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SCHOOL OF MANAGEMENT STUDIES

UNIT – I – OPERATIONS MANAGEMENT– SBAA5204

I. INTRODUCTION TO OPERATIONS MANAGEMENT

Introduction and Overview of Operations Management -Understanding similarities and difference among Products, Goods and Services - Historical Development and Current Issues in Operations Management - Operations Strategy and Competitiveness - Product Design – New Product Development, Make or Buy Decisions.

INTRODUCTION

Innovations in technology have resulted in the development of manufacturing capabilities of organisation. Moreover, the study and application of management techniques in managing the affairs of the organisation have also changed its nature over the period of time. Therefore, managing a service system has become a major issue in the global competitive environment. Operations Management has been a driving force in the improvement of business practice around the world. Operations Management leads the way for the organizations to achieve its goals with minimum effort.

Operations management is recognized as an important factor in a country‘s economic growth. Operation management is the crucial area in the functioning of organizations and therefore, an in-depth study of the subject matter becomes essential. Operation is concerned with the transformation of inputs into the required output or services. Management is the continuous process, which combines and transforms various resources used in the operations system of the organization into value added services. Operation Management is the set of interrelated management activities, which are involved in manufacturing of certain products or services.

Concept of Production:

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

PRODUCTION SYSTEM

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

The production system has the following features:

1. Production is a well organized activity with pre-established objectives.
2. The production system converts the various inputs into outputs.

HISTORY OF OPERATIONS MANAGEMENT

The traditional view of manufacturing management began in eighteenth century when Adam smith recognized the economic benefits of specialization of labor. He recommended breaking of jobs down into subtasks and recognizes workers to specialized tasks in which they would become highly skilled and efficient. In the early twentieth century, F.W. Taylor implemented Smith‘s theories and developed scientific management. From then till 1930, many techniques were developed prevailing the traditional view.

Production Management became the acceptable term from 1930s to 1950s. As F.W. Taylor‘s works become more widely known, managers developed techniques that focused on economic efficiency in manufacturing. Workers were studied in great detail to eliminate wasteful efforts and achieve greater efficiency.

At the same time, psychologists, socialists and other social scientists began to study people and human behaviour in the working environment. In addition, economists, mathematicians, and computer socialists contributed newer approaches. With the 1970s emerged other two distinct changes.

The most obvious of these, reflected in the new name Operations Management was a shift in the service and manufacturing sectors of the economy. As service sector became more prominent, the change from production ‘to operations ‘emphasized the broadening of field to service organizations. The second, more suitable change was the beginning of an emphasis on synthesis, rather than just analysis, in management practices. A brief account of development of operations and production management is given below:

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

OPERATIONS MANAGEMENT – CONCEPT:

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

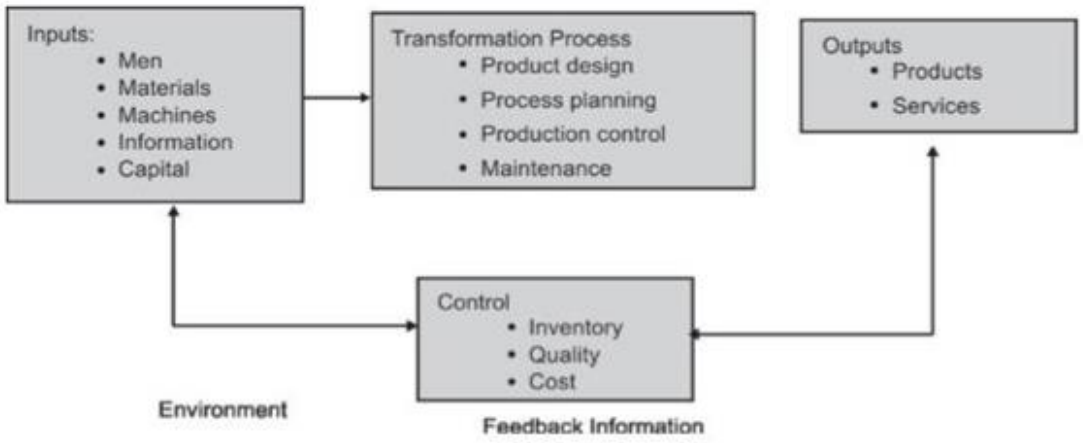
DEFINITION OF OPERATION MANAGEMENT

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

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

The value addition to an input can be done in the following ways.

They are mentioned below:



OPERATION MANAGEMENT - Core Functions:

- Marketing function (communicating)
- Product/service development function (creating) Operations function (fulfilling)

Support Functions:

- The accounting and finance function.
- The human resources function.

Two Meanings of Operations:

· Operations as a function.

· Operations as an activity.

'End-to-end' business processes: Processes that totally fulfill a defined external customer need. **Business process reengineering:** The philosophy that recommends the redesign of processes to fulfill defined external customer needs.

Different characteristics of operations processes:

- **Volume**: repeatability, systemization.
- **Variety**: Standardization, flexible
- **Variation**: variation in demand
- **Visibility**: process exposure
- **Front office**: The high visibility part of an operation

Back office: The low visibility part of an operation

Activities that apply to all types of Operations:

- Understanding the operation‘s strategic objectives
- Developing an operations strategy for the organization
- Designing an operations strategy for the organization
- Planning and controlling the operation
- Improving the performance of the operation
- The broad responsibilities of operations management

Why is operations management important?

- Reduce costs
- Increase revenue
- Reduce the amount of investment
- Provide the basis for future innovation
- More profitability

Operations Management:

- Operations strategy
- Improvement
- Planning and control
- Design

Operations strategy:

- The operation‘s strategic objectives
- The operation‘s competitive role and position
- Improvement
- Operations strategy

OBJECTIVES OF OPERATION MANAGEMENT

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

- **To provide customer service** the main objective of any operating management systems is to utilize resources judiciously for the satisfaction of customer needs and wants. Therefore, customer satisfaction is a key objective of operations management. Operation management focuses on providing the right products at a right price at the right time. Hence, this objective will influence the operations manager‘s decisions to achieve the required customer service.
- **Effective utilization of resources** that are used in the business organisation must be carefully utilized. Inefficient use of resources or inadequate customer service leads to commercial failure of an organisation. Operations management is concerned essentially with the utilization of resources. It aims at obtaining maximum output from the available resources with minimum cost.
- **To reduce cost of production** Operation management aims at reduction in the cost of production of goods and services. The cost per unit of the product has to be set properly and all efforts should be taken to control the actual cost to pre-determined cost of production. Cost can be classified in to fixed cost and variable cost. The variable cost changes with every level of production. This variable cost can be checked by means of inventory and labor control techniques.
- **To improve product quality** control and maintenance are the two important objectives of operations management. Quality control consists of all those activities, which are designed to define, maintain and control specific quality of products within reasonable limits. It is the systematic regulation of all variables affecting the goodness of the final product. In other words, quality control involves determination of quality standards and its actual measurement .It is necessary to ensure that the established standards are practiced and maintained. It does not attempt to achieve the perfect quality but to secure satisfactory or reasonable quality at a reasonable level of cost.
- **To fix time schedule** Another important objective of operation management is to establish time schedule for various operation activities. The schedule fixation includes the operating cycle time, inventory turnover rate, machine utilization rate, capacity utilization etc.

- **Proper utilization of Machinery** Operation management has to take number of decisions with regard to machinery and equipment. New machines should be installed and the old machines are to be replaced. It has to ensure judicious utilization of machinery and equipment.
- **Material control based on the sales forecast** and production plans, the materials planning and control is done. This involves estimating the individual requirements of parts, preparing materials budget, forecasting the levels of inventories, scheduling the orders and monitoring the performance in relation to production and sales.

What is Role of OM?

OM Transforms inputs to outputs ➢ Inputs are resources such as People, Material, and Money

➢Outputs are goods and services.

BASIS FOR COMPARISON	GOODS	SERVICES
Meaning	Goods are the material items that can be seen, touched or felt and are ready for sale to the customers.	Services are amenities, facilities, benefits or help provided by other people.
Nature	Tangible	Intangible
Transfer of ownership	Yes	No
Evaluation	Very simple and easy	Complicated
Return	Goods can be returned.	Services cannot be returned back once they are provided.
Separable	Yes, goods can be separated from the seller.	No, services cannot be separated from the service provider.
Variability	Identical	Diversified
Storage	Goods can be stored for use in future or multiple use.	Services cannot be stored.
Production and Consumption	There is a time lag between production and consumption of goods.	Production and Consumption of services occurs simultaneously.

COMPONENTS PRODUCTON FUNCTION

- **The Product:**

It is the most obvious embodiment of the interface between marketing and production and it is not sufficient that the customers require a product; the organization must be capable of producing it. Agreement, therefore, must be reached between all the business functions on

matters such as performance, aesthetics, quality, reliability, selling price or production/operating costs, date of delivery and/or time.

- **The Plant:**

A plant of some kind, both in terms of building and equipment is required to manufacture a product. This plant, which accounts for the bulk of the fixed assets of the organization, must continue to be so as long as the consumer‘s needs can be foreseen. Production management therefore, will be concerned with questions such as future possible demands, design and layout of buildings and offices, performance and reliability of equipment, maintenance of performance, safety of installations and operations, social responsibility, etc.

- **The Process:**

The decision on product or service creation is made by bringing together the technical and organizational needs of the product and the organization and the people within the organization. In deciding upon a process, it is necessary to examine factors such as plant and equipment, safety, maintenance requirements, cost reduction, etc.

- **The Programme:**

A timetable, setting down the date of transfer of products or services to the consumers is the other visible expression of the production/marketing interface, not merely setting down date and time but also determining cash flow, the prime controller of organizational viability. Framing of master timetable further helps to generate timetables for purchasing, maintenance, storage, transport, etc.

- **The People:**

Production from start to finish depends upon people. Like all other products, human beings are variable in intellect, skill and expectations. The work of a social scientist lies in continuously enlarging our understanding of people and organizations and also bringing home better communications, worker participation, industrial democracy, job enrichment, etc. Hence, the production manager should, be involved in discussion on wages/salaries, safety, conditions of work, motivation, training and trade unions.

- **The Policy:**

Production policy is the term applied to those aspects of corporate policy which particularly concern the production or operations departments. Clearly production policy is an integral part of corporate policy and must act within and not independently of it. However, it is the role of the production manager to frame policies, decide on operational details which should be within the organization‘s capability in determining appropriate production policy.

NEW CONCEPTS AND TRENDS IN OM

- Mass Customization
- Supply Chain Management
- Outsourcing
- Lean manufacturing
- Agility
- Electronic Commerce

PRODUCT DESIGN STAGES:

Every product design passes through the following six stages:

- **Conception:** It is the first stage and the most importance stage in any product design. A draft specification is prepared at this stage by the marketing department consultation with the design department.
- **Acceptance:** Draft specification prepared earlier is scrutinized for its viability by subjecting it to all possible calculations model making, preliminary drawing, laboratory scale processes, etc, if it is not accepted, it may have to be modified or rejected and such decisions are taken jointly by design and marketing department.
- **Execution:** This stage involves the conversion of design specifications into drawings to build the prototype model should be a true replica of the proposed new product satisfying all the requirements of the customer.
- **Evaluation:** The design is evaluated by a cross functional team having representatives from finance, marketing manufacturing and service department to achieve optimal design (the overall best combination of product qualities at the lowest per unit production cost) The design is reviewed to ensure that all requirements of the product such as function, aesthetics (appearance), materials and process alternatives, and their cost, economic assembly , repair and maintenance , lead time required for installing the new process and training the labor etc, are met by the product design.
- **Translation:** In this stage based on the experiences in the previous stages, the detailed engineering drawings for parts, subassemblies, final assemblies, parts lists etc., are prepared. These documents are known as provisional design documents which take into account the Productivity aspects of the design. Also detailed estimates of costs are prepared at this stage.
- **Preproduction:** A pilot production run is carried out using the provisional design

documents and the Production aspect in this stage. Based on the experience gained in preproduction, the provisional design is modified in to final design approved for bulk production later.

TYPES OF DESIGN:

- **Functional design:** Functional design involves developing an idea in to a rough model of the proposed products
- **Aesthetic:** Before production on a commercial scale is undertaken another type of design must be integrated with the functional design and its aesthetic design for market acceptability.
- **Production design or product design:** The functional design is translated into production design to make it easy for manufacturing.
- **Packing design:** Packing design should also be appealing to the consumers depending upon the size and nature of the product. Different packing materials can be used to suit the consumers taste and to maintain the chemical properties of the product

CHARACTERISTICS OF A GOOD PRODUCT DESIGN:

A good product design should possess the following characteristics:

- **Function:** A product can be sold if it meets the needs of the consumer and as such the product must be designed to meet such needs. For example, a customer expects a gas lighter to be convenient (i.e., to instantly light the gas stove). If the gas lighter cannot achieve that, then the purpose is lost as the basic function is not met.
- **Reliability:** It is the probability that there will not be any major failure of the product during its use. For example, if certain components of a product are put into use very often, the reliability of each component should be staggeringly high which may not be practical from production point of view. To overcome this problem, duplicate components can be operated in parallel i.e., if one component fails its duplicate may be put into operation.
- **Maintainability:** The lubrication points and other areas for servicing of the product to be designed ought to be easily accessible even though the physical form may have to be altered a bit. The alternative is to make a trouble free product with expensive design. The trade-off between being trouble- free and maintainability is an important decision at the design stage and it mainly depends on the nature of the product. The

after sales feedback from customers is quite valuable in improving upon the maintainability of a product.

