process, make sure that you have someone representing all the parts of the process from start to the end.

2. ***Cooperation:*** The innovation team should work together so that instead of trying to come up with an idea separately, they can bounce ideas off one another and create a collaborative solution. This can include the use of online tools, attendance of events such as trade shows that can be inspiring and informative, or simply consist of brainstorming sessions. You might consider having a trained business coach facilitating the discussions. There are many online tools available for real-time document sharing that might help teams that are geographically separated to still have intense cooperation.

3. ***Combination of ideas:*** Once the ideas are in, choose the best ones and then consider whether they can be combined to create an even greater idea. Often, strong ideas will be complementary to one another and will join well to create an even better result. As you know, the whole result can be bigger than its individual parts. And for this combination to work well, you need representatives of all parties involved in the process, because they for sure have ideas that people from other departments could not come up with. Business coaches may be useful here for making sure that all the angles of innovative aspect are covered.

4. ***Evaluation of innovation:*** This is an important and yet all too frequently overlooked aspect of the innovation management process. When the best ideas have been combined, fine-tuned, and polished, it is time to subject them to evaluation based on peer reviews. This helps to ensure that any ideas that have a promising veneer but that are poorly thought out will be identified before resources, funding and time have been poured into them. It also helps to select the ideas with the greatest potential from among several that appear equally capable of being successful. It is cheap to change your innovation at this stage compared to later stages. Each step you take forward will cost you more…

5. ***Testing the ideas:*** Once the ideas with the greatest potential have been identified, they can be tested so that they can be better developed. One of the most common means of testing a product or service idea is to create a prototype or test group. This allows the team, as well as customers and investors to have a better look at how the product will function and what changes can be made to it so that it will be even further improved. Make sure that the product or service not only raises interest but is able to generate orders also. If people say that they are interested in it, then ask them if they give you the order right away.

6. ***Execution of innovation implementation:*** The ideas that survive the testing process can be further developed and altered until they are ready to be executed as a part of the business offerings. The execution of implementation is a step that is unique to your business and, unless your new product causes you to have to drastically alter the typical way that your go-to-market strategy functions, then this part of the innovation management process should be relatively commonplace in your organization. It should be easier for you to move from testing to execution if you were able to generate orders already in testing phase.

7. ***Assessment of innovation life-cycle:*** After the execution of an idea, its implementation needs to be carefully monitored and assessed in terms of a number of milestones that should be set. Should a milestone not be reached, then changes will need to be made or the idea will need to be shut down. Remember to keep always customer in your mind also in execution phase and design your measuring systems so that they measure added value for the customer (you get what you measure and customers weight you based on that!).

Notes

3.7.4 Uses of Innovation Management

Innovation management is quickly becoming a critical requirement for enabling a sustainable business. Some of the uses/benefits for doing it well include:

- Improved timing for market introduction
- Ability to maintain or improve business margins
- Enabling access to new customers and markets
- Increased market share
- Improved and longer lasting competitive advantage
- Increased employee engagement and initiative
- Improved customer satisfaction
- Sustainable increase in shareholder returns

3.8 SUMMARY

A project is an organized endeavor to accomplish a specified non-repetitive task. A project passes through a life cycle that depends on the size and complexity of the project. Once the project receives the green light, it needs a solid plan to guide the team, as well as keep them on time and on budget. A well-written project plan gives guidance for obtaining resources, acquiring financing and procuring required materials. The project plan gives the team direction for producing quality outputs, handling risk, creating acceptance, communicating benefits to stakeholders and managing suppliers In critical studies of project management it has been noted that phased approaches are not well suited for projects which are large-scale and multi-company, with undefined, ambiguous, or fast-changing requirements, or those with high degrees of risk, dependency, and fast-changing technologies. The cone of uncertainty explains some of this as the planning made on the initial phase of the project suffers from a high degree of uncertainty. This becomes especially true as software development is often the realization of a new or novel product. An increasing number of organizations are using what is referred to as project portfolio management (PPM) as a means of selecting the right projects and then using project management techniques as the means for delivering the outcomes in the form of benefits to the performing private or not-for-profit organization. Innovation management is quickly becoming a critical requirement for enabling a sustainable business.

3.9 SELF ASSESSMENT QUESTIONS

Short Type Questions

1. Define project management.
2. What is project life cycle?
3. What do you mean by process based management?
4. Justify the concept of project documentation.
5. Explain the characteristics of project management.
6. Explain how society is benefited out of project management.
7. Mention the responsibility of project manager.

Notes

Essay Type Questions

1. Explain various types of project management.
2. Describe the function & classification of project management.
3. Explain various phases and uses of innovation management.
4. Narrate the different types of decisions taken by a project manager.
5. Explain the most important differences between PERT and CPM.

Notes

UNIT 4 SUPPLY CHAIN MANAGEMENT

Structure

4.0 OBJECTIVES

After completing this unit, you will be able to learn about:

- Define MRP.
- Identify the functions of MRP.
- Understand the meaning of JIT. Describe its Uses.
- Define Supply chain Management.
- Functions of Supply chain Management
- Aggregate product Planning

Notes

4.1 INTRODUCTION

MRP is one of the most widely used systems for harnessing computer power to automate the manufacturing process.

IBM engineer Joseph Orlicky developed MRP in 1964 after he studied the Toyota Production System, which was the model for the production methodology. Power tool maker Black & Decker built the first computerized MRP system that same year, according to several sources.

It's important to note, however, that MRP and lean production are not the same and are considered by some practitioners to be antithetical, though some say MRP can help with lean production. MRP is considered a "push" system -- inventory needs are determined in advance, and goods produced to meet the forecasted need -- while lean is a "pull" system in which nothing is made or purchased without evidence of actual -- not forecasted -- demand.

Orlicky's ideas spread rapidly throughout the manufacturing sector after the 1975 publication of his book, Material Requirements Planning: The New Way of Life in Production and Inventory Management, and by the early 1980s, there were hundreds of commercial and homegrown MRP software programs.

4.2 BASICS OF MRP

Material requirements planning (MRP) is a system for calculating the materials and components needed to manufacture a product. It consists of three primary steps: taking inventory of the materials and components on hand, identifying which additional ones are needed and then scheduling their production or purchase. MRP uses information from the bill of materials (a list of all the materials, subassemblies and other components needed to make a product, along with their quantities), inventory data and the master production schedule to calculate the required materials and when they will be needed during the manufacturing process.

MRP is useful in both discrete manufacturing, in which the final products are distinct items that can be counted -- such as bolts, subassemblies or automobiles -- and process manufacturing, which results in bulk products -- such as chemicals, soft drinks and detergent -- that can't be separately counted or broken down into their constituent parts.

4.2.1 MRP vs. ERP

An extension of MRP, developed by management expert Oliver Wight in 1983 and called manufacturing resource planning (MRP II), broadened the planning process to include other resources in the company, such as financials and added processes for product design, capacity planning, cost management, shop-floor control and sales and operations planning, among many others.

In 1990, the analyst firm Gartner coined the term enterprise resource planning (ERP) to denote a still more expanded and generalized type of MRP II that took into account other major functions of a business, such as accounting, human resources and supply chain management, all of it managed in a centralized database. Both MRP and MRP II are considered direct predecessors of ERP.ERP quickly expanded to other industries, including services, banking and retail that did not need an MRP component. However, MRP is still an important part of the ERP software used by manufacturers.

4.2.2 Objectives of Material Requirements Planning

Not surprisingly, the primary objective of MRP is to make sure that materials and components are available when needed in the production process and that manufacturing takes place on schedule. Effective inventory management and optimization is another goal of MRP. While MRP is designed to ensure adequate inventory at the required times, a company can be tempted to hold more inventory than is necessary, thereby driving up inventory costs. MRP can also improve manufacturing efficiency by using accurate scheduling to optimize the use of labour and equipment.

Notes

Proponents of MRP and DDMRP say these approaches can help achieve a better matching of supply and demand. This achievement, in turn, can reduce product costs and increase revenues as customer demand is fully met and no revenue opportunities are lost from missed ship dates or inventory shortfalls.

4.2.3 JIT - Background and History

JIT is a Japanese management philosophy which has been applied in practice since the early 1970s in many Japanese manufacturing organizations. It was first developed and perfected within the Toyota manufacturing plants by Taiichi Ohno as a means of meeting consumer demands with minimum delays. Taiichi Ohno is frequently referred to as the father of JIT.

Toyota was able to meet the increasing challenges for survival through an approach that focused on people, plants and systems. Toyota realized that JIT would only be successful if every individual within the organization was involved and committed to it, if the plant and processes were arranged for maximum output and efficiency, and if quality and production programs were scheduled to meet demands exactly.

JIT manufacturing has the capacity, when properly adapted to the organization, to strengthen the organization's competitiveness in the marketplace substantially by reducing wastes and improving product quality and efficiency of production.

There are strong cultural aspects associated with the emergence of JIT in Japan. The Japanese work ethic involves the following concepts.