- **Producibility:** A product should be designed in such a manner that it can be produced easily at a reasonable cost. Least number of operations are required to produce a product quickly and cheaply. This may be possible with change in technology. For example, instead of machining an intricate part such as gear, it can be molded, without affecting its function.

  Producibility can also be enhanced by reducing work content of the job involved. For example, the instrument panel of a car used to be maize of wires. This has been redesigned with a printed circuit board where only multiple pin plugs needs to be connected into it. This has resulted into reduced work content and greater product reliability.
- **Simplification:** Simplification and producibility go hand in hand. The simpler the design of the product, the easier it is to produce, the lesser it costs and more reliable it is.
- **Product standardization and variety reduction:** Variety to a large extent depends on market forces. The larger the market, the greater is the degree of standardization possible which makes economies of scale possible. If there is a competitive market, products can have a selling edge if variety is offered. This will involve a design for the product in such a way which will lend itself to modularization so as to gain advantage of large production.
- **Quality:** A good quality product design ensures that the quality of a final product is obtained through its individual components. The tolerance specified at every stage ensures a end product with the desired quality.
- **Minimum cost:** Design influences manufacturing cost. A good product design must ensure minimum manufacturing cost. Some of the areas in which savings can be affected at the design stage.
- **Warranties:** Whether or not a manufacturer is legally bound to put right whatever wrong the customer does is the question here. The point is, a customer is too valuable to be lost, especially if the manufacturer wishes to retain him and established his goodwill. Breakdown of a component may or may not owe their origin to poor maintenance or misuse of the component by a customer it may be due to faulty material, faulty design and faulty processing. The manufacturer must keep in mind the

importance of a customer and the costs to be incurred in fixing up a product for the customer.

- **Modular design:** The products should consist of detachable components or sub-assemblies so that whenever a component fails, it can be replaced by a new one easily. The use of standard sub-assembly gives rise to numerous end products in different combinations. The concept is known as modularity. The need of a modular design is enforced by the customer who wants a variety to choose from what he/she likes the best. Maintaining stocks of modules and assembling them promptly enable the manufacturer to offer variety in customer‘s hands.

Thus, the advantages of modular diversity can be listed as:

Diversity can be offered to the customers Inventories can be substantially reduced. Cannibalization i.e., using parts of one equipment salvaged for use in another application is made easy. Repairing a product becomes in expensive because only a few standard tools are needed. The company can contract or expand its capacity. An example of modular design is a gasoline pump that permits the customer to mix his own blend.

FACTORS AFFECTING PRODUCT DESIGN:

1. **Customer requirements:** Product design has to give due respect to the requirements of customers. So designers have to ensure that the product they design suits the convenience of customers for use. The product design has to be in a way that they can be used in all conditions.

2. **Facility to operators:** The designer must see that an operator is provided with all possible comforts and facilities in handling the operations involved in the product design. An

operator may not perform efficiently if the product design is so complicated. Operator may get tired off soon and may produce less with a complicated design. Thus machines and tools to perform the operations prescribed in the design must be convenient and comfortable to handle.

3. Functionality: A product design should be functionally sound. Purpose of any product design is the complete satisfaction of consumers. So, it has has to function for which it is made. There should be proper coordination in its appearance and service to the consumers.

4. Cost/price ratio: Product designers, in a competitive market, face lot of pressures in designing one which is cost effective, better quality and the one that attracts a consumer. Cost effectiveness and quality should be an integral part of a product design. With a constraint on the upper limit on producing products, the designer must ensure cost effective designs.

5. Product quality: Quality of a product and its design go hand in hand. Product quality partly depends on how well the design is and partly on conformity. The policy of a firm should stress quality of a product in the design stage itself.

6. Process capability: A product design should stress the quality of conformance. The product design should take into consideration the quality of conformance. This depends on how much the equipment and machines can process. So, a product designer should have adequate knowledge of his machinery. He should be capable enough to specify tolerances which can be achieved by the available machines and equipment.

7. Material requirements: The nature and quality of the materials have significant impact on the design of the product. The designer should have up to date information about new materials available to make the desired product. Industrial, scientific and technical journals as well as the consumers of the product can provide necessary information in this regard.

8. Work methods and equipment: For a most viable design, necessary equipment and method of work carry a significant amount of importance. So, a product designer should be innovative in nature. He should be aware of the innovations for improving the work methods and nature of the equipment.

Production cost can be influenced by a simple modification in work methods. The product design should be such that there is sufficient adaptability and scope for improvement in work methods and type of equipment required for the operations involved in production process.

9. Effect on existing products: When a product is designed to replace an existing one, a product designer should consider the use of standard parts and components, manufacturing process, distribution strategies and the techniques to blend new manufacturing technology

with the existing product. This will keep the cost of implementing the change and marketing the product to a minimum.

10. Packaging: Packaging is an essential part of a product. Design of a package is equally important as the design of the product. Packaging design should consider the objectives of packaging such as protection and promotion of the product. Attractive packaging enhances the sales appeal of product in case of consumer products (non-durables).

NEW PRODUCT DEVELOPMENT – STAGES/ PROCESS:

Idea generation:

The new product development process starts with idea generation. Idea generation refers to the systematic search for new-product ideas. Typically, a company generates hundreds of ideas, maybe even thousands, to find a handful of good ones in the end. Two sources of new ideas can be identified: Internal idea sources: the company finds new ideas internally. That means R&D, but also contributions from employees.

External idea sources: the company finds new ideas externally. This refers to all kinds of external sources, e.g. distributors and suppliers, but also competitors. The most important external source are customers, because the new product development process should focus on creating customer value.

Idea screening:

The next step in the new product development process is idea screening. Idea screening means nothing else than filtering the ideas to pick out good ones. In other words, all ideas generated are screened to spot good ones and drop poor ones as soon as possible. While the purpose of idea generation was to create a large number of ideas, the purpose of the succeeding stages is to reduce that number. The reason is that product development costs rise greatly in later stages. Therefore, the company would like to go ahead only with those product ideas that will turn into profitable products. Dropping the poor ideas as soon as possible is, consequently, of crucial importance.

Concept development and Testing:

To go on in the new product development process, attractive ideas must be developed into a product concept. A product concept is a detailed version of the new-product idea stated in meaningful consumer terms. A product concept à a detailed version of the idea stated in meaningful consumer terms A product image à the way consumers perceive an actual or potential product.

Let‘s investigate the two parts of this stage in more detail.

Concept development

Imagine a car manufacturer that has developed an all-electric car. The idea has passed the idea screening and must now be developed into a concept. The marketer‘s task is to develop this new product into alternative product concepts. Then, the company can find out how attractive each concept is to customers and choose the best one. Possible product concepts for this electric car could be:

Concept 1: an affordably priced mid-size car designed as a second family car to be used around town for visiting friends and doing shopping.

Concept 2: a mid-priced sporty compact car appealing to young singles and couples.

Concept 3: a high-end midsize utility vehicle appealing to those who like the space SUVs provide but also want an economical car.

As you can see, these concepts need to be quite precise in order to be meaningful. In the next sub-stage, each concept is tested.

Concept testing

New product concepts, such as those given above, need to be tested with groups of target consumers. The concepts can be presented to consumers either symbolically or physically. The question is always: does the particular concept have strong consumer appeal? For some concept tests, a word or picture description might be sufficient. However, to increase the reliability of the test, a more concrete and physical presentation of the product concept may be needed. After exposing the concept to the group of target consumers, they will be asked to answer questions in order to find out the consumer appeal and customer value of each concept.

Marketing strategy development

The next step in the new product development process is the marketing strategy development. When a promising concept has been developed and tested, it is time to design an initial marketing strategy for the new product based on the product concept for introducing this new product to the market. The marketing strategy statement consists of three parts and should be formulated carefully: A description of the target market, the planned value proposition, and the sales, market share and profit goals for the first few years An outline of the product‘s planned price, distribution and marketing budget for the first year The planned long-term sales, profit goals and the marketing mix strategy.

Business analysis:

Once decided upon a product concept and marketing strategy, management can evaluate the business attractiveness of the proposed new product. The fifth step in the new product development process involves a review of the sales, costs and profit projections for the new product to find out whether these factors satisfy the company‘s objectives. If they do, the product can be moved on to the product development stage.

In order to estimate sales, the company could look at the sales history of similar products and conduct market surveys. Then, it should be able to estimate minimum and maximum sales to assess the range of risk. When the sales forecast is prepared, the firm can estimate the expected costs and profits for a product, including marketing, R&D, operations etc. All the sales and costs figures together can eventually be used to analyze the new product‘s financial

attractiveness.

Product development:

The new product development process goes on with the actual product development. Up to this point, for many new product concepts, there may exist only a word description, a drawing or perhaps a rough prototype. But if the product concept passes the business test, it must be developed into a physical product to ensure that the product idea can be turned into a workable market offering. The problem is, though, that at this stage, R&D and engineering costs cause a huge jump in investment. The R&D department will develop and test one or more physical versions of the product concept. Developing a successful prototype, however, can take days, weeks, months or even years, depending on the product and prototype methods.

Also, products often undergo tests to make sure they perform safely and effectively. This can be done by the firm itself or outsourced.

In many cases, marketers involve actual customers in product testing. Consumers can evaluate prototypes and work with pre-release products. Their experiences may be very useful in the product development stage.

Test marketing:

The last stage before commercialization in the new product development process is test marketing. In this stage of the new product development process, the product and its proposed marketing programme are tested in realistic market settings. Therefore, test marketing gives the marketer experience with marketing the product before going to the great expense of full introduction. In fact, it allows the company to test the product and its entire marketing programme, including targeting and positioning strategy, advertising, distributions, packaging etc. before the full investment is made. The amount of test marketing necessary varies with each new product. Especially when introducing a new product requiring a large investment, when the risks are high, or when the firm is not sure of the product or its marketing programme, a lot of test marketing may be carried out.

Commercialization:

Test marketing has given management the information needed to make the final decision: launch or do not launch the new product. The final stage in the new product development process is commercialization. Commercialization means nothing else than introducing a new product into the market. At this point, the highest costs are incurred: the company may need to build or rent a manufacturing facility. Large amounts may be spent on advertising, sales promotion and other marketing efforts in the first year.

MAKE-OR-BUY DECISION

DEFINITION of ' Make-Or-Buy Decision': The act of choosing between manufacturing a product in-house or purchasing it from an external supplier. In a make-or-buy decision, the two most important factors to consider are cost and availability of production capacity.

Factors Influencing Make or Buy Decision:

1. Volume of Production:

The quantity or volume of production affects the make or buy decision to the greater extent. If the volume of production is high, it favors' the make decision and low volume favors buy decisions.

2. Cost Analysis:

The cost analysis refers to the determination of costs to make an item as well as the cost to buy it. The cost to make include – the material cost, direct lab our cost, set up and tooling up costs, depreciation, administrative overheads, interest, insurance, taxes and inventory carrying costs of raw materials and work in process. The cost to make also includes the appropriate allowances, spoilage of work or scrap, and the risk associated with doing business. The cost to buy an item should include -purchase price of the item or component, transportation cost, sales tax and octopi, procurement cost, carrying cost, receiving and incoming inspection costs. The analysis of these two costs helps take decision whether to make or buy.

3. Utilization of Production Capacity:

The organization, which has created large production capacity, favors the decision to make.

4. Integration of Production System:

The vertical integration favors the make decision whereas horizontal integration favors buy decision.

5. Availability of Manpower:

Availability of skilled and competent manpower favors makes decision where as scarce manpower prefers buy decision.

6. Secrecy or Protection of Patent Right:

This condition favors the make decision.

7. Fixed Cost:

A lower fixed cost favors the decision to make and higher fixed cost the make decision.

8. Availability of competent suppliers or vendors

9. Quality and reliability of vendors

FUNCTIONAL ASPECTS OF MAKE OR BUY DECISION:

Make or buy decision should be viewed with both long term and short term perspectives in mind. Some of the effects are tangible and others are intangible. These are classified as follows:

- **Financial Aspects:**

The make decision is always demands an investment in plant, machineries and equipment. The investments can be categorized in to fixed cost and variable cost. The buy decision is associated with only variable cost. Expressing all factors in to money terms carries out a thorough and comparative analysis. Then the decision is to be taken based on which one is more economical, to make or to buy.

- **Technological Aspects:**

The make or buy decision is influenced by:

- ✓ The access to the latest technology to the organization.
- ✓ Feasibility and terms and conditions of technology transfer
- ✓ Outdating of technology
- ✓ Product life cycle.

- **Marketing Aspects:**

The marketing aspects have the influence on make or buy decision. When there is a fierce competition, an organization tries to enhance the quality and cut down the costs. The make decision assures the quality and reliability of the parts. Under the situation of increasing market share and a good future sales potential company can have an additional investment potential and hence can opt for make decision. When there is a doubt about the market potential, the company should opt for buy decision.

- **Purchasing Aspects:**

The decision is influenced by:

- ✓ The availability of items or components in sufficient quantities
- ✓ The delivery commitments must be reliably met.
- ✓ The acceptable quality and price level of the product
- ✓ Economy in transportation from the source to the organization
- ✓ Competence and reliability of vendors.
- ✓ Long lasting and mutually rewarding relationships with vendors

- **Strategic Aspects:**

Any decision that is to be taken including make or buy decision should be taken with due

consideration to overall objective of the organization. Due importance should be given to the economy, secrecy and flexibility in taking decision regarding make or buy.

EXAMPLE PROBLEMS

1. Demand for the component is at the rate of 6000 per year and this demand is going to continue for next three years. The company has two options. It can get the component manufactured from outside or it can manufacture in house. It costs the company Rs. 2.8 per unit to buy the component. The in house manufacture will incur a fixed cost to the extent of Rs. 10,000 and variable cost of Rs. 1.5 per unit. Give the decision rule for make or buy.

Let x represent the number of units.

The total cost incurred in buying the component is

$$\text{Total cost } (Y) = 2.8x$$

Total cost incurred in making the component in house

$$\text{Total cost } (Y) = 10{,}000 + 1.5x$$

At BEP, both alternatives result in equal total cost

$\therefore$ At BEP, equation (1) = equation (2)

$$2.8x = 10{,}000 + 1.5x$$

$$1.3x = 10{,}000$$

$$x = 7692.3 \text{ say } 7693$$

The decision rules are:

If the quantity is 7693, both make and buy are equally economical (Results in same costs)

1. Quantity less than 7693, it is economical to buy
2. Quantity more than 7693, it is economical to manufacture

2. The ABC Company is investigating the decision whether to make or buy a plastic packaging, which is currently being purchased at Rs. 7 each.

The demand estimates are shown below:

Demand (Units)	20,000	30,000	40,000	50,000	60,000
Chance (%)	10	30	40	15	5

The decision to manufacture in house costs the company an annual fixed cost of Rs. 80,000 towards renovation and conditioning. Variable costs are estimated at Rs. 5 per unit Give your decision whether to make or buy. At what quantity it is profitable to produce rather than buy.

Solution:

The expected demand (or volume) is determined treating the percentage chance as a probability

Demand (D)	Probability (P)	D.P(D)
20,000	0.10	2,000
30,000	0.30	9,000
40,000	0.40	16,000
50,000	0.15	7,500
60,000	0.05	3,000
	Total	37,500

The Expected Cost to Produce

$$TC = \text{Fixed cost} + \text{Variable cost} \times \text{Quantity}$$
$$= 80,000 + 5 \times 37,500$$
$$= 2,67,500$$

The decision is economical to continue to buy.

(*ii*) **Break Even Point**

BEP is the volume of production where the total costs to make is equal to the total costs to buy.

Total cost to make = Total cost to buy

$\therefore \quad 80,000 + 5x = 7x$

$\therefore \quad x = 40,000$

It is economical to produce, if the quantity is > 40,000 units.

3. An item, which is required by the company, can be manufactured on any of the three following machines and also it can be purchased at a price of Rs. 1.2 per component. Suggest the best option if the requirement is 2,000 units and give the decision rules.

Solution: Let x be the quantity required.

Machine	Fixed Cost (Rs.)	Variable Cost (Rs/Unit)
M1	9,000	0.75
M2	3,500	0.50
M3	92,000	0.05

Buy	$TC_B = 1.2x$	...(1)
M1	$TC_{M1} = 9{,}000 + 0.75x$	...(2)
M2	$TC_{M2} = 3{,}500 + 0.50x$	...(3)
M3	$TC_{M3} = 92{,}000 + 0.05x$	...(4)

The cost equations for 4 options are:

The relationship between cost and volume is established. The total costs for all the four alternatives are determined at various quantities (volume).

Expected cost to buy

$TC = 7 \times 37{,}500 = 2{,}62{,}500$

The decision is economical to continue to buy.

(*ii*) **Break Even Point**

BEP is the volume of production where the total costs to make is equal to the total costs to buy.

Total cost to make = Total cost to buy

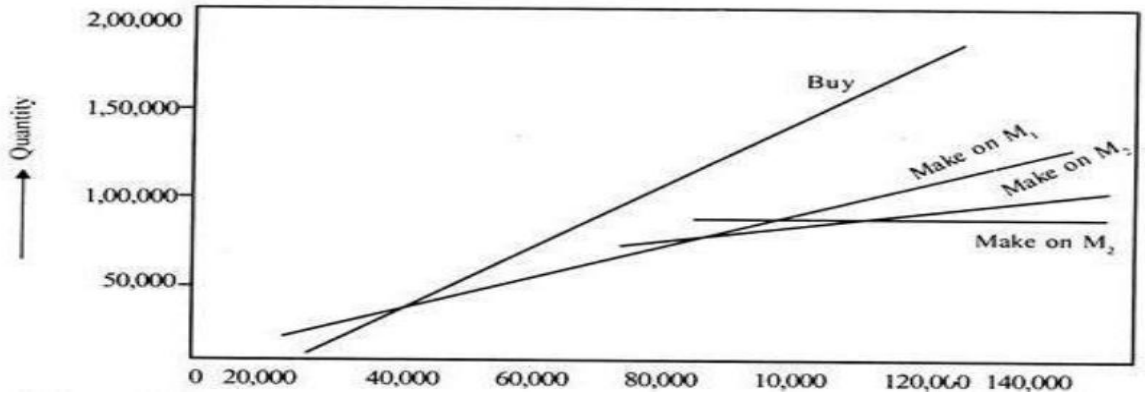
$\therefore \quad 80{,}000 + 5x = 7x$

$\therefore \quad x = 40{,}000$

It is economical to produce, if the quantity is > 40,000 units.

Alternative	Buy	Machines		
Volume (x)	(TC_B)	TCM_1	TCM_2	TCM_3
10,000	12,000	16,500	40,000	97,000
20,000	24,000	24,000	45,000	93,000
50,000	60,000	46,500	60,000	94,500
60,000	72,000	53,000	65,000	95,000
80,000	96,000	69,000	75,000	96,000
1,00,000	1,20,000	84,000	85,000	97,000
1,10,000	1,32,000	91,000	90,000	97,500
1,20,000	1,44,000	99,000	95,000	98,000
1,30,000	1,56,000	1,06,500	1,00,000	98,500
1,50,000	1,80,000	1,21,000	1,10,000	99,500

The requirement is to the extent of 1, 20,000. The best option is to make on M2, which results in lowest cost.



SCHOOL OF BUSINESS ADMINISTRATION

I MBA – II SEMESTER

SBAA5204 – OPERATIONS MANAGEMENT – QUESTION BANK

UNIT – I

PART - A

S. No	Questions (6 marks)	CO	Level
1	Define operations management and state its objectives.	CO1	L1
2	Mention the types of product design.	CO1	L2
3	Recall the characteristics of operations management.	CO1	L1
4	Explain design of production system.	CO1	L1
5	Bring out the core functions of operations management.	CO1	L1
6	Distinguish between goods and services.	CO1	L1
7	Memorize the objectives of designing a product.	CO1	L1
8	State the importance of operations strategy.	CO1	L1
9	State the methods for improving Productivity.	CO1	L2
10	List out the factors influencing make or buy decisions.	CO1	L2

PART – B

S. No	Questions (10 marks)	CO	Level
1	Explain historical approach of operations management.	CO1	L4
2	Evaluate the stages in the development of a new product. Explain each stage in brief?	CO1	L4
3	Explain batch production and mass production along with its advantages and disadvantages.	CO1	L4
4	Highlight the functional aspects of make or buy decisions	CO1	L4
5	Compare and contrast between goods and services.	CO1	L4
6	Discuss the recent trends in production/operations management?	CO1	L5

PART – C

CASE STUDY – (20 marks)

S. No	Questions (20 marks)	CO	Level
1	World's largest car-maker, Toyota Motor (TMC) plans to utilize proposed Indo-Thai Free Trade Agreement (FTA) to make India a hub for small cars to be exported to its global markets. A few auto-parts already enjoy duty free status but the FTA, which is about to be formally inked, will make most auto parts duty free. Toyota imports crucial spares such as the engine for its 'Innova' and 'Corolla Altis' from Thailand. Its top end vehicles Camry Sydan, Prado and Land Cruiser SUV are imported into India. But the company plans to use FTA with Thailand that will allow it to import auto-parts at zero duty when it comes into effect against 7-10% duty it now pays to assemble cars here. TMC says it is looking at all options to make India the manufacturing base for its global operations. Toyota's Indian operations will see a major change once its small cars hit roads in India. Toyota has earmarked Rs. 3,200 crore for year 2008-11 to set up a second plant in Bangalore to make 2 lakh units (cars) from current 80,000 units. Toyota's small cars assembled in India will be exported to overseas. a. Give your analysis about the case. b. Create various ways to solve the problem	CO1	L6
2	A company manufactures and sells gas stoves. It makes some of the parts for the gas stoves and purchases others. The engineering department believes that it is possible to cut costs by manufacturing one of the parts currently being purchased at Rs 8.50 each. The firm uses 1,00,000 of these parts every year and the accounting department compiles the following list of costs based on engineering estimates fixed cost will increase by Rs 50,000,labour cost will rise by Rs 1,25,000.Factory over heads currently running to Rs5, 00,000 per year may increase by 12%. Raw materials used to make the part will cost Rs.6,00,000. Given the above estimate, should the company make the part or continue to buy?	CO1	L6

TEXT / REFERENCE BOOKS

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SCHOOL OF MANAGEMENT STUDIES

UNIT – II – OPERATIONS STRATEGY– SBAA5204

II. OPERATIONS STRATEGY

Process Planning – Process Redesigning, Procedure for designing a process - Production Planning and Control– Objectives, Elements, Stages of PPC - Capacity Planning – Importance, Types, Capacity Requirement Planning(CRP) – Forecasting – Factors affecting Forecast, Types of Forecast in Decision Making, Forecasting Models.

PROCESS PLANNING - CONCEPT

A process (manufacturing process) is defined as any group of actions Instrumental to the achievement of the output of an operations system in accordance with a specified measure of effectiveness. When the product is designed, certain specifications are established; physical dimensions, tolerance, standards and quality are set forth. Then it becomes a matter of deciding over the specific details of how to achieve the desired output. This decision is the essence of Process Planning.

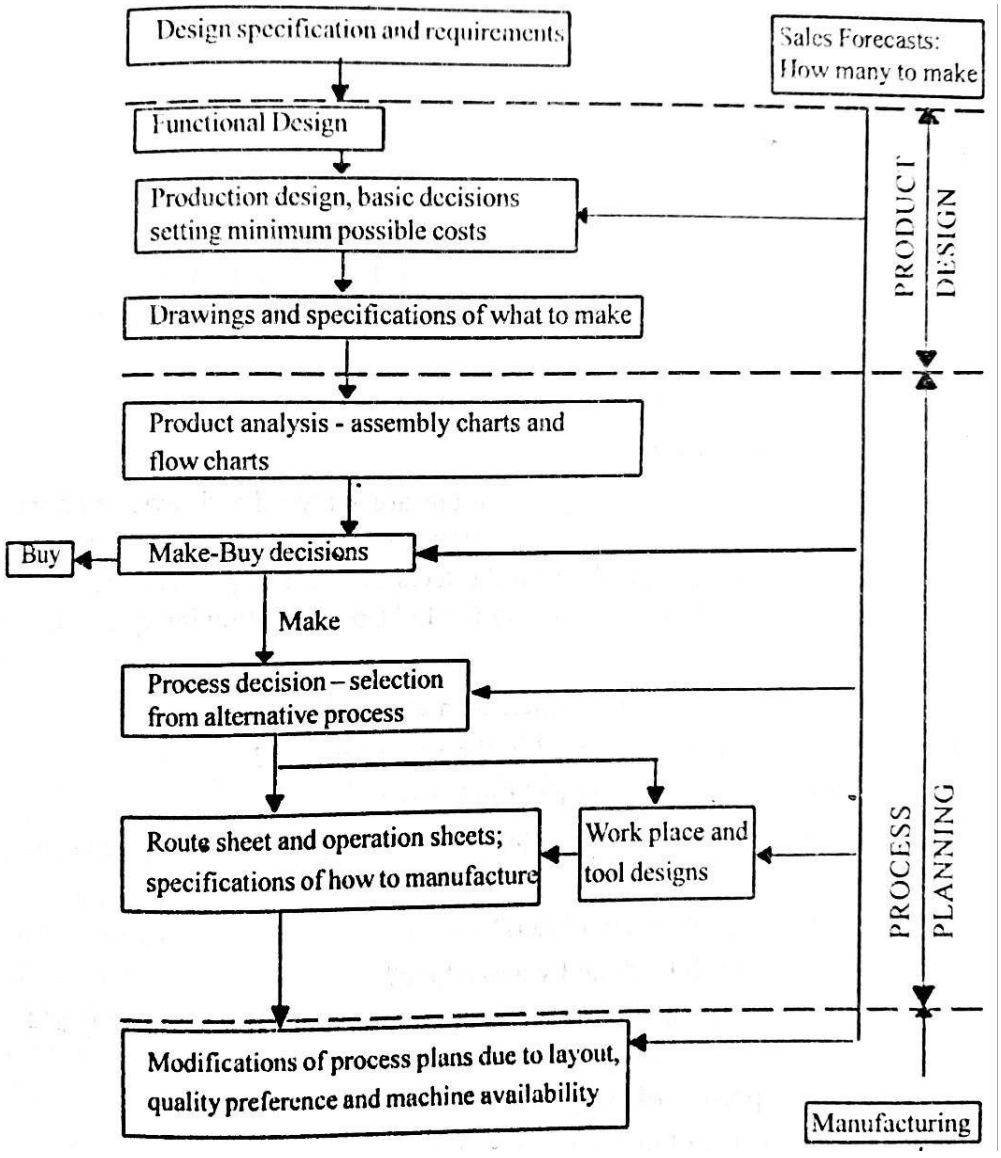
The production function essentially is a transformation process that accepts the inputs, and gives the outputs after adding value to the inputs. Process selection is a major strategic decision as it involves allocation of men and material resources as well as financial commitments for a long period. Corporate planning these days, gives enough importance to operations, on par with marketing to which it plays a supportive role. The transformation process is expected to generate an output desired by the market, in the most cost efficient way.