- Workers are highly motivated to seek constant improvement upon that which already exists. Although high standards are currently being met, there exist even higher standards to achieve.
- Companies focus on group effort which involves the combining of talents and sharing knowledge, problem-solving skills, ideas and the achievement of a common goal.
- Work itself takes precedence over leisure. It is not unusual for a Japanese employee to work 14-hour days.
- Employees tend to remain with one company throughout the course of their career span. This allows the opportunity for them to hone their skills and abilities at a constant rate while offering numerous benefits to the company.

  These benefits manifest themselves in employee loyalty, low turnover costs and fulfillment of company goals.`Just-in-time' is a management philosophy and not a technique.

  It originally referred to the production of goods to meet customer demand exactly, in time, quality and quantity, whether the `customer' is the final purchaser of the product or another process further along the production line.

  It has now come to mean producing with minimum waste. "Waste" is taken in its most general sense and includes time and resources as well as materials. Elements of JIT include:

  - Attacking fundamental problems - anything that does not add value to the product.
  - Devising systems to identify problems.
  - Striving for simplicity - simpler systems may be easier to understand, easier to manage and less likely to go wrong.
  - A product oriented layout - produces less time spent moving of materials and parts.
  - Quality control at source - each worker is responsible for the quality of their own output.
  - Poka-yoke - `foolproof' tools, methods, jigs etc. prevent mistakes
  - Preventative maintenance, Total productive maintenance - ensuring machinery and equipment functions perfectly when it is required, and continually improving it.

Notes

- Eliminating waste. There are seven types of waste:
  - waste from overproduction.
  - waste of waiting time.
  - transportation waste.
  - processing waste.
  - inventory waste.
  - waste of motion.
  - waste from product defects.
- Good housekeeping - workplace cleanliness and organisation.
- Set-up time reduction - increases flexibility and allows smaller batches. Ideal batch size is 1item. Multi-process handling - a multi-skilled workforce has greater productivity, flexibility and job satisfaction.
- Levelled / mixed production - to smooth the flow of products through the factory.
- Kanbans - simple tools to `pull' products and components through the process.
- Jidoka (Autonomation) - providing machines with the autonomous capability to use judgement, so workers can do more useful things than standing watching them work.
- Andon (trouble lights) - to signal problems to initiate corrective action.

4.2.4 Objectives and Benefits

Objectives and benefits of JIT manufacturing may be stated in two primary ways: first, in specific and quantitative terms, via published case studies; second, general listings and discussion.

A case-study summary from Daman Products in 1999 lists the following benefits: reduced cycle times 97%, setup times 50%, lead times from 4 to 8 weeks to 5 to 10 days, flow distance 90% – achieved via four focused (cellular) factories, pull scheduling, kanban, visual management, and employee empowerment.

Another study from NCR (Dundee Scotland) in 1998, a producer of make-to-order automated teller machines, includes some of the same benefits while also focusing on JIT purchasing: In switching to JIT over a weekend in 1998, eliminated buffer inventories, reducing inventory from 47 days to 5 days, flow time from 15 days to 2 days, with 60% of purchased parts arriving JIT and 77% going dock to line, and suppliers reduced from 480 to 165.

Hewlett-Packard, one of western industry's earliest JIT implementers, provides a set of four case studies from four H-P divisions during the mid-1980s. The four divisions, Greeley, Fort Collins, Computer Systems, and Vancouver, employed some but not all of the same measures. At the time about half of H-P's 52 divisions had adopted JIT.

	Greeley	**Fort Collins**	**Computer Systems**	**Vancouver**
Inventory reduction	2.8 months	75%	75%	
Labour cost reduction	30%	15%		50%
Space reduction	50%	30%	33%	40%
WIP stock reduction	22 days to 1 day			
Production increase	100%			
Quality improvement		30% scrap, 79% rework	80% scrap	30% scrap & rework
Throughput time reduction		50%	17 days to 30 hours	
Standard hours reduction	50%			
No. of shipments increase				20%

Notes

4.3 DEFINITION OF SUPPLY CHAIN MANAGEMENT

If you go to a Supermarket and pick up a few items off the shelf from electronics and white goods or even clothes and look at the labels, the chances are that you will find them having been manufactured in China or Mexico. The coffee pods you buy to use for your everyday use comes from Africa. Computers have been shipped out of South American Factories and Soft furnishings on the shelves are from India and Hong Kong.

Global markets are expanding beyond borders and re-defining the way demand and supplies are managed. Global companies are driven by markets across continents. To keep the cost of manufacturing down, they are forced to keep looking to set up production centers where the cost of raw materials and labor is cheap. Sourcing of raw materials and vendors to supply the right quality, quantity and at right price calls for dynamic procurement strategy spanning across countries.

With the above scenario you find companies procuring materials globally from various vendors to supply raw materials to their factories situated in different continents. The finished goods out of these different factory locations then pass through various chains of distribution network involving warehouses, exports to different countries or local markets, distributors, retailers and finally to the end customer.

In simple language, managing all of the above activities in tandem to manage demand and supply on a global scale is Supply Chain Management. As per definition SCM is the management of a network of all business processes and activities involving procurement of raw materials, manufacturing and distribution management of Finished Goods. SCM is also called the art of management of providing the Right Product, At the Right Time, Right Place and at the Right Cost to the Customer.

4.3.1 Information Technology and SCM

Supply Chain Management is a broad-based function that encompasses all business and operational processes involved in but not limited to Procurement, Manufacturing, and Finished Goods Transportation, warehousing & Distribution and Inventory Management.

In a globalized business scenario characterized by geographically spread markets, raw material procurement sources across the world and cheaper manufacturing and labor markets being available in developing world, the business of meeting demand with supply is constantly changing and evolving.

Global business has been fuelled and enabled by the IT Technology which has redefined all aspects of business today. All businesses today are run on ERP - Enterprise Resource Planning which provides the organizations with tools to manage all the functions including procurement, production, sales, and finance management in seamless and integrated manner.

4.3.2. Logistics - An Integral Component of Supply Chain Management

Supply Chain Management encompasses, planning, design, control and implementation of all business processes related to procurement, manufacturing, distribution and sales order fulfillment functions of a business. All these activities involve multiple networks of vendors and service providers which are integrated and co-coordinated by the Supply Chain Experts of the organization to move raw materials and finished goods from and to all distant locations across the globe.

Logistics is the backbone on which Supply Chains are driven. Logistics refers to the management of the flow of goods and supplies involving information, data and documentation between two entities or points. Logistics plays important role in post procurement function of delivery of raw material from the supplier to the point of production and Finished Goods Supply chain management from the point of dispatch from factory to the point of delivery to the customer.

Notes

4.3.3 Logistics Operations in Supply Chain Network

Logistics has aided and contributed to enabling global trade. Third Party Logistics Service Providers both at global levels and local levels form major partners to manage and offer Supply Chain services and the second major factor being the Internet and IT technology that helps manage information and data ahead of or along with flow of materials and goods. Supply Chain Consultants and professionals find it very essential to have knowledge of the operational field and how things work on the ground. Theoretical models can be effectively deployed only when realities on the ground are understood and adapted to.

Take an example of DELL which has successfully implemented its Supply Chain strategy built around the concept of JIT manufacturing and Direct Marketing.

Dell has manufacturing facilities located in Austin-Texas, North Carolina, Miami, Florida that service US Markets. European Markets are serviced from its plants in Ireland and Poland. Asia and other sub-continents are supported by its manufacturing facilities in Penang in Malaysia and Xiamen in China along with the latest factory set up in Chennai in India. South America is serviced from its Eldora do plant while the new plan in Brazil supports the African continent.

One can imagine the complexities involved in designing procurement systems. Dell does not buy raw materials and components and maintains inventory. Dell's vendors use third party service providers to set up logistics parks and distribution warehouses close to Dell's plants and deliver materials just in time to the plant against an order for production that is triggers based on an order confirmed by the customer on the internet.

Under procurement logistics, in this case, some logistics service providers play a major part in ensuring smooth operations. Vendors are based out of Europe, Taiwan, China, Singapore, Hong Kong, Korea, and Japan, etc.

Though the raw materials belong to the vendors until the time they are supplied to production shop floor, the design, planning and selection of logistics service provider are initiated and managed by Dell. Dell has appointed freight forwarders such as DHL, CEVA, UPS etc sector wise to pick up shipments from vendor locations, transport the collected shipments by road and consolidate inventories of all providers in the freight forwarders consolidation warehouses situated at the gateways in each country and ship out cargo by ships to the port of destination or airfreight shipments to the plant locations after completing exports and customs clearance formalities on behalf of vendors.

While the shipments are in transit, the freight forwarders electronically transfer shipment information and documentations to their overseas offices or agents at the destination and keep Dell and vendors informed of the status of shipments.

Freight forwarders at the destination ports file advance shipment documents with customs and on arrival of cargo, complete customs formalities and custom cleared cargo is then transported to freight forwarders warehouse or customs bonded warehouse or to another designated third party warehouse that houses all inventories meant for Dell.