Meaning of Process Planning

Process planning (also known as process designing) is concerned with the specification of process required and its sequence. Process planning is concerned with designing and implementing a work system that will produce the desired product in the required quantities. Process planning consists of all the work that is necessary to arrange for the manufacture of a product by the most economical means and in compliance with all the safety regulations. Process designing begins with receipt of the product specification and ends with the final plans for manufacture of the product. Process planning activities include the type of work flow and the design of work centers.

The objective is to choose and prescribe appropriate methods for manufacturing a product at an optimum cost. Process planning takes into consideration the sale forecasts, order or contracts with customers, drawings and other specifications. The drawings indicate the relationship of parts, models

and assembly. Drawings are analyzed to determine the overall scope and sequence of the production process. Process planning is a key decision in production as it affects the efficiency of production. It is essential to design the production process before the actual production takes place. It determines the transformation process after taking into consideration available transformation alternatives involving all possible inputs and outputs. Thus, process planning is the systematic determination of the methods by which a product is to be manufactured, economically and competitively.



Process Redesigning:

Process designing is not restricted to new concerns or new products only. Any transformation process

design is related to a particular situation. With changes in conditions, the transformation process should be redesigned or adapted. While planning a process, industrial engineers have to consider several factors, e.g., efficiency, effectiveness, capacity, lead time, flexibility, etc., these considerations are so interdependent and interwined that a change in one will result in a change in others.

Procedure of Designing a Process:

- **Product Design:** Designing a process begins with the consideration or a careful review of the product design and specifications to ensure that economical manufacturing is feasible. The product engineer and the process planner should collaborate on the design of the product to make sure that realistic specifications are set and the product is designed to permit the use of the most economical method.
- **Material List:** All the materials and parts that will be used are listed. The standard quantity of each item that will be required for manufacturing one unit of final product should be determined. A bill of materials to be bought from outside.
- **Sequence of Operations:** The labor operations to be performed on each component and their sequences (order) are decided. The sequence should be such that it will permit the desired rate and quality of output at the Optimum manufacturing cost. The process engineer must be well experienced in methods and tool design so that the most appropriate sequence of operations can be selected. The method selected must ensure optimization of cost.
- **Tool Design:** The machines, equipment and tools most appropriate for the product and volume of output are then designed. Machine setting e.g., speed, feed temperature, pressure, etc., are also decided at this stage. If a finished product is made up of a large number of components or parts, the sub-assemblies and final assembly are determined to simplify control and to minimize costs.
- **Layout:** The layout of production, installation of manufacturing facilities and auxiliary service is decided. Related operations should be effectively integrated. The grouping of equipment and their proximity to each other would depend upon the volume of production and available production facilities. Close integration of operations makes plant layout compact and reduces time and cost of processing materials. However, it may reduce flexibility of the manufacturing process.
- **Control System:** Necessary control of materials, machines and manpower is established to ensure effective utilization of the manufacturing facilities and most economical production of

the product.

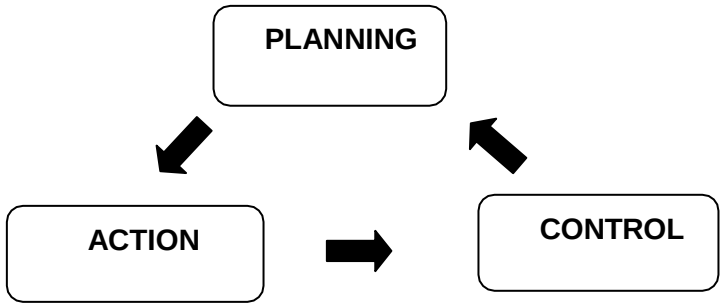
- The above steps or elements of process designing are usually known as Production engineering or Process engineering or Tool engineering.

PRODUCTION PLANNING AND CONTROL - CONCEPT

Production consists of a sequence of operations that transforms materials from a given form to a desired form (products). The highest efficiency in production is obtained by manufacturing the required quantity of products of the required quality, at the required time, by the best and cheapest method. To achieve this objective, production management employs production planning and control function which is a management tool that coordinates all manufacturing activities. The four factors, Quantity, Quality, Time and Cost encompass the production system of which production planning and control is the nerve center or brain.

There Are Three Stages in PPC

- **Planning:** The choice from several alternatives of the best means of utilizing the resources available to achieve the desired objectives in the most efficient and economic manner.
- **Action:** Performance in accordance with the details set out in the production plan.
- **Control:** The monitoring of performance through a feedback by comparing the results achieved with the planned targets so that performance can be improved through proper corrective action.



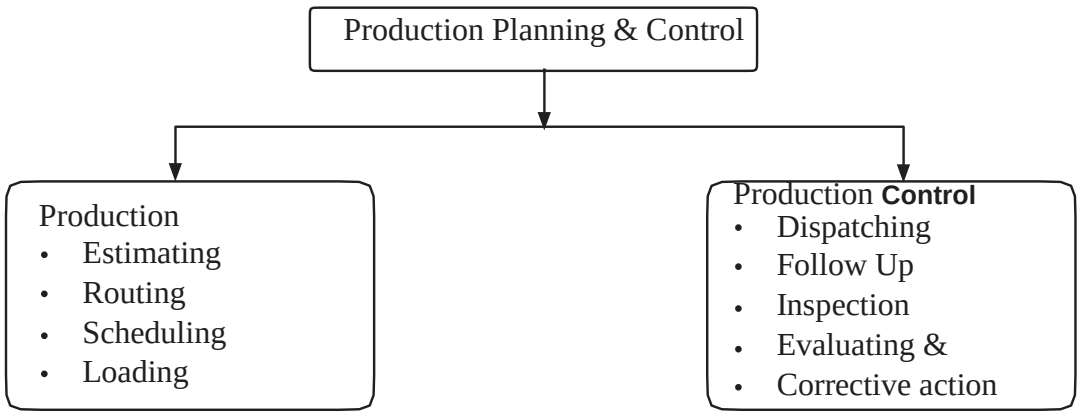
Hence, Production, Planning and Control may be defined as the planning, direction and coordination of the firm's material and physical facilities towards the attainment of predetermined production objectives in the most economical manner. Production, planning and control (PPC) is referred to as operations planning and control because the production planning and control techniques used in production systems manufacturing tangible goods can also be employed in operations or services

systems providing services. Production/operation planning and control involves the organization and control of an overall manufacturing system to produce a product (or a service).

Objectives of Production Planning and Control

- To ensure maximum utilization of all resources.
- To ensure production of quality products.
- To minimize the product through put time or production/manufacturing cycle time.
- To maintain optimum inventory levels.
- To maintain flexibility in manufacturing operations.
- To co-ordinate between labor machines and various supporting departments.
- To plan for capacities between labor and machines and various supporting departments.
- To plan for plant capacities for future requirements.
- To ensure effective cost reduction and cost control.
- To prepare production schedules and ensure that promised delivery dates are met.
- To produce effective results for least total cost.
- The ultimate objective is to contribute to profit of the enterprise.

Elements of Production Planning and Control



Estimating:

- It involves deciding the quality of products to be produced and cost involves in it on the basis of sales forecast.
- Estimating manpower, machine capacity and materials required to meet the planned production

targets are the key activities before budgeting for resources.

Routing:

- This is the process of determining the sequence of operations to be performed in the production process.
- Routing determines what work must be done, where and how?
- Routing information is provided by product or process engineering function and it is useful to prepare machine loading charts and schedules.
- Route sheets: These are the documents providing information and instruction for converting the raw materials into finished products.

Scheduling:

- It involves fixing priorities for each job and determining the starting time and finishing time for each operation, the starting dates and finishing dates for each part, sub assembly and final assembly.
- Scheduling lays down a time table for production indicating the total time required for the manufacture of a product and also the time required for carrying out the operation for each part on each machine or equipment.

Loading:

- Facility loading means loading of facility or work center and deciding which jobs to be assigned to which work center or machine. Loading is the process of converting operation schedules into practice.
- Machine loading is the process of assigning specific jobs to machines, men or work centers based in relative priorities and capacity utilization.
- A machine loading chart is prepared showing the planned utilization of men and machines by allocating the jobs to machines or workers as per priority sequencing established at the time of scheduling.

Dispatching:

- It is defined as, setting production activities in motion through the release of orders and instructions in accordance with the previously planned time schedules and routings.
- Dispatching function includes Collecting tools, issuing job orders, obtaining inspection schedules, internal material handling and movement of materials to inspection area after

completing the operation, returning jigs and fixtures etc.

Follow up

- Expediting or progressing ensures that the work is carried out as per plan and delivery scheduling is met.
- Progressing includes activities such as status reporting, attending to bottlenecks or holdups in production and removing the same, controlling variation and deviations from planned performance levels, following up and monitoring progress of work through all stages of production, coordinating with purchase, stores, tool room and maintenance departments and modifying the production plans and re-plan if necessary.

In short, production planning and control function is concerned with decision making regarding:

What to produce: product planning and development includes product design.

How to produce: process planning, material planning, tool planning etc.

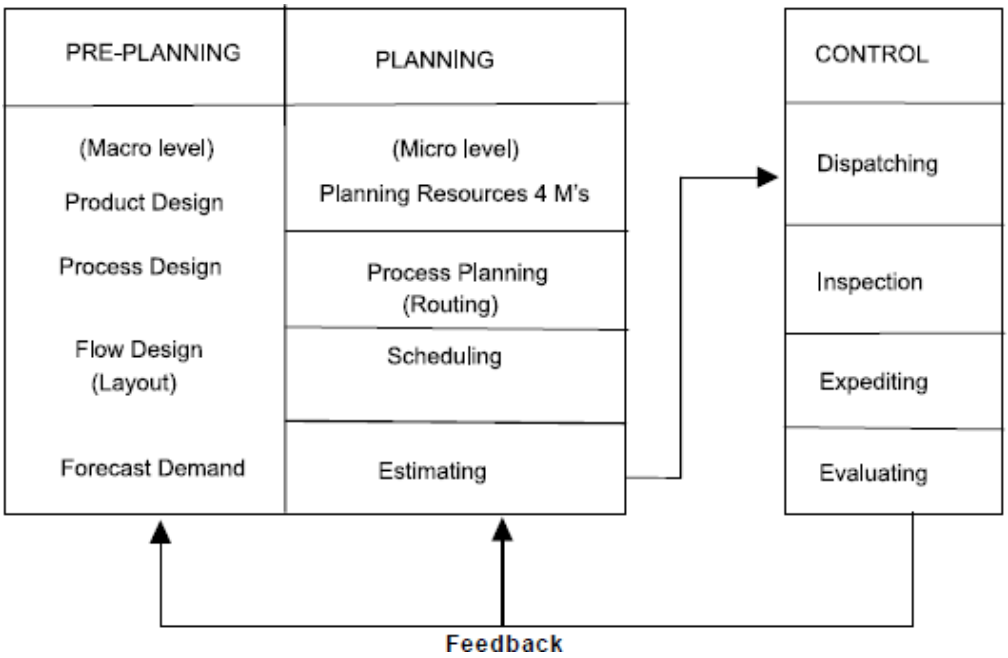
Where to produce: facilities planning, capacity planning and sub-contracting planning.

When to produce: production scheduling and machine loading.

Who will produce: man power planning?

How much to produce: Planning for quantity, economic batch size etc.

STAGES IN PPC



Pre-Planning:

Under this phase of production planning, basic ground work on the product design, layout design and work flow are prepared. The operations relating to the availability scope and capacity of men, money materials, machines, time are estimated.

Planning:

This is a phase where a complete analysis on routing, estimating and scheduling is done. It also tries to find out the areas of concern for short time and long time so that prominent planning can be prepared.

Control:

Under this phase, the functions included are dispatching, follow up, inspection and evaluation. It tries to analyze the expedition of work in progress. This is one of the important phases of the Production Planning and Control.

CAPACITY PLANNING – CONCEPT:

Capacity planning refers to determining what kind of labor and equipment capacities are required and when they are required. Capacity is usually planned on the basis of labor or machine hours available within the plant. Thus, capacity planning is planning for quantity or scale of output. There are four major considerations in capacity planning:

- Level of demand
- Production
- Availability of fund
- Management Policy

Importance of Capacity Planning

- **Capacity limits the rate of output:** Therefore, capacity planning determines the ability of an enterprise to meet future demand for its products and services.
- **Capacity influences the operating costs:** Capacity is determined on the basis of estimated demand. Actual demand is often different from estimated demand. As a result, there arises excess capacity or under capacity. Excess or idle capacity increases the cost per unit of output. Whereas under capacity results in the loss of sales.
- Capacity decisions leave a direct impact on the amount of fixed investment made initially.
- **Capacity decisions result in Long-term commitment of funds.** Such long-term

decisions cannot be reversed except at major costs.

Types of Capacity

- **Licensed capacity** - denotes the capacity licensed by the Government authorities concerned.
- **Potential capacity** - The decision on potential capacity is taken mostly by a senior most executive of the organization.
- **Immediate capacity** - is that which can be made available within the current budget period. Immediate capacity is subject to certain constrains like plant equipment size, availability of equipment, availability of manpower, financial policy, sub-contracting policy, the technical demands of the tasks, and the number of different tasks being undertaken. For example, the capacity of a restaurant is limited by the size of the dining area or the number of tables.
- **Design or Installed capacity** - It is the maximum output that can be achieved in a given time period form a particular plant. It is a theoretical capacity as it does not take into consideration power breakdown, pool planning, non-availability of materials, labor absenteeism, etc. This capacity is reliable only if certain conditions are satisfied. They are:
    - There are no interruptions of any kind.
    - There is 100% utilization of capacity.
    - Men and machines work in ideal conditions.
    - Quality of inputs according to specification.