The third party service provider who manages the inventories in his warehouse receives the cargo, unpacks the shipments from bulk skids to individual carton level and completes inbound formalities including updating of inventories in its system and stocks the materials in designated rack locations. Both vendors and Dell are continuously kept informed of the data regarding shipments and stocks. The warehouse stocks inventory in the name of various vendors at SKU level. Most of the times these warehouses are situated adjacent to the plant or at proximity. Upon receiving a production order from Dell, as per Bill of Material received through DELL ERP system, items are picked up, loaded into the supply cages and trays as per predetermined design and delivered to the plant after completing documentation and system entries to remove inventory from its system held in vendors name, invoice raised and physical delivery accompanied with documents completes the supply chain cycle of Raw material supply.

Notes

4.3.4 Logistics Service Providers keeps Supply Chain Moving

Procurement Logistics, Manufacturing Logistics and Finished Goods Logistics functions are managed by different independent departments in a company. Though the duties of the departments involve common activities like transportation etc., however, the processes and nature of logistics functions are specific to each function besides the requirements and sensitivities of delivery times, schedules, etc. With the emerging trends and availability of third party logistics providers has pushed the companies to adapt the practice of outsourcing all supply chain components and logistics functions termed as non-core functions to their logistics providers. In this topic we shall examine the role and functions of Third Party Service Providers a little closely to understand how they make a difference to the supply chain activities.

Third Party Logistics field is a multi-layer or multi-tier integration of various players who have the niche segment expertise to manage any one or many functions of Logistics. In any Logistics Contract or Supply Chain Network, you will not find one single service provider being able to manage the entire chain of activities. You can have a lead logistics service provider who will further tie up with and manage other service providers to provide a single window service to the client organization. At all levels, a lot of components of logistics get outsourced by these service providers to contractors and local players. Like for example in a contract logistics facility, the third party logistics provider who has secured the contract may not own and operate the facility himself. Labor is often outsourced along with other operations like Loading/ Unloading, Yard Management, Fleet Management, etc.

Normally in Logistics, the lead players front ending the businesses would be the Freight Forwarders, Transport Companies (generally in long haul segment only) and Warehousing Service Providers. In many cases Freight Forwards own and manage warehousing facilities too.

Freight forwarders are those agencies who consolidate the cargo and book the cargo for onward freight using an airline or a shipping line or use ground transportation network including rail services wherever required. Freight forwarders do not own any mode of transportation services. They book the space with airlines and shipping lines and negotiate the freight. They play the key role of providing origin and destination services coupled with single window client services using other third party service providers. Most of them also have in-house customs clearance division to support ground logistics operations

4.3.5 International Logistics

The foundation of logistics function is based mainly on Transportation by Road, Rail, and Air & Sea. Maritime trade has existed since times immemorial. History is replete with the major maritime routes that connected continents across the globe and enabled trade between them. Harbors and waterways have flourished in strategic locations in all countries attracting trade and commerce.

Global trade is dependant 80% on sea route than air route, simply for the fact that air route is far more expensive and is used only in case of light weight cargo, perishable cargo, and priority shipments or in other conditions where shipping would not be possible.

Shipping trade is characterized by shipping companies who own vessels and specialize in the transportation of certain types of cargo like General Cargo, Containerized cargo, bulk commodities carriers, oil tankers, gas tankers, OD cargo carriers, etc. Normally the so called mother vessels ply on the main shipping route across the continents traveling through Pacific or Atlantic oceans and calling on countries from point to point. Mother vessels are bigger vessels with higher cargo carrying capacity. Some of the main routes normally traversed by mother vessels are the Far East to Europe and Mediterranean, Europe to America East Coast and the Gulf of Mexico, Far East Australia to South Africa, Intra Asia, Asia to the Middle East, and Europe to South Africa, etc. The schedules in detail are announced in advance for each of the vessels. The feeder vessels carry cargo from individual ports in nearby countries which discharge the cargo at the port of calling to be transshipped on to the main vessel.

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Thus for example, a cargo originating in India bound for South Africa may follow the route where cargo reaches one of the ports in Ceylon or Dubai even Singapore in some cases and travels right up to Europe where in is further transshipped on another vessel bound to South Africa. Likewise the global shipping trade lanes have certain gateways and lanes which they operate and in turn are fed and supported by feeder lanes and vessels.

4.3.6 Finished Goods Supply Chain

Buying a Desktop computer for your home or a Laptop for your use is very easy. You browse the internet to see the latest models and configurations, decide on your specific requirement and click to place an order. At times, of course, you might go into an electronic supermarket and check out the physical product before you buy. Immediately on payment, you cannot wait for the delivery

Finished Goods supply chains are very dynamic and are the backbone of a good sales organization. Some departments are responsible for working in coordination and seamlessly to ensure Finished Goods reach the markets and the customers. Logistics and supply chain departments have to work in tandem with or aim to be ahead of Marketing and Sales and ensure that when a product is announced for sale by marketing, the products are made available at all nook and corner of the city, state, and country.

4.3.7 Spare Parts Supply Chain

Today the brand image or market demand rides not only the quality of the product but on the quality of service support too. Service support is critical in industries like Computers, Telecom, Aero spares, etc.. In all cases the response time and availability of the spares become critical. In all cases corporate installations demanding onsite support coupled with critical downtime service level measurements have pushed the suppliers to set up an efficient spare parts supply chain.

Take the case of an installation of a server in a bank's central processing division cannot afford to be down at all. The company who installs the server is required to ensure that service engineer is available at site during normal hours and on call basis on 24 × 7 basis. It is not enough to have the engineer attending to or being available at site; the required spare parts need to be available. Aero spare parts supply chain has also been built around processes to ensure fastest lead times and ready availability and immediate retrieval of the right component.

In most cases the essential spare parts are kept in stock at the country level based on the number of installations or volumes of sale under each category of product. In case of non availability the parts are called for on urgent basis from a regional distribution center normally available at a regional level servicing a continent and flown down on urgent courier mode.

4.3.8 Reverse Logistics

As Supply Chain Activities are evolving and partnering changes in business models, the focus and activities are not restricted to the management of raw materials and finished goods from point of origin from the vendors to plants and further on to the end customers. There is another extension to Supply Chain Process called as Reverse Logistics.

Reverse Logistics as the name denotes, deals with the planning, process and flow of finished goods inventory, packaging materials and parts of finished product back from end customer to the product company as sales return or warranty return or unsold inventory with trading partners. Reverse Logistics planning further re-captures value from these materials as much as possible by way of re salvaging, repair, refurbishing, recycling etc.

4.3.9 3PL Contract Logistics Operations

While Freight Forwarding is an important function of 3PL Service providers to facilitate the Supply Chain, another equally important function managed by 3PL Logistics Companies is Contract Logistics. Under the broad umbrella of Contract Logistics, 3PL providers provide services of setting up consolidation centers, distribution centers, warehouses and inventory management services.

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European network of transportation and warehouses stand apart from the rest of the world and are highly evolved regarding supply chain capabilities. America too has similar capabilities developed in recent years. Normally warehousing facilities are built and rented out as real estates. Warehousing Parks or Distribution Facilities are designed with complete layout and infrastructure for truck parking, yard management, and security systems, etc. Warehousing buildings of sizes ranging from 1000 sq. mtrs to several hundred sq. mtrs come equipped with all weather docks, dock levelers, and dock platforms to facilitate continuous loading and unloading activities and quick turnaround of vehicles. These facilities include office facilities and other utilities too as a complete stand-alone facility.

4.3.10 Warehouse Management System

In any Supply Chain, Inventory Management and Warehousing form a part of operations intensive function and is one of the key building blocks in the entire chain. Most of the inventory is held at the warehouses as compared to the pipeline, and the efficiency of the warehouse operations will determine the further supply chain efficiency.

Though it is a normal industry practice now to outsource the warehousing operations to a 3PL Logistics service provider, the SCM managers who are the decision makers and network owners would need to know the intricacies of warehouse operations and get actively involved in choosing the right partner and right facility.

A distribution center or a warehouse is the key to the entire model as it holds the inventories and also manages other operations like bundling, packing, labeling, co-packing, kitting, etc. as per buyer requirement. Most of the marketing and buyers requirements are met with from the warehouses.

The Warehouse Management System controls two sets of operations:

1. On the inventory front, the system maintains inventory in the warehouse at Zone & individual location level, SKU level, pallet wise, carton wise and unit level inventories for multiple customers and allows specific inventory attributes and parameters to be built in to manage, allocate or block the inventory. The system also provides options to adapt FIFO, LIFO or other methods of inventory flow.
2. On the Operations front the system manages, controls and directs all operations including receiving processes, put away processes, order processing, inventory allocation, picking process, packing process and finally shipment along with inventory updating. The intelligent system guides and helps operations manager to schedule and manage all operations for various groups and teams simultaneously depending upon the workload and pattern and thereby manage resource allocation too.

4.3.11 Documentation in Supply Chain Management

Supply chain operations and network extend beyond domestic boundaries and global boundaries of all countries. A logistical exercise originates at the buyers end and involves multiple agencies including buyer, seller, 3PL freight forwarder, transporters at various juncture, shipping lines, airlines, various governmental agencies, customs departments at various locations and financial institutions like banks to complete the entire supply chain cycle.

Smooth flowing of materials in a journey originating at one point and going through the entire cycle of exports and imports to reach a point of consumption would mean engagement and interaction with all of the above agencies who have a stake in the said transaction. Need for decision making concerning financial, commercial, technical, operational matters about shipments arise at various times in the cycle, which demands that the 3PL, the logistics carrier, the buyer, the supplier are actively engaged and have visibility to information and documentation for the smooth flow across various transit points. In fact, in faultless logistics operations, the documentation and information flow should precede physical movement of goods.

Documentation becomes important not only for the physical logistics operations involving multiple agencies engaged in the entire chain, the financial, trading and accounting processes of

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the both buyer and seller organizations and partner banks also involved depend upon the entire set of documentation pertaining to each transaction to be able to recognize the sale, recognize value of consignment and effect necessary payment. Accounting practices of the organizations require detailed documentation as per bookkeeping practices and norms. Finally, goods and services are recognized and identified at every stage only with the set of authenticated documentation showing ownership based on which the customs allow them to be exported or imported into or out of the country. There are many more aspects like terms of carriage by the carrier coupled with insurance liabilities and coverage that call for set of documentation covering specific aspects of each transaction.

A supply chain manager needs to be aware of the complete set of documentation requirement along with the various aspects to be able to design processes and documentation control mechanisms. Errors in documentation will lead to financial damage, delays in delivery and performance that is what every manager aims to avoid.

4.4 AGGREGATE PRODUCT PLANNING

An organization can finalize its business plans on the recommendation of demand forecast. Once business plans are ready, an organization can do backward working from the final sales unit to raw materials required. Thus annual and quarterly plans are broken down into labor, raw material, working capital, etc. requirements over a medium-range period (6 months to 18 months). This process of working out production requirements for a medium range is called aggregate planning.

4.4.1 Factors Affecting Aggregate Planning

Aggregate planning is an operational activity critical to the organization as it looks to balance long-term strategic planning with short term production success. Following factors are critical before an aggregate planning process can actually start;

- Complete information is required about available production facility and raw materials.
- A solid demand forecast covering the medium-range period
- Financial planning surrounding the production cost which includes raw material, labor, inventory planning, etc.
- Organization policy around labor management, quality management, etc.

For aggregate planning to be a success, following inputs are required;

- An aggregate demand forecast for the relevant period
- Evaluation of all the available means to manage capacity planning like sub-contracting, outsourcing, etc.
- Existing operational status of workforce (number, skill set, etc.), inventory level and production efficiency

Aggregate planning will ensure that organization can plan for workforce level, inventory level and production rate in line with its strategic goal and objective.

4.4.2 Aggregate Planning as an Operational Tool

Aggregate planning helps achieve balance between operation goal, financial goal and overall strategic objective of the organization. It serves as a platform to manage capacity and demand planning. In a scenario where demand is not matching the capacity, an organization can try to balance both by pricing, promotion, order management and new demand creation. In scenario where capacity is not matching demand, an organization can try to balance the both by various alternatives such as.

- Laying off/hiring excess/inadequate workforce until demand decrease/increase.
- Including overtime as part of scheduling there by creating additional capacity.
- Hiring a temporary workforce for a fix period or outsourcing activity to a sub-contractor.

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4.4.3 Importance of Aggregate Planning

Aggregate planning plays an important role in achieving long-term objectives of the organization. Aggregate planning helps in:

- Achieving financial goals by reducing overall variable cost and improving the bottom line
- Maximum utilization of the available production facility
- Provide customer delight by matching demand and reducing wait time for customers
- Reduce investment in inventory stocking
- Able to meet scheduling goals there by creating a happy and satisfied work force

4.4.4 Aggregate Planning Strategies

There are three types of aggregate planning strategies available for organization to choose from. They are as follows.

1. ***Level Strategy:*** As the name suggests, level strategy looks to maintain a steady production rate and workforce level. In this strategy, organization requires a robust forecast demand as to increase or decrease production in anticipation of lower or higher customer demand. Advantage of level strategy is steady workforce. Disadvantage of level strategy is high inventory and increase back logs.
2. ***Chase Strategy:*** As the name suggests, chase strategy looks to dynamically match demand with production. Advantage of chase strategy is lower inventory levels and back logs. Disadvantage is lower productivity, quality and depressed work force.
3. ***Hybrid Strategy:*** As the name suggests, hybrid strategy looks to balance between level strategies and chase strategies.

4.5 SUMMARY

Material requirements planning (MRP) is a system for calculating the materials and components needed to manufacture a product. It consists of three primary steps: taking inventory of the materials and components on hand, identifying which additional ones are needed and then scheduling their production or purchase. Supply chain operations and network extend beyond domestic boundaries and global boundaries of all countries. A logistical exercise originates at the buyers end and involves multiple agencies including buyer, seller, 3PL freight forwarder, transporters at various juncture, shipping lines, airlines, various governmental agencies, customs departments at various locations and financial institutions like banks to complete the entire supply chain cycle.

JIT is a Japanese management philosophy which has been applied in practice since the early 1970s. Objectives and benefits of JIT manufacturing may be stated in two primary ways: first, in specific and quantitative terms, via published case studies; second, general listings and discussion. Aggregate planning is an operational activity critical to the organization as it looks to balance long-term strategic planning with short term production success.

4.6 SELF ASSESMENT QUESTIONS

Short Type Questions

1. Define Material Requirement Planning (MRP).
2. What are objectives of MRP?
3. What do you mean by JIT?
4. Justify the basics of MRP.
5. Explain the benefits of JIT.

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6. Explain objectives of JIT.
7. Who is father of JIT?
8. What is Supply chain management?
9. What do you mean by spare parts supply chain?
10. Explain warehouse management system.

Essay Type Questions

1. What is supply chain management? Discuss different types of SCM and its documentation process.
2. What is aggregate product planning? Discuss the factors affecting it.
3. What is the importance of Aggregate Product Planning? Discuss Aggregate planning strategy.

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UNIT 5 INVENTORY MANAGEMENT

Structure

5.0 OBJECTIVES

After completing this unit, you will be able to learn about:

- Define MRP.
- Identify the functions of MRP.
- Understand the meaning of JIT. Describe its Uses.
- Define Supply chain Management.
- Functions of Supply chain Management
- Aggregate product Planning

5.1 INTRODUCTION

Inventory management is a very important function that determines the health of the supply chain as well as the impacts the financial health of the balance sheet. Every organization constantly strives to maintain optimum inventory to be able to meet its requirements and avoid over or under inventory that can impact the financial figures.

Inventory is always dynamic. Inventory management requires constant and careful evaluation of external and internal factors and control through planning and review. Most of the organizations have a separate department or job function called inventory planners who continuously monitor, control and review inventory and interface with production, procurement and finance departments.

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5.2 DEFINING INVENTORY

Inventory is an idle stock of physical goods that contain economic value, and are held in various forms by an organization in its custody awaiting packing, processing, transformation, use or sale in a future point of time.

Any organization which is into production, trading, sale and service of a product will necessarily hold stock of various physical resources to aid in future consumption and sale. While inventory is a necessary evil of any such business, it may be noted that the organizations hold inventories for various reasons, which include speculative purposes, functional purposes, physical necessities etc.

The term inventory has been defined by several authors. The popular among them are :-"the term inventory includes materials-raw, in process, finished packaging, spares and others stocked in order to meet an unexpected demand or distribution in the future."

– B.D. Khare, Inventory Control, NPC, p.1.

From the above definition the following points stand out with reference to inventory:

- All organizations engaged in production or sale of products hold inventory in one form or other.
- Inventory can be in complete state or incomplete state.
- Inventory is held to facilitate future consumption, sale or further processing/value addition.
- All inventoried resources have economic value and can be considered as assets of the organization.

5.3 DIFFERENT TYPES OF INVENTORY

Inventory of materials occurs at various stages and departments of an organization. A manufacturing organization holds inventory of raw materials and consumables required for production. It also holds inventory of semi-finished goods at various stages in the plant with various departments. Finished goods inventory is held at plant, FG Stores, distribution centers etc. Further both raw materials and finished goods those that are in transit at various locations also form a part of inventory depending upon who owns the inventory at the particular juncture. Finished goods inventory is held by the organization at various stocking points or with dealers and stockiest until it reaches the market and end customers.

Besides Raw materials and finished goods, organizations also hold inventories of spare parts to service the products. Defective products, defective parts and scrap also forms a part of inventory as long as these items are inventoried in the books of the company and have economic value.