In real life situation, it is difficult to fulfill these conditions. Therefore, installed capacity only sets the maximum limit and also serves to judge the actual utilization of plant capacity. Hence it is also known as maximum capacity.

- **Effective or Practical or Operating capacity**: Effective capacity can be influenced by technical abilities in the pre-operations stages, organizational skills in the planning stages, purchasing skills, sub-contracting skills, maintenance policies and abilities, efficiency of workforce, multiple shift operation, etc. No plant can work up to the maximum or theoretical capacity due to plant efficiency factor and scrap factor. A portion of the available hours cannot be worked due to scheduling delays, machine breakdown, preventive maintenance, etc. This results in the efficiency of plant being less than what is rated.
- **Actual or Utilized capacity**: This is the actual output achieved during a particular time period.

If installed capacity is 100,000 tonnes and the actual production is 80,000 tonnes, we say that capacity utilization is 80% or the plant worked at 80% of the capacity.

- **Normal Capacity or Rated capacity**: It is the capacity estimated by a qualified authority as to the amount of production that should be usually secured Actual capacity is usually expressed as a percentage of the rated capacity.
- **Excess capacity**: Generally plant and equipment are indivisible in nature. Plant and equipment are long term facilities and constitute the major part of production cost. It is not possible to adjust fully and immediately the size of the plant and machinery to suit day to day changes in sales and production. Therefore, excess (unutilized) capacity may occur frequently.

Procedure for Capacity Planning

- **Assessment of Existing Capacity:** Capacity of a unit can be measured in terms of output or inputs. Output measure is appropriate in case of manufacturing concerns. e.g., automobile plant (number of cars), iron and steel plant (tons of steel), cannery (tons of food), etc. Service concerns like hospitals (number of beds), theatres (number of seats), etc., can measure capacity in terms of inputs.
- **Forecasting Future Capacity Needs:** Short term capacity requirements can be estimated by forecasting product demand at different stages of the product life cycle. It is more difficult to anticipate long-term capacity requirements due to uncertainties of market and technology. Capacity forecast helps to determine the gap between the existing capacity and estimated capacity so that necessary adjustments may be made.
- **Identifying Alternative ways of Modifying Capacity:** In case where the existing capacity is inadequate to meet the forecast demand capacity, the expansion is required to meet the shortage. Additional shifts may be employed to expand the capacity. Expansion will provide economies of scale and help in meeting the forecast demand. But it involves additional investment and danger of fall in forecast demand in future. When the existing capacity exceeds forecast capacity, there is a need for reduction of excess capacity. Developing new products, selling of existing facilities, layout of workers or getting work from other firms are the methods of overcoming it.
- **Evaluation of Alternatives:** Various alternatives for capacity expansion or reduction are evaluated from economic, technical and other viewpoints. Reactions of employees and local community should also be considered. Cost-Benefit analysis, Decision theory and Queuing

theory are the main techniques of evaluating alternatives.

- **Choice of Suitable Course of Action:** After performing the cost-benefit analysis of various alternatives to expand or reduce the capacity, the most appropriate alternative is selected.

CAPACITY REQUIREMENT PLANNING (CRP) – CONCEPT:

Capacity is a measure of the productive capability of a facility per unit of time. Capacity decisions begin with the initial facility layout and extend to aggregate planning, master scheduling, capacity requirements planning .CRP is a technique for determining what personnel and equipment capacities are needed to meet the production objectives embodied in the master Schedule and the material requirements plan.

CRP is an effort to develop a match between the MRP schedule and the production capacity of the company. Determination of the capacity of the work center and the capacity requirements imposed on those work centers by a particular product mix enables a company to know the level of sales its production system can support. Thus, company will be able to make realistic sales commitments. Capacity planning helps to avoid under-utilization of capacity and also CRP enables the company to anticipate production bottlenecks in some work centers in time to take corrective actions.

To be effective, capacity requirements planning must be coordinated with MRP. Working together, MRP and CRP programmes translate the master schedule to requirements for components and capacity, simulating the impact of the master schedule that provided the input for MRP programme. CRP can be used to refine the master production schedule (MPS) further after MRP is run.

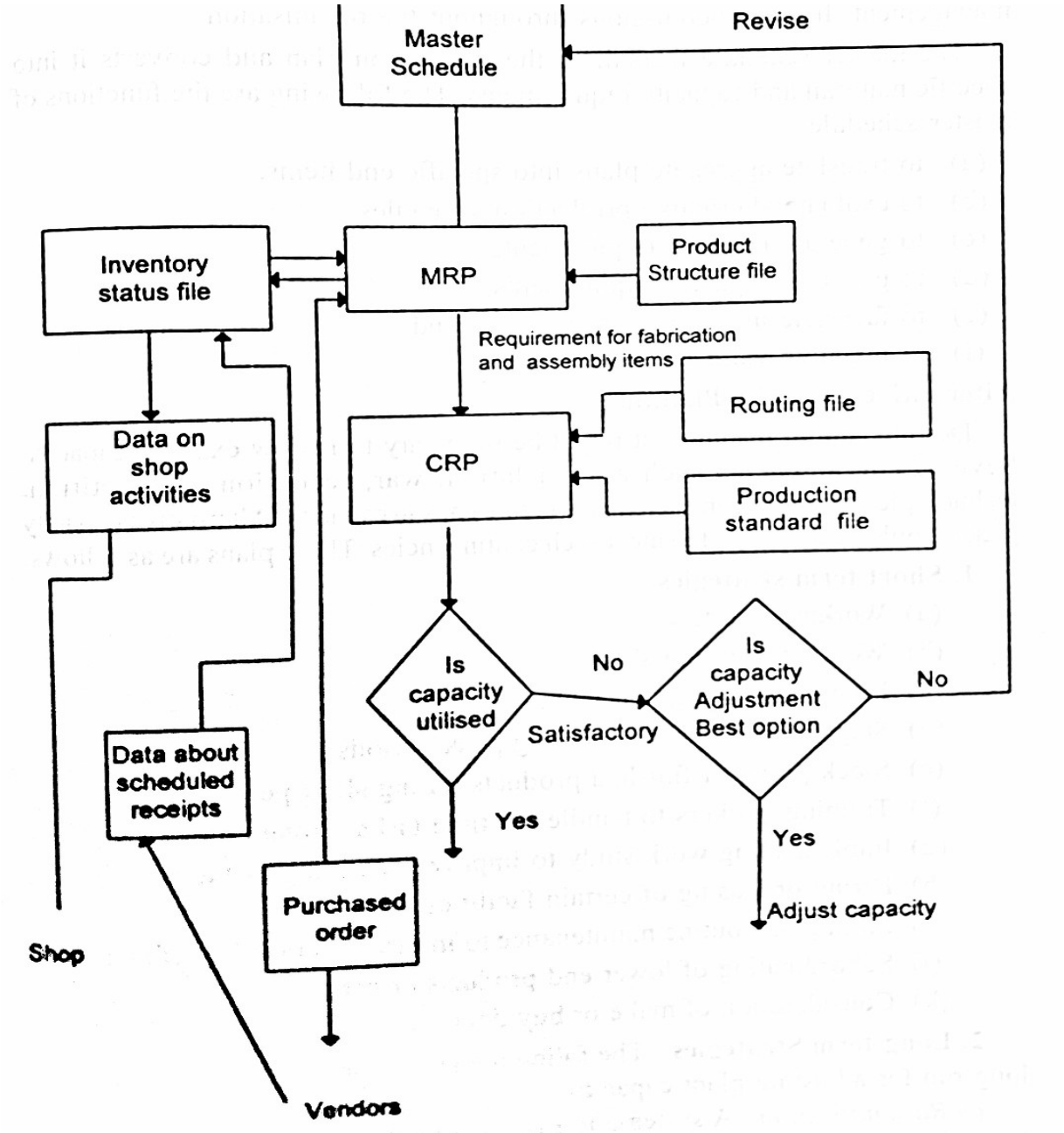
Inputs for CRP Process:

- Planned orders and released orders from the MRP system.
- Loading information from work center status file.
- Routing information from the shop routing file.
- Changes which modify capacity give alternative routings or alter planned orders.

The released and planned orders from the MRP system are converted into standard hours of load by the CRP system. MRP system assumed that capacity is available when needed unless otherwise indicated.

Outputs of CRP:

Apart from information for modification of capacity or revision of MPS, the major outputs of the CRP system are the verification of planned orders for the MRP system and load reports. The firm can plan for the average amount of labor and equipment that is expected without actually designating the capacity for specific orders. The flow of information in CRP is shown;



FORECASTING – CONCEPT:

A forecast is an estimate of an event which will happen in future. The event may be demand of a product, rainfall at a particular place, population of a country, or growth of a technology. The forecast value is not a deterministic quantity. Since, it is only an estimate based on the past data related to a particular event, proper care must be given in estimating it.

In any industrial enterprise, forecasting is the first level decision activity. That is the demand of a particular product must be available before taking up any other decision problems like, materials planning, scheduling, type of production system (Mass or batch production) to be implemented, etc.

So, forecasting provides a basis for coordination of plans for activities in various parts of a company. All the functional managers in any organization will base their decisions on the forecast value. So, it is vital information for the organization. Due to these reasons, proper care should be exercised while estimating forecast values.

In business, forecasts may be classified into technology forecasts, economic forecasts and demand forecasts.

- **Technology Forecast:**

  Technology is a combination of hardware and software. Hardware is any physical product while software is the know-how, technique or procedure. Technology forecast deals with certain characteristics such as level of technical performance, rate of technological advances. Technological forecast is a prediction of the future characteristics of useful machines, products, process, procedures or techniques. Based on the importance of this activity, Government of India has established a "Technology Information Forecasting and Assessment Council (TIFAC)", under the Ministry of Science and Technology to promote action oriented studies and forecasting in selected areas.

- **Economic Forecasts:**

  Government agencies and other organizations involve in collecting data and prediction of estimate on the general business environment. These will be useful to government agencies in predicting future tax revenues, level of business growth, level of employment, level of inflation, etc. Also, these will be useful to business circles to plan their future activities based on the level of business growth.

- **Demand Forecast:**

  The demand forecast gives the expected level of demand for goods or services. This is the basic input for business planning and control. Hence, the decisions for all the functions of any

corporate house are influenced by the demand forecast.

Factors Affecting Forecast (Demand):

- Business cycle
- Random variation
- Customer's plan
- Product's life cycle
- Competition's efforts and prices
- Customer's confidence and attitude
- Quality
- Credit policy
- Design of goods or services
- Reputation for service
- Sales effort
- Advertising

Types of Forecasting In Decision Making

Forecasting in different functional areas of management such as Marketing, Production, Finance and Personnel play a crucial role for planning ahead. The various types of forecast in each of the aforementioned areas are as follows:

1. Marketing

- Demand forecasting of products
- Forecast of market share
- Forecasting trend in prices

2. Production

- Forecast of Materials requirements
- Forecast of Trends in material and labor costs
- Forecast of Maintenance requirements
- Forecast of Plant capacity

3. Finance:

- Forecast of Cash flows
- Forecast of Rates of expenses
- Forecast of Revenues

4. Personnel:

- Forecast of Number of workers in each category
- Forecast of Labor turn over
- Forecast of Absenteeism

FORECASTING MODELS

The forecasting techniques can be classified into qualitative techniques and quantitative techniques. These are presented below. Qualitative techniques use subjective approaches. These are useful where no data is available and are useful for new products. Quantitative techniques are based on historical data. These are more accurate and computers can be used to speed up the process.

Quantitative Forecasting Techniques

- Simple moving average
- Single exponential smoothing
- Double moving average
- Double exponential smoothing
- Simple regression
- Semi-average method
- Multiple regression
- Box Jenkins

Qualitative Forecasting Techniques

- Delphi type method
- Market surveys

Selection of a Forecasting Technique:

The selection of a forecasting technique depends on the following three factors:

I. The characteristics of the decision making situation, which include:
- The time horizon
- Level of detail
- Number of items
- Control versus Planning

II. The characteristics of the forecasting methods:
- The time horizon (number of periods for which forecasting required)
- The pattern of data (horizontal, seasonal, trend, etc.)

- Type of model (casual, time series or statistical)
- Cost
- Accuracy
- Ease of application

III. Present situation, which includes:
- The item that is being forecast
- Amount of historical data available
- Time allowed for preparing forecast

Measures of Forecast Accuracy:

Demand forecast influences most of the decisions in all the functions. Hence, it must be estimated with the highest level of precision. Some common measures are inevitable to measure the accuracy of a forecasting technique. This measure may be an aggregate error (deviation) of the forecast values from the actual demands. The different types of errors which are generally computed are as presented below.

- **Mean Absolute Deviation (MAD):**

  It is the mean of absolute deviations of forecast demands from actual demand values. The MAD is sometimes called as the mean absolute error (MAE).

- **Mean Square Error (MSE):**

  Mean square error is the mean of the squares of the deviations of the forecast demands from the actual demand values. Usually the effects on operations of small errors are not serious. These errors may be smoothed out by inventory or overtime work. It will be difficult to have smoothed values for forecast even if there are few large errors. Consequently, a method of measuring errors that penalizes large errors more than small errors is sometime desired. The mean square error (MSE) provides this type of measure of forecast error.

- **Mean Forecast Error (MFE):**

Mean forecast error (MFE) is the mean of the deviations of the forecast demands from the actual demands.

- **Mean Absolute Percentage Error (MAPE):**
  Mean absolute percentage error (MAPE) is the mean of the percent deviations of the forecast demands from the actual demands.