Types of Inventory by Function

INPUT	PROCESS	OUTPUT
Raw Materials	Work In Process	Finished Goods
Consumables required for processing. Eg : Fuel, Stationary, Bolts & Nuts etc. required in manufacturing	Semi Finished Production in various stages, lying with various departments like Production, WIP Stores, QC, Final Assembly, Paint Shop, Packing, Outbound Store etc.	Finished Goods at Distribution Centers through out Supply Chain
Maintenance Items/Consumables	Production Waste and Scrap	Finished Goods in transit

Notes

Packing Materials	Rejections and Defectives	Finished Goods with Stockiest and Dealers
Local purchased Items required for production		Spare Parts Stocks & Bought Out items
		Defectives, Rejects and Sales Returns
		Repaired Stock and Parts
		Sales Promotion & Sample Stocks

5.4 NEED FOR INVENTORY MANAGEMENT

Most of the organizations have raw material inventory warehouses attached to the production facilities where raw materials, consumables and packing materials are stored and issue for production on JIT basis. The reasons for holding inventories can vary from case to case basis.

1. ***Meet variation in Production Demand:*** Production plan changes in response to the sales, estimates, orders and stocking patterns. Accordingly the demand for raw material supply for production varies with the product plan in terms of specific SKU as well as batch quantities.

   Holding inventories at a nearby warehouse helps issue the required quantity and item to production just in time.

2. ***Cater to Cyclical and Seasonal Demand:*** Market demand and supplies are seasonal depending upon various factors like seasons; festivals etc and past sales data help companies to anticipate a huge surge of demand in the market well in advance. Accordingly they stock up raw materials and hold inventories to be able to increase production and rush supplies to the market to meet the increased demand.

3. ***Economies of Scale in Procurement:*** Buying raw materials in larger lot and holding inventory is found to be cheaper for the company than buying frequent small lots. In such cases one buys in bulk and holds inventories at the plant warehouse.

4. ***Take advantage of Price Increase and Quantity Discounts:*** If there is a price increase expected few months down the line due to changes in demand and supply in the national or international market, impact of taxes and budgets etc, the company's tend to buy raw materials in advance and hold stocks as a hedge against increased costs.

   Companies resort to buying in bulk and holding raw material inventories to take advantage of the quantity discounts offered by the supplier. In such cases the savings on account of the discount enjoyed would be substantially higher that of inventory carrying cost.

5. ***Reduce Transit Cost and Transit Times:*** In case of raw materials being imported from a foreign country or from a far away vendor within the country, one can save a lot in terms of transportation cost buy buying in bulk and transporting as a container load or a full truck load. Part shipments can be costlier.

   In terms of transit time too, transit time for full container shipment or a full truck load is direct and faster unlike part shipment load where the freight forwarder waits for other loads to fill the container which can take several weeks.

   There could be a lot of factors resulting in shipping delays and transportation too, which can hamper the supply chain forcing companies to hold safety stock of raw material inventories.

6. ***Long Lead and High demand items need to be held in Inventory:*** Often raw material supplies from vendors have long lead running into several months. Coupled with this if the particular item is in high demand and short supply one can expect disruption of supplies. In such cases it is safer to hold inventories and have control.

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5.5 FINISHED GOODS INVENTORY

1. ***Production Strategy necessitates Inventory holding:*** The blue print of the entire Production strategy is dependent upon the marketing strategy. Accordingly organizations produce based on marketing orders. The production is planned based on Build to stock or Build to Order strategies.

   While Build to Order strategy is manufactured against specific orders and does not warrant holding of stocks other than in transit stocking, Build to Stock production gets inventoried at various central and forward locations to be able to cater to the market demands.

2. ***Market penetration:*** Marketing departments of companies frequently run branding and sales promotion campaigns to increase brand awareness and demand generation. Aggressive market penetration strategy depends upon ready availability of inventory of all products at nearest warehousing location so that product can be made available at short notice - in terms of number of hours lead time, at all sales locations throughout the state and city. Any non-availability of stock at the point of sale counter will lead to dip in market demand and sales. Hence holding inventories becomes a necessity.

3. ***Market Size, location and supply design:*** Supply chain design takes into account the location of market, market size, demand pattern and the transit lead time required to reach stocks to the market and determine optimum inventory holding locations and network to be able to hold inventories at national, regional and local levels and achieve two major objectives. The first objective would be to ensure correct product stock is available to service the market. Secondly stocks are held in places where it is required and avoid unwanted stock build up.

4. ***Transportation and Physical Barriers:*** Market location and the physical terrain of the market coupled with the local trucking and transportation network often demand inventory holding at nearest locations. Hilly regions for example may require longer lead-time to service. All kinds of vehicles may not be available and one may have to hire dedicated containerized vehicles of huge capacities. In such cases they will have to have an inventory holding plan for such markets.

   Far away market locations means longer lead times and transportation delays. Inventory holding policy will take into account these factors to work out the plan.

5. ***Local tax and other Govt. Rules:*** In many countries where GST is not implemented, regional state tax rules apply and vary from state to state. Accordingly while one state may offer a tax rebate for a particular set of product category, another state may charge higher local taxes and lower interstate taxes. In such cases the demand for product from the neighboring state may increase than from the local state. Accordingly inventory holding would have to be planned to cater to the market fluctuation.

   While in case of exports from the country of origin into another market situated in another country, one needs to take into account the rules regarding import and customs duties to decide optimum inventories to be held en route or at destination.

6. ***Production lead times:*** FG inventory holding becomes necessary in cases where the lead-time for production is long. Sudden market demand or opportunities in such cases require FG inventories to be built up and supplies to be effected.

7. ***Speculative gain:*** Companies always keep a watch on the economy, annual state budget, financial environment and international environment and are able to foresee and estimate situations, which can have an impact on their business and sales.

   In cases where they are able to estimate a increase in industry prices, taxes or other levies which will result in an overall price increase, they tend to buy and hold huge stocks of raw materials at current prices. They also hold up finished stock in warehouses in anticipation of a impending sale price increase. All such moves cause companies to hold inventories at various stages.

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8. ***Avoid Certain Costs:*** Finally organizations hold FG inventories to satisfy customer demand, to reduce sales management and ordering costs, stock out costs and reduce transportation costs and lead times.

9. ***Markets and Supply Chain Design:*** Organizations carry out detailed analysis of the markets both at national as well as international / global levels and work out the Supply Chain strategy with the help of SCM strategists as to the ideal location for setting up production facilities, the network of and number of warehouses required to reach products to the markets within and outside the country as well as the mode or transportation, inventory holding plan, transit times and order management lead times etc, keeping in mind the most important parameter being, to achieve Customer Satisfaction and Demand Fulfillment.

5.6 INDEPENDENT AND DEPENDANT DEMAND INVENTORIES

Inventory Management deals essentially with balancing the inventory levels. Inventory is categorized into two types based on the demand pattern, which creates the need for inventory. The two types of demand are Independent Demand and Dependant Demand for inventories.

Independent Demand

An inventory of an item is said to be falling into the category of independent demand when the demand for such an item is not dependent upon the demand for another item.

Finished goods Items, which are ordered by External Customers or manufactured for stock and sale, are called independent demand items.

Independent demands for inventories are based on confirmed Customer orders, forecasts, estimates and past historical data.

Dependant Demand

If the demand for inventory of an item is dependent upon another item, such demands are categorized as dependant demand.

Raw materials and component inventories are dependent upon the demand for Finished Goods and hence can be called as Dependant demand inventories.

Take the example of a Car. The car as finished goods is an held produced and held in inventory as independent demand item, while the raw materials and components used in the manufacture of the Finished Goods - Car derives its demand from the demand for the Car and hence is characterized as dependant demand inventory.

This differentiation is necessary because the inventory management systems and process are different for both categories.

While Finished Goods inventories which is characterized by Independent demand, are managed with sales order process and supply chain management processes and are based on sales forecasts, the dependant demand for raw materials and components to manufacture the finished goods is managed through MRP -Material Resources Planning or ERP – Enterprise Resource Planning using models such as Just In Time, Kanban and other concepts. MRP as well as ERP planning depends upon the sales forecast released for finished goods as the starting point for further action.

Managing Raw Material Inventories is far more complicated than managing Finished Goods Inventory. This involves analyzing and co-coordinating delivery capacity, lead times and delivery schedules of all raw material suppliers, coupled with the logistical processes and transit timelines involved in transportation and warehousing of raw materials before they are ready to be supplied to the production shop floor. Raw material management also involves periodic review of the inventory holding, inventory counting and audits, followed by detailed analysis of the reports leading to financial and management decisions.

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5.7 INVENTORY COSTS

Inventory costs are basically categorized into three headings:

1. Ordering Cost
2. Carrying Cost
3. Shortage or stock out Cost & Cost of Replenishment
    a. Cost of Loss, pilferage, shrinkage and obsolescence etc.
    b. Cost of Logistics
    c. Sales Discounts, Volume discounts and other related costs.
4. ***Ordering Cost:*** Cost of procurement and inbound logistics costs form a part of Ordering Cost. Ordering Cost is dependant and varies based on two factors - The cost of ordering excess and the Cost of ordering too less.

    Both these factors move in opposite directions to each other. Ordering excess quantity will result in carrying cost of inventory. Whereas ordering less will result in increase of replenishment cost and ordering costs.

    These two above costs together are called Total Stocking Cost. If you plot the order quantity vs the TSC, you will see the graph declining gradually until a certain point after which with every increase in quantity the TSC will proportionately show an increase.

    This functional analysis and cost implications form the basis of determining the Inventory Procurement decision by answering the two basic fundamental questions - How Much to Order and When to Order.

    How much to order is determined by arriving at the Economic Order Quantity or EOQ.
5. ***Carrying Cost:*** Inventory storage and maintenance involves various types of costs namely:
    a. Inventory Storage Cost
    b. Cost of Capital

    Inventory carrying involves Inventory storage and management either using in house facilities or external warehouses owned and managed by third party vendors. In both cases, inventory management and process involves extensive use of Building, Material Handling Equipments, IT Software applications and Hardware Equipments coupled managed by Operations and Management Staff resources.

    a. *Inventory Storage Cost:* Inventory storage costs typically include Cost of Building Rental and facility maintenance and related costs. Cost of Material Handling Equipments, IT Hardware and applications, including cost of purchase, depreciation or rental or lease as the case may be. Further costs include operational costs, consumables, communication costs and utilities, besides the cost of human resources employed in operations as well as management.
    b. *Cost of Capital:* Includes the costs of investments, interest on working capital, taxes on inventory paid, insurance costs and other costs associate with legal liabilities.

The inventory storage costs as well as cost of capital is dependent upon and varies with the decision of the management to manage inventory in house or through outsourced vendors and third party service providers.

Current times, the trend is increasingly in favor of outsourcing the inventory management to third party service provides. For one thing the organizations find that managing inventory operations requires certain core competencies, which may not be in line with their business competencies. They would rather outsource to a supplier who has the required competency than build them in house.

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Secondly in case of large-scale warehouse operations, the scale of investments may be too huge in terms of cost of building and material handling equipments etc. Besides the project may span over a longer period of several years, thus blocking capital of the company, which can be utilized into more important areas such as R & D, Expansion etc. than by staying invested into the project.

5.8 INVENTORY CLASSIFICATION - ABC CLASSIFICATION, ADVANTAGES & DISADVANTAGES

Depending upon the nature of business, the inventory holding patterns may vary. While in some cases the inventory may be very high in value, in some other cases inventory may be very high in volumes and number of SKU. Inventory may be help physically at the manufacturing locations or in a third party warehouse location.

Inventory Controllers are engaged in managing Inventory. Inventory management involves several critical areas. Primary focus of inventory controllers is to maintain optimum inventory levels and determine order/replenishment schedules and quantities. They try to balance inventory all the time and maintain optimum levels to avoid excess inventory or lower inventory, which can cause damage to the business.

ABC Classification

Inventory in any organization can run in thousands of part numbers or classifications and millions of part numbers in quantity. Therefore inventory is required to be classified with some logic to be able to manage the same.

In most of the organizations inventory is categorized according to ABC Classification Method, which is based on parent principle. Here the inventory is classified based on the value of the units. The principle applied here is based on 80/20 principles. Accordingly the classification can be as under:

- A Category Items Comprise 20% of SKU & Contribute to 80% of $ spend.
- B Category Items Comprise 30% of SKU & Contribute to 15% of $ spend.
- C Category Items Comprise 50% of SKU & Contribute to 5% of $ spend.

The above is only an illustration and the actual numbers as well as percentages can vary.

Example: Table of Inventory Listing by Dollar Usage Percentage.

Item	Annual Usage in No. Units	Unit Cost-$	Usage in Dollars	Percentage of Total Dollar Usage
1	5,000	1.50	7,500	2.9%
2	1,500	8.00	12,000	4.7%
3	10,000	10.50	105,000	41.2%
4	6,000	2.00	12,000	4.7%
5	7,500	0.50	3,750	1.5%
6	6,000	13.60	81,000	32.0%
7	5,000	0.75	3,750	1.5%
8	4,500	1.25	5,625	2.2%
9	7,000	2.50	17,500	6.9%
10	3,000	2.00	6,000	2.4%
Total			**$254,725**	**100.0%**

Advantages of ABC Classification

- This kind of categorization of inventory helps one manage the entire volume and assign relative priority to the right category. For Example A Class items are the high value items.

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Hence one is able to monitor the inventory of this category closely to ensure the inventory level is maintained at optimum levels for any excess inventory can have huge adverse impact in terms of overall value.

- ***A Category Items:*** Helps one identify these stocks as high value items and ensure tight control in terms of process control, physical security as well as audit frequency.

  It helps the managers and inventory planners to maintain accurate records and draw management's attention to the issue on hand to facilitate instant decision-making.

- ***B Category Items:*** These can be given second priority with lesser frequency of review and less tightly controls with adequate documentation, audit controls in place.

- ***C Category Items:*** Can be managed with basic and simple records. Inventory quantities can be larger with very few periodic reviews.

Example: Take the case of a Computer Manufacturing Plant; the various items of inventory can be broadly classified as under:

SKU Description	Classification of Inventory	Remarks
Processor Chips	A Class	Kept under High Value Storage/Asset Tracking / Access Control required
Memory Chips	A Class	Kept under High Value Storage/Asset Tracking / Access Control required
Hard Disk / Storage Media	A Class	Kept under High Value Storage/Asset Tracking / Access Control required
Software License	A Class	Kept under High Value Storage/Asset Tracking / Access Control required
Disk Drives	A Class	Normal Storage / Access Control Required
Cabinet / Case	B Class	Normal Procedures
Battery Pack	B Class	Normal Procedures
Monitor	A Class	Normal Storage / Access Control Required
Keyboard	B Class	Normal Procedures
Training Manuals	C Class	Minimal Procedures
Mouse	B Class	Normal Procedures
Stickers	C Class	Minimal Procedures
Screws & Nuts	C Class	Minimal Procedures
Power Cord	C Class	Minimal Procedures
Starter Assembly Pack-Instructions	C Class	Minimal Procedures

Disadvantages

- Inventory Classification does not reflect the frequency of movement of SKU and hence can mislead controllers.
- B & C Categories can often get neglected and pile in huge stocks or susceptible to loss, pilferage, slackness in record control etc.

5.9 FACTORS AFFECTING INVENTORY OPERATIONS

Inventory management entails study of data on movement of inventory, its demand pattern, supply cycles, sales cycles etc. Active management calls for continuous analysis and management of inventory items to target at lean m inventory Management.

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Inventory Management function is carried out by the inventory planners in the company in close co ordination with procurement, supply chain logistics and finance, besides marketing departments. The efficiencies of inventory management are largely dependent upon the skills and knowledge of the inventory planners, the focus and involvement of management and the management policies coupled with the inventory management system.

However inventory operations management is not under the control of the inventory management team but rests with the third party service providers. In this section of the article we aim to uncover few of the critical areas and action points on the part of operations that can impact the inventory of the company.

1. ***Unskilled Labour and Staff:*** Inventory operations management is a process-oriented operation. Every task and action required to be carried out by the operatives will impact the inventory as well as the delivery lead times and other parameters. Therefore knowledge of what one is required to do and the effect of the action should be known to the operatives who are on the shop floor. For Example: If an operative is given a put away task, he should know how and where he should put away the pallet, how to scan the pallet ID and confirm it back to the system. Besides he should also know the impact of not completing any of these actions or doing something wrong. The impact his action will have on the system as well as physical inventory should be clear to the operative.

   Secondly different inventory items would have to be handled differently. Operatives who are carrying out the task should know why and what is required to be done. They should also know the consequences of not following the process. A pallet might have to be scanned for the pallet id and put away on a floor location, while a carton might have to be opened and scanned for individual boxes inside and put away into a bin. The operatives should be trained on the entire process and understand why and what he is doing.

   The WMS systems are quite operational and task intensive. Where the warehouses are being managed on RF based systems, the operatives should be able to manage the RF readers, understand how to access and complete transactions through the RF Guns.

   Often it is noticed that when the warehouse operations are being managed by a third party service provider and the principle customer is not present at the location, the quality of staff and operatives is compromised and people are not given adequate training before being allocated their responsibility. Such situations can lead to inventory discrepancies.

2. ***In adequate SOP, Training and emphasis on processes compliance:*** When a inventory management project kicks off at a third party warehouse location, both the principle customer as well as the third party service provider work on the project and setup basic processes, document them in Standard Operating Procedures and conduct training as a part of the project management methodology.

   However over a period of time, the nature of business requirements changes, resulting in change in the operating processes. These do not get documented in terms of amendments and the SOPs become outdated. Thereafter one finds that the new comers who are introduced on the shop floor are required to learn the processes by working along with others where as no training or SOP document is provided to him for reference. With the result they often have half-baked knowledge of the processes and carry on tasks not knowing why they are doing and what they are required to do.

   This situation is very dangerous for the health of the inventory and it shows slackness in the attitude of the third party service provider. Continuation of such a situation will lead to bad housekeeping, inventory mismatches, and discrepancies and also affect the service delivery. If left unchecked can lead to theft, pilferage and misuse of inventory.