- **Simple Moving Average Method:**
  A simple moving average is a method of computing the average of a specified number of the most recent data values in a series.
- **Weighted Moving Average:**
  Equal weights were assigned to all periods in the computation of the simple moving average. The weighted moving average assigns more weight to some demand values (usually the more recent ones) than to others.
- **Simple (Single) Exponential Smoothing:**
  Another form of weighted moving average is the exponential smoothed average. This method keeps a running average of demand and adjusts it for each period in proportion to the difference between the latest actual demand figure and the latest value of the average.
- **Adjusted Exponential Smoothing:**
  The simple exponential smoothing forecast is a smoothed average positioned on the current period. It is taken as a next period forecast. In reality, trend exists in demand pattern of much business. Hence, due recognition should be given to make correction in the demand forecast for trend also. Adjusted exponential smoothed forecast model actually projects the next project forecast by adding a trend component to the current period smoothed forecast.
- **Linear Regression:**

Regression means dependence and involves estimating the value of a dependent variable Y, from an independent variable X. In simple regression, only one independent variable is used, whereas in multiple regression on two or more independent variables are involved.

- **Semi-average Method:**

  This method is sometimes employed when a line appears to be an inadequate explanation of the trend. According to this method, the original data are divided into two equal parts and the values of each part are then summed up and averaged. The average of each part is centered in the period of the time of the part from which it has been calculated and then plotted on a graph. Then a straight line is drawn to pass through the plotted points. This line constitutes the semi- average trend line. When the number of years is odd, the middle year is not considered while dividing the data into two equal parts and obtaining the average.

- **Delphi Method:**

  Delphi method is a forecasting technique applied to subjective nature of demand values. In view of globalization in India, Indian companies will have difficulty in estimating the demand of their products mainly because of possible mixed reactions of customers towards various attributes of a specific product which is manufactured by multinational firms and indigenous firms. Under such situation, one has to resort to subjective estimates. Technology forecasting is another example where there is no quantitative data based on which the future technology can be predicted. In this situation, we will have information at various stages of technological advancement for a particular application. If we closely examine the development of computer languages, the following is the order of development.

  - Machine Language.

    - Assembly Language (First Generation Languages)
    - High Level Languages (Second Generation Languages)
    - Third Generation Languages (Dbase-III, Lotus 1-2-3)
    - Fourth Generation Languages (Oracle, Sybase, PC-Focus)
- Beyond this stage, the next level development would be clubbed under Fifth Generation languages. But the features of such languages are yet to be known. If the objective is to predict the capabilities of such languages, one has to use Delphi method.
- In Delphi method of forecasting, several knowledgeable persons are asked to provide subjective estimates of demands or forecasts of possible advances of technology. The experts may provide several opinions. Based on the Opinions of the experts, a consensus will be arrived at the demand of product/advances of technology.
- The essential precautions to be followed in this method are as follows:
    - Panel members must be unknown to each other.
    - The initial questionnaire should be unambiguous and it should explain every matter about which opinion is sought.
- After getting the opinions from the panel members, they are to be compared for similarity. If the variation among the opinions is too much, the summary of opinions is to be circulated again among the members without mentioning the names of persons who provided the opinions. Generally, 50% of the estimate is treated as the basis for comparison. The panel members whose opinions differ significantly from the middle 50% of the estimate will be asked to reconsider their opinions. Still, if they want to stick to their original opinions, they will be asked to provide rationale for the same.
- So, the Delphi method is an iterative process until the panel converges on a specific value or a range of values as defined by

the required accuracy, or arrives at a consensus on the matter under consideration.

SCHOOL OF BUSINESS ADMINISTRATION

I MBA – II SEMESTER

SBAA5204 – OPERATIONS MANAGEMENT – QUESTION BANK

UNIT – II

PART – A

S. No	Questions (5 marks)	CO	Level
1	Discuss the factors influencing product design.	CO2	L1
2	Give reasons for the process redesigning.	CO2	L2
3	Mention the three stages of PPC.	CO2	L3
4	Explain the concept of CRP.	CO2	L2
5	List down the objectives of PPC.	CO2	L2
6	State the meaning of process planning.	CO2	L3
7	Memorize the importance of capacity planning.	CO2	L3
8	What are the factors affecting forecasting demand?	CO2	L3
9	Bring out the types of forecasting areas in decision making.	CO2	L4
10	List any four disadvantages of market research method of demand forecasting.	CO2	L3

PART – B

S. NO	Questions (10 marks)	CO	Level
1	Elaborate the procedure of designing a process.	CO2	L4
2	Enumerate the stages in PPC.	CO2	L4
3	Draw diagram and explain capacity requirement planning.	CO2	L4
4	Briefly explain the forecasting methods based on business context.	CO2	L5
5	Elaborate the quantitative forecasting techniques.	CO2	L6
6	Analyze the qualitative forecasting technique.	CO2	L6

PART – C

CASE STUDY – (20 marks)

S. No	Questions (20 marks)	CO	Level
1	Mahindra and Mahindra hired, Prof. Yasutoshi Washio, a Japanese expert, to implement Deming guidelines in the company. Prof. Yasutoshi Washio was skeptical about the Indian companies and workers. He felt that the Indian companies are more like the American companies, which feel that results are important. On the other hand, for the Japanese, the process is more important. Moreover, he had serious doubts about the attitude of the Indians workers with respect to a team work - a Deming prerequisite - as he felt that Indians were individualistic. In the initial few years of interaction with the management of FES, Washio found himself isolated due to disagreements on various fronts. Washio has major difficulties in making most of the Indian companies understand the importance of implementation over creating a perfect framework a. Give your analysis about the case, b. Create various process planning techniques.	CO2	L6
2	The GM (Works) has problems with manufacturing budgets, meeting cost reduction targets, and dealing with new products manufacturing schedules. When an in-depth interview (non-directive type) was conducted between the GM (Works) and the Chairman of the Company, the GM (Works) explained that many things are happening in the Company about which he is ignorant, particularly the preparation, new product integration, etc. He agrees to the view that the Company is interested in high-growth and high-profit, but he has never been given an opportunity to review his own scheme of things and explain to the top management. The production culture of the company has never been assessed whereas the stringent rules are being directed by the finance and personnel departments. And sometimes, show cause notices are being served to supervisors and	CO2	L6

	senior employees. The Company is introducing new products without assessing the capability of the manufacturing system and the resources. (a) Under the above situation, if you are asked to work as a consultant to show the perspectives to the Board of Management, what action plans would you suggest? (b) Does Business Process Re-engineering (BPR) help in situations like these?		

TEXT / REFERENCE BOOKS

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SCHOOL OF MANAGEMENT STUDIES

UNIT – III – OPERATIONS MANAGEMENT– SBAA5204

III. PLANT LOCATION & LAYOUT

Facility Location – Factors influencing Plant Location, Break even Analysis. Plant Layout – Classification of Layout, Layout Design Procedures – CRAFT, ALDEP, CORELAP. Line Balancing – Objectives of Assembly Line Balancing, Ranked Positional Weight Method, COMSOAL

PLANT LOCATION – CONCEPT

Plant location is defined as deciding a suitable location or place etc., where the factory or plant will start functioning. Plant location or the facilities location problem is an important strategic level decision- making for an organisation. One of the key features of a conversion process (manufacturing system) is the efficiency with which the products (services) are transferred to the customers. This fact will include the determination of where to place the plant or facility.

The selection of location is a key-decision as large investment is made in building plant and machinery. It is not advisable or not possible to change the location very often. So an improper location of plant may lead to waste of all the investments made in building and machinery, equipment.

Before a location for a plant is selected, long range forecasts should be made anticipating future needs of the company. The plant location should be based on the company‘s expansion plan and policy, diversification plan for the products, changing market conditions, the changing sources of raw materials and many other factors that influence the choice of the location decision. The purpose of the location study is to find an optimum location one that will result in the greatest advantage to the organization.

Objectives of plant location:

- Reduced capital investment and operating cost
- Ensuring effective plant layout
- Coordination with government policies
- Employee welfare and public needs Security

Aspects of plant location:

There are three aspects;

- Selection of a region

- Selection of a locality (community factor)
- Selection of a site

Need for location selection:

I. When starting a new organization, i.e., location choice for the first time.

II. In case of existing organization.

III. In case of Global Location.

I. In case of location choice for the first time or new organizations:

Cost economies are always important while selecting a location for the first time, but should keep in mind the cost of long-term business/organisational objectives. The following are the factors to be considered while selecting the location for the new organizations:

- **Identification of region:** The organisational objectives along with the various long-term considerations about marketing, technology, internal organisational strengths and weaknesses, region specific resources and business environment, legal-governmental environment, social environment and geographical environment suggest a suitable region for locating the operations facility.
- **Choice of a site within a region:** Once the suitable region is identified, the next step is choosing the best site from an available set. Choice of a site is less dependent on the organisation‘s long-term strategies. Evaluation of alternative sites for their tangible and intangible costs will resolve facilities-location problem. The problem of location of a site within the region can be approached with the following cost-oriented non-interactive model, *i.e*., dimensional analysis.

II. In case of location choice for existing organization:

In this case a manufacturing plant has to fit into a multi-plant operations strategy. That is, additional plant location in the same premises and elsewhere under following circumstances:

- Plant manufacturing distinct products.
- Manufacturing plant supplying to specific market area.
- Plant divided on the basis of the process or stages in manufacturing.
- Plants emphasizing flexibility.

The different operations strategies under the above circumstances could be:

- **Plants manufacturing distinct products:** Each plant services the entire market area for the organization. This strategy is necessary where the needs of technological and resource inputs are specialized or distinctively different for the different product-lines.

For example, a high quality precision product-line should not be located along with other product-line requiring little emphasis on precision. It may not be proper to have too many contradictions such as sophisticated and old equipment, highly skilled and semi-skilled personnel, delicate processes and those that could permit rough handlings, all under one roof and one set of managers. Such a setting leads to much confusion regarding the required emphasis and the management policies.

Product specialization may be necessary in a highly competitive market. It may be necessary to exploit the special resources of a particular geographical area. The more decentralized these pairs are in terms of the management and in terms of their physical location, the better would be the planning and control and the utilization of the resources.

- **Manufacturing plants supplying to a specific market area:** Here, each plant manufactures almost all of the company‘s products. This type of strategy is useful where market proximity consideration dominates the resources and technology considerations. This strategy requires great deal of coordination from the corporate office. An extreme example of this strategy is that of soft drinks bottling plants.
- **Plants divided on the basis of the process or stages in manufacturing:** Each production process or stage of manufacturing may require distinctively different equipment capabilities, labor skills, technologies, and managerial policies and emphasis. Since the products of one plant feed into the other plant, this strategy requires much centralized coordination of the manufacturing activities from the corporate office that are expected to understand the various technological aspects of all the plants.
- **Plants emphasizing flexibility:** This requires much coordination between plants to meet the changing needs and at the same time ensure efficient use of the facilities and resources. Frequent changes in the long-term strategy in order to improve be efficiently temporarily, are not healthy for the organization. In any facility location problem the central question is: Is this a location at which the company can remain competitive for a long time?

For an established organization in order to add on to the capacity, following are the ways:

- **Expansion of the facilities at the existing site:** This is acceptable when it does not

violate the basic business and managerial outlines, i.e., philosophies, purposes, strategies and capabilities. For example, expansion should not compromise quality, delivery, or customer service.

- **Relocation of the facilities (closing down the existing ones):** This is a drastic step which can be called as "Uprooting and Transplanting". Unless there are very compelling reasons, relocation is not done. The reasons will be either bringing radical changes in technology, resource availability or other destabilization.

All these factors are applicable to service organizations, whose objectives, priorities and strategies may differ from those of hardcore manufacturing organizations.

III. In case of global location:

Because of globalization, multinational corporations are setting up their organizations in India and Indian companies are extending their operations in other countries. In case of global locations there is scope for virtual proximity and virtual factory.

- **Virtual Proximity:** With the advance in telecommunications technology, a firm can be in virtual proximity to its customers. For a software services firm much of its logistics is through the information/ communication pathway. Many firms use the communications highway for conducting a large portion of their business transactions. Logistics is certainly an important factor in deciding on a location whether in the home country or abroad. Markets have to be reached. Customers have to be contacted. Hence, a market presence in the country of the customers is quite necessary.
- **Virtual Factory:** Many firms based in USA and UK in the service sector and in the manufacturing sector often out sources part of their business processes to foreign locations such as India. Thus, instead of one's own operations, a firm could use its business associates operations facilities. The Indian BPO firm is a foreign-based company's virtual service factory'. So a location could be one's own or one's business associates. The location decision need not always necessarily pertain to own operations.

Reasons for a Global/Foreign Location:

A. Tangible Reasons:

The tangible reasons for setting up an operation facility abroad could be as follows:

Reaching the customer: One obvious reason for locating a facility abroad is that of

capturing a share of the market expanding worldwide. The phenomenal growth of the GDP of India is a big reason for the multinationals to have their operations facilities in our country.

An important reason is that of providing service to the customer promptly and economically which is logistics-dependent. Therefore, cost and case of logistics is a reason for setting up manufacturing facilities abroad. By logistics set of activities closes the gap between production of goods/services and reaching of these intended goods/services to the customer to his satisfaction. Reaching the customer is thus the main objective. The tangible and intangible gains and costs depend upon the company defining for it as to what that reaching means. The tangible costs could be the logistics related costs; the intangible costs may be the risk of operating is a foreign country. Tangible gains are the immediate gains; the intangible gains are an outcome of what the company defines the concepts of reaching and customer for it. The other tangible reasons could be as follows:

- The host country may offer substantial tax advantages compared to the home country.
- The costs of manufacturing and running operations may be substantially less in that foreign country. This may be due to lower labor costs, lower raw material cost, better availability of the inputs like materials, energy, water, ores, metals, key personnel etc.
- The company may overcome the tariff barriers by setting up a manufacturing plant in a foreign country rather than exporting the items to that country.