   In any third party owned inventory operations warehouse, the principle client should ensure that periodic review and training is conducted for all staff. Inventory operations should be periodically reviewed and inventory counts and audits carried out regularly.

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5.10 INVENTORY TURNOVER AS INDICATOR OF HEALTH INVENTORY AND BUSINESS

Inventory management as well as Supply chain operations are often overlapping and hold the key to the success of sales operations. In all of the businesses be in automobile, manufacturing, pharma or retail industry, status of inventory reflects the health of the business.

Inventory operations have two key elements namely Inventory System and Physical operations. Today inventory systems have replaced the book keeping and financial accounting that was being practiced earlier. Current inventory systems not only do the book keeping but are linked to upstream as well as downstream activities including procurement, sales processing, and financial accounting.

In terms of measuring a sales performance in relation to Inventory, we often use the term Inventory Turnover. Inventory turnover simply refers to the number of times the inventory is sold or used in a period of one year. Inventory turnover is also termed as stock turn, or stock turnover. Inventory Turnover is calculated by taking the Total Cost of Goods Sold, divided by Average Inventory. Adding together opening inventory and closing inventory and dividing the figure by 2 which in turn gives average Inventory.

The inventory turnover as a measure of health of sales and business is used extensively in Retail, textile as well as FMCG segments. A higher inventory turnover does indicate a healthy trend of increased sales and indicates the need to maintain adequate inventory levels to avoid stock outs. In adequate stocks can result in loss of business opportunities and is something that the management needs to keep watching closely. On the other hand a lower inventory turnover shows that either the sales of the said inventory is slowing down or that the unused inventory is building up clogging the system somewhere. A slow inventory turn can help the inventory manager focus on finding non-moving, obsolete and slow moving inventory items and thereby steps can be taken to deal with them appropriately.

Inventory turnover also reflects the holding cost that is incurred in managing inventory. Increased inventory turns reduce the holding costs. The costs especially fixed costs like rent and cost of operations get distributed over higher inventory throughput and thereby the cost of inventory transactions reduces

Inventory turnover is also indicative of the health of inventory operations. When the inventory turnover is higher, the inventory operations efficiency will also be high to meet with the increased operational requirements thereby good housekeeping and increased responsiveness to market requirements.

Inventory turn in some cases or some systems is also calculated based on the numbers sold rather than the average value of inventory. In such a system the Inventory turn is calculated by dividing the Number of Units Sold divided by the Average number of Units inventory held in a given period of time.

Over a number of years, each industry has developed methods to check inventory turnover and industry standards have been standardized. So whenever a new business venture is set up, they are able to have the industry standard as benchmark to be achieved and use it as a guide to streamline operations.

5.11 INVENTORY PLANNING

When in case of raw material inventory management function is essentially dealing with two major functions. First function deals with inventory planning and the second being inventory tracking. As inventory planners, their main job consists in analyzing demand and deciding when to order and how much to order new inventories. Traditional inventory management approach consists of two models namely:

- EOQ - Economic Order Quantity
- Continuous Ordering

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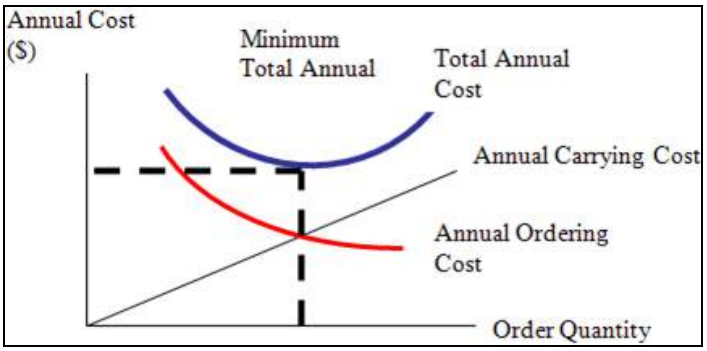
- Periodic Ordering

1. ***EOQ:*** Economic Order Quantity method determines the optimal order quantity that will minimize the total inventory cost. EOQ is a basic model and further models developed based on this model include production Quantity Model and Quantity Discount Model.
2. ***Continuous Order Model:*** works on fixed order quantity basis where a trigger for fixed quantity replenishment is released whenever the inventory level reaches predetermined safety level and triggers re ordering.
3. ***Periodic System Model:*** This model works on the basis of placing order after a fixed period of time.

EOQ Model



Example: Biotech.Co produces chemicals to sell to wholesalers. One of the raw materials it buys is sodium nitrate which is purchased at the rate of $22.50 per ton. Biotech's forecasts show a estimated requirement of 5,75,000 tons of sodium nitrate for the coming year. The annual total carrying cost for this material is 40% of acquisition cost and the ordering cost is $595. What is the Most Economical Order Quantity?

$$EOQ = \sqrt{2DS / C}$$

D = Annual Demand

C = Carrying Cost

S = Ordering Cost

D = 5,75,000 tons

C =0.40(22.50) = $9.00/Ton/Year

S = $595/Order

$$EOQ = \sqrt{2(5,750,000)(595) / 9.00}$$

= 27,573.135 tons per Order.

This model pre supposes certain assumptions as under:

- No safety Stocks available in inventory.
- No Shortages allowed in order delivery.
- Demand is at uniform rate and does not fluctuate
- Lead Time for order delivery is constant
- One order = One delivery no shortages allowed.
- This model does not take into account other costs of inventory such as stock out cost, acquisition cost etc to calculate EOQ.

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5.12 GOOD INVENTORY MANAGEMENT PRACTICES

Good inventory Management practices in the company help by adding value in terms of having control over and maintaining lean inventory. Inventory should not be too much or too less. Both the situations are bad for the company. However often we see that inventory is not focused upon by the management and hence lot of inefficiencies build up over a period of time without the knowledge of the management. It is only when we start a cost reduction drive that the inventory goof ups and skeletons come out of the cupboard and results in revamping the entire operations.

However those companies, which have always focused on inventory as a principle function and recognized that the inventory effects their sales, as well as the books of accounts and profits, have managed to introduce and improve inventory management processes. Many business models work on lean inventory principle or JIT inventory along with other models like VMI etc. Inventory management to a large extent is dependent upon the supply chain efficiency as well as operations.

Inventory management is a management cum operations function. It requires operational processes to be followed and maintained on the floor and in inventory management systems. Coupled with operations, it entails continuous study; analysis and decision making to control and manage inventory levels.

We have covered below briefly few of the points which when followed, can go a long way in ensuring that the inventory is lean and clean.

1. ***Review Inventory periodically and revise stocking patterns and norms:*** Inventory is dependent upon the demand as well as the supply chain delivery time. Often companies follow one stocking policy for all items. For example, all A, B & C categories may be stocking inventory of 15 days, which may not be the right thing that is required. While some items may have a longer lead-time thus affecting the inventory holding, the demand pattern and the hit frequency in terms of past data may show up differently for each of the inventory items. Therefore one standard norm does not suit all and can lead to over stocking of inventory as well as in efficiencies in the system.

2. ***Get into detailed inventory planning - One size does not fit all:*** Understand the inventory types and the specific characteristics of the items you are carrying. Then build the inventory stocking parameters taking into account the unique characteristics of the particular inventory.

   From amongst your inventory list, you will find that all types of materials are not of the same value. Some might be very expensive and need to be carried in stock for a longer period, while another item might have a shorter lead-time and may be fast moving. Quite a few items often have shelf life and hence require separate norms and focus to manage such items.

   Getting into the detailed understanding will help you identify the inventory-stocking norm required to manage these characteristics to ensure optimum efficiency. The solution quite often may not be to carry stocks; rather it may involve setting up the customer service standard for such items and specifying a delivery time depending upon the frequency of demand. Quite a few items often have shelf life and hence require separate norms and focus to manage such items.

3. ***Study demand pattern, movement patterns and cycles to build suitable inventory norms for different categories of inventory:*** Companies which are into retail segments and dealing with huge inventories in terms of number of parts as well as value will necessarily need to ensure they practice review of inventory list and clean up operations on ongoing basis.

   Popularly known as catalogue management, inventory norms review should be carried out based on detailed study of the sales data, demand pattern, sales cycles etc. Understanding of the business and sales cycles specific to the product category helps one manage inventories better. For example, in case of retail garments, with every season certain skus become redundant no matter how their demand was in the previous months. This helps identify those stocks which are required to be managed at a micro level and identify the high value and fast moving items that need to be always on the radar to avoid stock outs.

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It does not help for example to carry standard stocks of all items including low value items as well as high value items. If the low value items are locally available and the lead-time is less, one can cut down on the inventory and change the buying pattern. Similarly high value items too can be managed by cutting down the delivery lead times and in turn reducing inventory.

It helps to periodically study the past data and extrapolate the same to identify slow moving and obsolete items. The dead stocks should be flushed out and active catalogue items should be made available.