B. Intangible Reasons:

The intangible reasons for considering setting up an operations facility abroad could be as follows:

1. Customer-related Reasons:

- With an operations facility in the foreign country, the firm‘s customers may feel secure that the firm is more accessible. Accessibility is an important service quality determinant.
- The firm may be able to give a personal tough.
- The firm may interact more intimately with its customers and may thus understand their requirements better.
- It may also discover other potential customers in the foreign location.

2. Organisational Learning-related Reasons:

- The firm can learn advanced technology. For example, it is possible that cutting-edge technologies can be learning by having operations in a technologically more advanced country. The firm can learn from advanced research laboratories/universities in that country. Such learning may help the entire product-line of the company.

- The firm can learn from its customers abroad. A physical location there may be essential towards this goal.
- It can also learn from its competitors operating in that country. For this reason, it may have to be physically present where the action is.
- The firm may also learn from its suppliers abroad. If the firm has a manufacturing plant there, it will have intensive interaction with the suppliers in that country from whom there may be much to learn in terms of modern and appropriate technology, modern management methods, and new trends in business worldwide.

3. Other Strategic Reasons:

- The firm by being physically present in the host country may gain some ‗local boy' kind of psychological advantage. The firm is no more a foreign company just sending its products across international borders. This may help the firm in lobbying with the government of that country and with the business associations in that country.
- The firm may avoid political risk by having operations in multiple countries.
- By being in the foreign country, the firm can build alternative sources of supply. The firm could, thus, reduce its supply risks.
- The firm could hunt for human capital in different countries by having operations in those countries. Thus, the firm can gather the best of people from across the globe.
- Foreign locations in addition to the domestic locations would lower the market risks for the firm. If one market goes slow the other may be doing well, thus lowering the overall risk.

Factors influencing plant location:

- **Availability of raw materials:**

It is essential for the organization to get raw material in right qualities and time in order to have an uninterrupted production. The cost obtaining Example Nearness to raw material is important in case of industries such as sugar, cement, jute and cotton textiles.

- **Nearness to market:**

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

Locating nearer to the market is preferred if;

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

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

- **Transportation facilities:**

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

- **Climatic conditions:**

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

- **Government policy:**

The policies of the state governments and local bodies concerning labor laws, building codes, safety, etc., are the factors that demand attention. In order to have a balanced regional growth of industries, both central and state governments in our country offer the package of incentives to entrepreneurs in particular locations. The incentive package may be in the form of exemption from a sales tax and excise duties for a specific period, soft loan from financial institutions, subsidy in electricity charges and investment subsidy. Some of these incentives may tempt to locate the plant to avail these facilities offered.

- **Labour and wages:**

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

- **Community infrastructure and amenity:**

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

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

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

- **Supporting industries and services:**

Now a day the manufacturing organization will not make all the components and parts by itself and it subcontracts the work to vendors. So, the source of supply of component parts will be the one of the factors that influences the location.

- **Proximity to Customers:**

Location is a key factor in determining how conveniently customers can carry on business with a firm. For example, few people would like to go to remotely located dry cleaner or supermarket if another is more convenient. Thus the influence of location on revenues tends to be the dominant factor.

- **Transportation Costs and Proximity to Markets:**

For warehousing and distribution operations, transportation costs and proximity to markets are extremely important. With a warehouse nearby, many firms can hold inventory closer to the customer, thus reducing delivery time and promoting sales.

- **Capital:**

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

- **Disposal of waste:**

Some industries such as chemical plants leather industries, steel and plants etc, have the problem of disposal of effluents and the site selected should have provision for this availability of power is essential for any manufacturing firm coal and oil natural gas are sources of electric power in means a firm can gain one type of location benefit by giving up another.

- **Quality of life:**

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

- **Proximity to suppliers and resources:**

In many companies, plants supply parts to other facilities or rely on other facilities for management and staff support. These require frequent coordination and communication, which can become more difficult as distance increases. There are some other factors needed to be considered, including room for expansion, construction costs, accessibility to multiple modes of transportation, the cost of shuffling people and materials between plants, competition from other firms for the workforce, community attitudes, and many others. For global operations, firms are emphasizing local employee skills and education and the local infrastructure

Various models are available which help to identify the ideal location. Some of the popular models are:

- Factor rating method
- Weighted factor rating method
- Load-distance method
- Centre of gravity method
- Break even analysis

The process of selecting a new facility location involves a series of following steps:

- Identify the important location factors.
- Rate each factor according to its relative importance, *i.e.*, higher the ratings is indicative of prominent factor.
- Assign each location according to the merits of the location for each factor.
- Calculate the rating for each location by multiplying factor assigned to each location with basic factors considered.
- Find the sum of product calculated for each factor and select best location having highest total score.

LOCATION PROBLEM

The plant location should be based on the company‘s expansion plan and policy, diversification plan for the products, changing market conditions, the changing sources of raw materials and many other factors that influence the choice of the location decision. The purpose of the location study is to find an optimum location one that will result in the greatest advantage to the organization.

ILLUSTRATION 1:

Let us assume that a new medical facility, Health-care, is to be located in Delhi. The location factors, factor rating and scores for two potential sites are shown in the following table. Which is the best location based on factor rating method?

Sl. No.	*Location factor*	*Factor rating*	*Rating*	
			Location 1	*Location 2*
1.	Facility utilization	8	3	5
2.	Total patient per month	5	4	3
3.	Average time per emergency trip	6	4	5
4.	Land and construction costs	3	1	2
5.	Employee preferences	5	5	3

SOLUTION:

Sl. No.	*Location factor*	*Factor rating* (*1*)	*Location 1*		*Location 2*	
			(Rating) (*2*)	*Total=* (*1*) . (*2*)	*(Rating)* (*3*)	*Total* = (*1*) . (*3*)
1.	Facility utilization	8	3	24	5	40
2.	Total patient per month	5	4	20	3	15
3.	Average time per emergency trip	6	4	24	5	30
4.	Land and construction costs	3	1	3	2	6
5.	Employee preferences	5	5	25	3	15
			Total	96	Total	106

Result:

- **The total score for location 2 is higher than that of location 1.**
- **Hence location 2 is the best choice.**

In this method to merge quantitative and qualitative factors, factors are assigned weights based on relative importance and weightage score for each site using a preference matrix is calculated. The site with the highest weighted score is selected as the best choice.

ILLUSTRATION 2: *Let us assume that a new medical facility, Health-care, is to be located in Delhi. The location factors, weights, and scores (1 = poor, 5 = excellent) for two potential sites are shown in the following table. What is the weighted score for these sites? Which is the best location?*

Sl. No.	*Location factor*	*Weight*	*Scores*	
			Location 1	*Location 2*
1.	Facility utilization	25	3	5
2.	Total patient km per month	25	4	3
3.	Average time per emergency trip	25	3	3
4.	Land and construction costs	15	1	2
5.	Employee preferences	10	5	3

SOLUTION:

The weighted score for this particular site is calculated by multiplying each factors weight by its score and adding the results:

Weighed score location 1 = 25 × 3 + 25 × 4 + 25 × 3 + 15 × 1 + 10 × 5 = 75 + 100 + 75 + 15 + 50 = 315

Weighed score location 2 = 25 × 5 + 25 × 3 + 25 × 3 + 15 × 2 + 10 × 3= 125 + 75 + 75 + 30 + 30 = 335

Location 2 is the best site based on total weighted scores.

ILLUSTRATION 3:

From the following data select the most advantageous location for setting a plant for making transistor radios.

	Site X Rs.	*Site Y Rs.*	*Site Z Rs.*
(*i*) Total initial investment	2,00,000	2,00,000	2,00,000
(*ii*) Total expected sales	2,50,000	3,00,000	2,50,000
(*iii*) Distribution expenses	40,000	40,000	75,000
(*iv*) Raw material expenses	70,000	80,000	90,000
(*v*) Power and water supply expenses	40,000	30,000	20,000
(*vi*) Wages and salaries	20,000	25,000	20,000
(*vii*) Other expenses	25,000	40,000	30,000
(*viii*) Community attitude	Indifferent	Want business	Indifferent
(*ix*) Employee housing facilities	Poor	Excellent	Good

SOLUTION:

Total expenses	*Site X Rs.*	*Site Y Rs.*	*Site Z Rs.*
[Add (*iii*) (*iv*) (*v*) (*vi*) and (*vii*)]	1,95,000	2,15,000	2,35,000

$$\text{Rate of return (RoR), \%} = \frac{\text{Total sales} - \text{Total expenses}}{\text{Total investment}} \times 100$$

$$\text{RoR for Site X} = \frac{2,50,000 - 1,95,000}{2,00,000} \times 100$$

$$= \mathbf{27.5\%}$$

$$\text{RoR for Site Y} = \frac{3,00,000 - 2,15,000}{2,00,000} \times 100$$

$$= \mathbf{42.5\%}$$

$$\text{RoR for Site Z} = \frac{2,50,000 - 2,35,000}{2,00,000} \times 100$$

$$= \mathbf{7.5\%}$$

Location Y can be selected because of higher rate of return.

ILLUSTRATION 4:

The potential locations Chennai, Coimbatore and Madurai have the cost structure shown for producing telecommunication sets, expected to sell for Rs.90 find the best location for an expected volume of 1,850units /year.

SITE	FIXED COST/YEAR	VARIABLE COST/UNIT
Chennai	20,000	50
Coimbatore	40,000	30
Madurai	80,000	10

Solution:

Total cost = fixed cost +variable cost

Total cost at Chennai = 20,000 + (50*1,850) = 1, 12,500

Coimbatore = 40,000 + (30*1,850) = 95,000

Madurai = 80,000 + (10*1,850) = 98,500

Coimbatore is the best location profit = total revenue-total cost 90*1,850-95,500=71,000

RECENT TRENDS IN THE LOCATION OF INDUSTRIES

- **Priority for the suburban areas:**

The industrialists show their preference for the suburban area as the site for establishment of a new unit or relocation of the existing one. The industrial policy of the government does not permit the establishment of a new unit or expansion of an existing one in city areas. At the same time infrastructure facilities are developed in the sub urban areas.

- **Industrial development in the notified backward areas:**

In order to have balanced regional development, the Central Government as well as the State Government has notified certain backward areas Different types of incentives like cash subsidy, tax relief, financial assistance with low interest rates, cheaper land and power supply etc are provided. So, many such areas have been developed substantially in the recent times.

- **Decentralization of industries:**

Under the conscious industrial policy of the Government, concentration of industrial units is prevented through licensing policy. New units are not permitted to be started in certain industrially congested areas. Similarly, existing units either establish their additional plants in a less developed area or sometimes relocate the whole unit in such areas.

- **Competition between government and institutions:**

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

PLANT LAYOUT - CONCEPT

After deciding above the proper site for locating an industrial unit, next important point to be considered by an entrepreneur is to decide about the appropriate layout for the plant. Plant layout is primarily concerned with the internal set up of an enterprise in a proper manner. The concept of plant layout is not static but dynamic one. It is on account of continuous manufacturing and technological improvements taking place necessitating quick and immediate changes in production processes and designs. A new layout may be necessary because of technological changes in the products as well as simple change in processes, machines, methods and materials".

"Plant layout is the arrangement of machines, work areas and service areas within a factory". - George R. Terry.

"Plant layout involves the development of physical relationship among building, equipment and production operations, which will enable the manufacturing process to be carried on efficiently". - Morris E. Hurley.

Objectives of plant layout:

The primary objective of plant layout is to maximize production at minimum cost. The layout should be designed in such a way that it is flexible to change according to new processes and production techniques. The layout should be able to satisfy the needs of all those who are associated with the production system such as workers, supervisors, managers etc., to fulfill the above goals, the plant layout should be designed with the following objectives:

- Minimizing handling of materials.
- Maintaining flexibility of operations.
- Ensuring optimum utilization of men, materials, equipment and available space.
- Achieving good work flow and avoiding accumulation of work.
- Minimizing delays and bottlenecks in the production system.
- Ensuring safety of workmen by minimizing and eliminating the chances of accidents.
- Providing for effective supervision and production control.
- Minimizing work-in-process inventory.
- Providing sufficient and conveniently located service centres.
- Flexibility in design to adapt to the changing future requirements.

Need of Plant layout:

Many situations give rise to the problem of plant layout. Two plants having similar operations may not have identical layout. This may be due to size of the plant, nature of the process and management's caliber. The necessity of plant layout may be feeling and the problem may arise when.

- There are design changes in the product.
- There is an expansion of the enterprise.
- There is proposed variation in the size of the departments.
- Some new product is to be added to the existing line.
- Some new department is to be added to enterprise and there is reallocation of the existing department.
- A new plant is to be set up.

Principles of Plant Layout:

While designing the plant layout, the following principles must be kept in view:

- **Principle of minimum movement:** Materials and labor should be moved over minimum distances; saving cost and time of transportation and material handling.
- **Principle of space utilization:** All available cubic space should be effectively utilized – both horizontally and vertically.
- **Principle of flexibility:** Layout should be flexible enough to be adaptable to changes required by expansion or technological development.
- **Principle of interdependence:** Interdependent operations and processes should be located in close proximity to each other; to minimize product travel.
- **Principle of overall integration:** All the plant facilities and services should be fully integrated into a single operating unit; to minimize cost of production.
- **Principle of safety:** There should be in-built provision in the design of layout, to provide for comfort and safety of workers.
- **Principle of smooth flow:** The layout should be so designed as to reduce work bottlenecks and facilitate uninterrupted flow of work throughout the plant.
- **Principle of economy:** The layout should aim at effecting economy in terms of investment in fixed assets.
- **Principle of supervision:** A good layout should facilitate effective supervision over workers.
- **Principle of satisfaction:** A good layout should boost up employee morale, by providing them with maximum work satisfaction.