Why Inventory Management Is Important

Holding inventory ties up a lot of cash. That's why good inventory management is crucial for growing a company. Just like cash flow, it can make or break your business. Good inventory management saves you money in a few critical ways:

Avoid Spoilage

If you're selling a product that has an expiry date (like food or makeup), there's a very real chance it will go bad if you don't sell it in time. Solid inventory management helps you avoid unnecessary spoilage.

Avoid Dead Stock

Dead stock is stock that can no longer be sold, but not necessarily because it expired. It could have gone out of season, out of style, or otherwise become irrelevant. By managing your inventory better, you can avoid dead stock.

Save on Storage Costs

Warehousing is often a variable cost, meaning it fluctuates based on how much product you're storing. When you store too much product at once or end up with a product that's difficult to sell, your storage costs will go up.

Inventory Management Improves Cash Flow

Not only does good inventory management save you money, it also improves cash flow in other ways. Remember, inventory is product that you've likely already paid for with cash (checks and electronic transfers count as cash too), and you're going to sell it for cash, but while it's sitting in your warehouse it is definitively not cash. Just try paying your landlord with 500 iPhone cases.

This is why it's important to factor inventory into your cash flow management. It affects both sales (by dictating how much you can sell), and expenses (by dictating what you have to buy). Both of these things factor heavily into how much cash you have on hand. Better inventory management leads to better cash flow management. When you have a solid inventory system, you'll know exactly how much product you have, and based on sales, you can project when you'll run out and make sure you replace it on time. Not only does this make sure you don't lose sales (critical for cash flow), but it also helps you plan ahead for buying more so you can ensure you have enough cash set aside.

5.13 INVENTORY MANAGEMENT TECHNIQUES

Inventory management is a highly customizable part of doing business. The optimal system is different for each company. However, every business should strive to remove human error from inventory management as much as possible. This means taking of advantage of inventory management software. Regardless of the system you use, the following eight techniques will help you to improve your inventory management—and cash flow.

Set Par Levels

Make inventory management easier by setting "par levels" for each of your products. Par levels are the minimum amount of product that must be on hand at all times. When your inventory stock

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dips below the predetermined levels, you know it's time to order more. Ideally, you'll typically order the minimum quantity that will get you back above par. Par levels will vary by product based on how quickly the item sells, and how long it takes to get back in stock. Although it requires some research and decision-making up front, setting par levels will systemize the process of ordering. Not only will it make it easier for you to make decisions quickly, it will allow your staff to make decisions on your behalf. Remember that conditions change over time. Check on par levels a few times throughout the year to confirm they still make sense. If something changes in the meantime, don't be afraid to adjust your par levels up or down.

First-In First-Out (FIFO)

"First-in, first-out" is an important principle of inventory management. It means that your oldest stock (first-in) gets sold first (first-out), not your newest stock. This is particularly important for a perishable product so you don't end up with unsellable spoilage.It's also a good idea to practice FIFO for non-perishable products. If the same boxes are always sitting at the back, they're more likely to get worn out. Plus, packaging design and features often change over time. You don't want to end up with something obsolete that you can't sell. In order to manage a FIFO system; you'll need an organized warehouse. This typically means adding new products from the back, or otherwise making sure old product stays at the front. If you're working with a warehousing and fulfillment company they probably do this already, but it's a good idea to call them to confirm.

Manage Relationships

Part of successful inventory management is being able to adapt quickly. Whether you need to return a slow selling item to make room for a new product, restock a fast seller very quickly, troubleshoot manufacturing issues, or temporarily expand your storage space, it's important to have a good relationship with your suppliers. That way they'll be more willing to work with you to solve problems. In particular, having a good relationship with your product suppliers goes a long way. Minimum order quantities are often negotiable. Don't be afraid to ask for a lower minimum so you don't have to carry as much inventory. A good relationship isn't just about being friendly. It's about good communication. Let your supplier know when you're expecting an increase in sales so they can adjust production. Have them let you know when a product is running behind schedule so you can pause promotions or look for a temporary substitute.

Contingency Planning

A lot of issues can pop up related to inventory management. These types of problems can cripple unprepared businesses. For example:

- your sales spike unexpectedly and you oversell your stock
- you run into a cash flow shortfall and can't pay for product you desperately need
- your warehouse doesn't have enough room to accommodate your seasonal spike in sales
- a miscalculation in inventory means you have less product than you thought
- a slow moving product takes up all your storage space
- your manufacturer runs out of your product and you have orders to fill
- your manufacturer discontinues your product without warning

Regular Auditing

Regular reconciliation is vital. In most cases, you'll be relying on software and reports from your warehouse to know how much product you have stock. However, it's important to make sure that the facts matche up. There are several methods for doing this.

- ***Physical Inventory:*** A physical inventory is the practice is counting all your inventory at once. Many businesses do this at their year-end because it ties in with accounting and filing income tax. Although physical inventories are typically only done once a year, it can be incredibly disruptive to the business, and believe me, it's tedious. If you do find a

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discrepancy, it can be difficult to pinpoint the issue when you're looking back at an entire year.

- ***Spot Checking:*** If you do a full physical inventory at the end of the year and you often run into problems, or you have a lot of products, you may want to start spot checking throughout the year. This simply means choosing a product, counting it, and comparing the number to what it's supposed to be. This isn't done on a schedule and is supplemental to physical inventory. In particular, you may want to spot check problematic or fast-moving products.
- ***Cycle Counting:*** Instead of doing a full physical inventory, some businesses use cycle counting to audit their inventory. Rather than a full count at year-end, cycle counting spreads reconciliation throughout the year. Each day, week, or month a different product is checked on a rotating schedule. There are different methods of determining which items to count when, but, generally speaking, items of higher value will be counted more frequently.

Prioritize With ABC

Some products need more attention than others. Use an ABC analysis to prioritize your inventory management. Separate out products that require a lot of attention from those that don't. Do this by going through your product list and adding each product to one of three categories:

A high-value products with a low frequency of sales

B moderate value products with a moderate frequency of sales

C low-value products with a high frequency of sales

Items in category A require regular attention because their financial impact is significant but sales are unpredictable. Items in category C require less oversight because they have a smaller financial impact and they're constantly turning over. Items in category B fall somewhere in-between.

Accurate Forecasting

A huge part of good inventory management comes down to accurately predicting demand. Make no mistake; this is incredibly hard to do. There are so many variables involved and you'll never know for sure exactly what's coming—but you can get close. Here are a few things to look at when projecting your future sales:

- trends in the market
- last year's sales during the same week
- this year's growth rate
- guaranteed sales from contracts and subscriptions
- seasonality and the overall economy
- upcoming promotions
- planned ad spend

If there's something else that will help you create a more accurate forecast, be sure to include it.

Consider Drop shipping

Drop shipping is really the ideal scenario from an inventory management perspective. Instead of having to carry inventory and ship products yourself—whether internally or through third-party logistics—the manufacturer or wholesaler takes care of it for you. Basically, you completely remove inventory management from your business. Many wholesalers and manufacturers advertise drop shipping as a service, but even if your supplier doesn't, it may still be an option. Don't be afraid to ask. Although products often cost more this way than they do in bulk orders, you don't have to worry about expenses related to holding inventory, storage, and fulfillment.

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5.14 SUMMARY

Inventory management is a very important function that determines the health of the supply chain as well as the impacts the financial health of the balance sheet. Every organization constantly strives to maintain optimum inventory to be able to meet its requirements and avoid over or under inventory that can impact the financial figures. Inventory management requires constant and careful evaluation of external and internal factors and control through planning and review. Good inventory Management practices in the company help by adding value in terms of having control over and maintaining lean inventory. Inventory should not be too much or too less. Both the situations are bad for the company. However often we see that inventory is not focused upon by the management and hence lot of inefficiencies build up over a period of time without the knowledge of the management. It is only when we start a cost reduction drive that the inventory goof ups and skeletons come out of the cupboard and results in revamping the entire operations. Inventory operations have two key elements namely Inventory System and Physical operations. Today inventory systems have replaced the book keeping and financial accounting that was being practiced earlier. Current inventory systems not only do the book keeping but are linked to upstream as well as down stream activities including procurement, sales processing, financial accounting.

Inventory management entails study of data on movement of inventory, its demand pattern, supply cycles, sales cycles etc. Active management calls for continuous analysis and management of inventory items to target at lean m inventory Management.Inventory Management function is carried out by the inventory planners in the company in close co ordination with procurement, supply chain logistics and finance, besides marketing departments.

5.15 SELF ASSESSMENT QUESTIONS

Short Type Questions

1. Define inventory.
2. What is finished goods inventory?
3. What do you mean by inventory costs?
4. Justify the concept of inventory turnover.
5. Explain the benefits of inventory turnover.
6. Explain the need for inventory management

Essay Type Questions

1. Define inventory .Explain various types of inventory.
2. Describe the advantages and disadvantages of inventory management.
3. What do you mean by inventory turnover? Discuss different types of inventory costs.
4. Narrate the different types of inventory management techniques.