Types of Plant Layout:

Layouts can be classified into the following five categories:

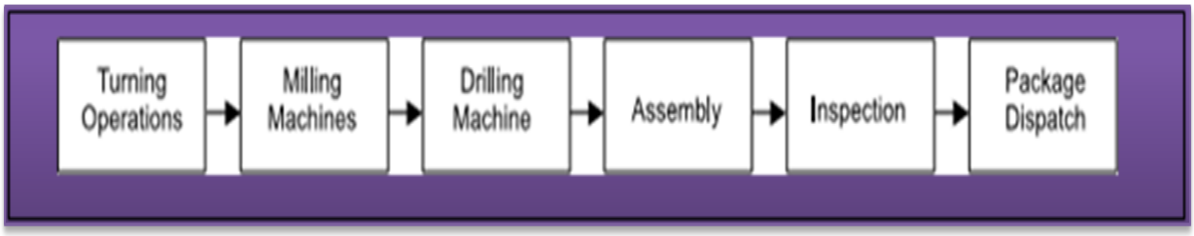
- Product layout
- Process layout
- Combination layout
- Fixed position layout
- Service Facility layout

- **Product Layout (or Line Layout):**

In this type of layout, all the machines are arranged in the sequence, as required to produce a specific product. It is called line layout because machines are arrange in a straight line. The raw materials are fed at one end and taken out as finished product to the other end. The raw material is supplied at one end of the line and goes from one operation to the next quite rapidly with a minimum work in process, storage and material handling.

Advantages offered by Product Layout:

(i) Lowers total material handling cost.



(ii) There is less work in processes.

(iii) Better utilization of men and machines,

(iv) Less floor area is occupied by material in transit and for temporary storages.

(v) Greater simplicity of production control.

(vi) Total production time is also minimized.

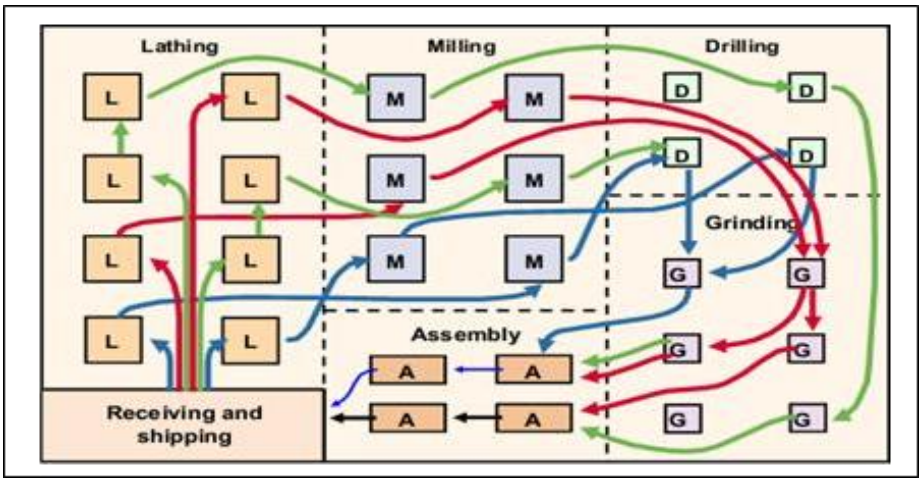
Limitations of Product Layout:

(i) No flexibility which is generally required is obtained in this layout.

(ii) The manufacturing cost increases with a fall in volume of production.

- **Process or Functional Layout:**

The process layout is particularly useful where low volume of production is needed. If the products are not standardized, the process layout is lower desirable, because it has creator process flexibility than other. In this type of layout, the machines and not arranged according to the sequence of operations but are arranged according to the nature or type of the operations. This layout is commonly suitable for non repetitive jobs.



Same type of operation facilities are grouped together such as lathes will be placed at one place; all the drill machines are at another place and so on. Therefore, the process carried out in that area is according to the machine available in that area.

Advantages of Process Layout:

(i) There will be less duplication of machines. Thus, total investment in equipment purchase will be reduced.

(ii) It offers better and more efficient supervision through specialization at various levels.

(iii) There is a greater flexibility in equipment and man power thus load distribution is easily controlled.

(iv) Better utilization of equipment available is possible.

(v) Break down of equipment can be easily handled by transferring work to another machine/work station.

(vi) There will be better control of complicated or precision processes, especially where much inspection is required.

Limitations of Process Layout:

(i) There are long material flow lines and hence the expensive handling is required.

(ii) Total production cycle time is more owing to long distances and waiting at various points.

(iii) Since more work is in queue and waiting for further operation hence bottle necks occur.

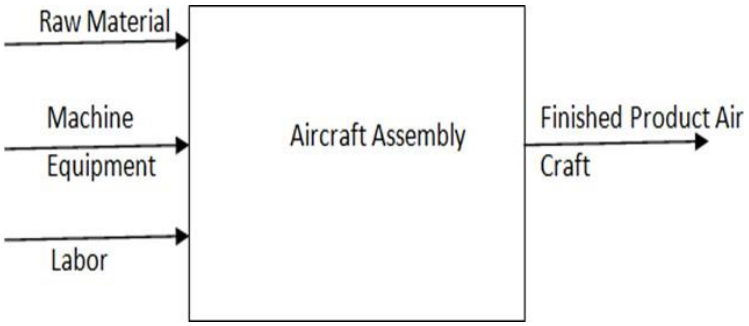
(iv) Generally, more floor area is required.

(v) Since work does not flow through definite lines, counting and scheduling is more tedious.

(vi) Specialization creates monotony and there will be difficult for the laid workers to find job in other industries.

- **Fixed Position Layout:**

This type of layout is the least important for today's manufacturing industries. In this type of layout the major component remain in a fixed location, other materials, parts, tools, machinery, man power and other supporting equipment's are brought to this location.



The major component or body of the product remain in a fixed position because it is too heavy or too big and as such it is economical and convenient to bring the necessary tools and equipment's to work place along with the man power. This type of layout is used in the manufacture of boilers, hydraulic and steam turbines and ships etc.

Advantages of Fixed Position Layout:

(i) Material movement is reduced.

(ii) Capital investment is minimized.

(iii) The task is usually done by gang of operators, hence continuity of operations is ensured.

(iv) Production centers are independent of each other. Hence, effective planning and loading can be made. Thus total production cost will be reduced.

(v) It offers greater flexibility and allows change in product design, product mix and production volume.

Limitations of Fixed Position Layout:

(i) Highly skilled man power is required.

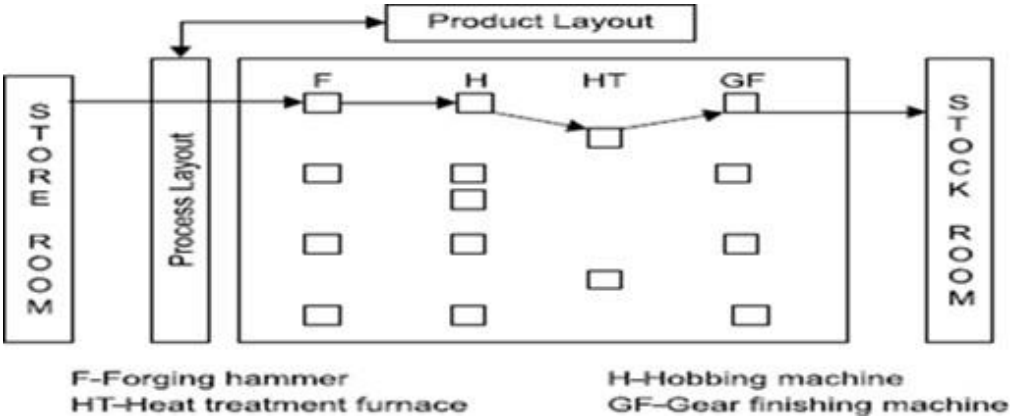
(ii) Movement of machines equipment's to production centre may be time consuming.

(iii) Complicated fixtures may be required for positioning of jobs and tools. This may increase the cost of production.

- **Combination Type of Layout:**

Now a day in pure state any one form of layouts discussed above is rarely found. Therefore, generally the layouts used in industries are the compromise of the above mentioned layouts. Every layout has got certain advantages and limitations. Therefore, industries would to like

use any type of layout as such. Flexibility is a very important factory, so layout should be such which can be molded according to the requirements of industry, without much investment. If the good features of all types of layouts are connected, a compromise solution can be obtained which will be more economical and flexible.



In practice, plants are rarely laid out either in product or process layout form. Generally a combination of the two basic layouts is employed; to derive the advantages of both systems of layout. For example, refrigerator manufacturing uses a combination layout.

Advantages:

- Component standardization rationalization.
- Effective machine operation and productivity.
- Customer service.
- It can decrease the paper work and overall production time.
- Work-in-progress and work movement

- **Service Facility Layout:**

Services facility layouts should provide for easy entrance to these facilities Large, well organized and well-designed walk ways to and from parking areas are some of the requirements of service requirements The fundamental difference between service facility and manufacturing facility layouts is that many service facilities exist together customers and services. Examples; Hospitals – processing of physical materials and production efficiency Banks - customer receiving and servicing function.

LAYOUT DESIGN PROCEDURE:

Layout design procedures can be classified into manual methods and computerized methods.

Manual methods: Under this category, there are some conventional methods like travel chart and Systematic Layout Planning (SLP).

Computerized methods: Under this method, again the layout design procedures can be classified in to constructive type algorithm and improvement type algorithms. Construction type algorithms Automated Layout Design program (ALDEP) Computerized Relationship Layout Planning (CORELAP) Improvement type Algorithm Computerized Relative Allocation of Facilities Technique (CRAFT).

Computerized Relative Allocation of Facilities Technique (CRAFT):

CRAFT algorithm was originally developed by Armour and Buffa. It is an improvement algorithm. It starts with an initial layout and improves the layout by interchanging the departments pairwise so that the transport cost is minimized. The algorithm continues until not further interchanges are possible to reduce the transportation cost. The result given by CRAFT is not optimum in terms of minimum cost of transportation. But the result will be good and close to optimum in majority of applications. Hence, CRAFT is mainly a heuristic algorithm. Unfortunately, plant layout problem comes under combinatorial category. So, usage of efficient heuristic like CRAFT is inevitable for such problem.

Features of CRAFT:

The major features of CRAFT are as listed below:

Attempts to minimize transportation cost, where **transportation cost = flow x distance x unit cost**. Required the assumptions that:

- Move costs are independent of the equipment utilization and
- Move costs are linearly related to the length of the move.

Distance matrix used in the rectilinear distance between department centroids. CRAFT being a path-oriented method, the final layout is dependent on the initial layout. Therefore, a number of different initial layouts should be used as input to the CRAFT layout. CRAFT allows the use of dummy departments to represent fixed areas in the layout.

CRAFT input requirements are:

- Initial layout.

- Flow data.
- Cost per unit distance.
- Total number of departments.
- Fixed departments and their location.
- Area of departments.

CRAFT Procedure:

The steps of CRAFT algorithm are summarized below:

Step1. Input: 1. Number of departments

2. Number of interchangeable departments
3. Initial layout
4. Cost matrix
5. Flow matrix (Load summary)
6. Area of departments.

Step2. Compute centroids of departments in the present layout.

Step3. Form distance matrix using the centroids.

Step4. Given data on flow, distance and cost, compute the total handling cost of the present layout.

Step5. Find all the possible pairwise interchanges of departments based on common border or equal area criterion. For each possibility, interchange the corresponding centroids and compute approximate costs.

Step6. Find the pair of departments corresponding to the minimum handling cost from among all the possible pairs of interchanges.

Step7. Is the cost in the previous step less than the total cost of the present layout? If yes, go to step 8. If not, go to step 11.

Step8. Interchange the selected pair of departments. Call this as the NEW LAYOUT. Compute centroids, distance matrix and total cost.

Step9. Is the cost of new layout less than the cost of the present layout? If yes, go to Step 10. If not, go to step 11.

Step10. The new layout is here after considered as the PRESENT LAYOUT. Its data on centroids, layout matrix and the total cost is retained. Go to step5.

Step11. Print the present layout as the FINAL LAYOUT.

Step12. Stop.

AUTOMATED LAYOUT DESIGN PROGRAM (ALDEP)

Now we will examine Automated Layout Design Program (ALDEP).ALDEP is basically a construction algorithm but it can also be used to evaluate two layouts. The algorithm uses basic data on facilities and builds a layout by successively placing the layout using relationship information between the departments.

The basic inputs to ALDEP are;

- Length and width of facility.
- Area of each department.
- Minimum closeness preference (MCP) value.
- Sweep width.
- Relationship chart showing the closeness rating.
- Location and size of any restricted area.

The procedures adopted for using ALDEP are:

Step 1: Input the following: 1. Length and width of facility.
2. Area of each department.
3. Minimum closeness preference (MCP) value.
4. Sweep width.
5. Relationship chart showing the Closeness rating.
6. Location and size of restricted area.

Step 2: One department is selected randomly and placed in the layout.

Step 3: In this step, the algorithm uses minimum closeness required between departments for the selection of departments to be placed with an earlier placed department. Select the department having maximum closeness rating. If there is no department having minimum closeness preference, then any department that remains to be placed is selected.

Step 4: If all the departments are placed in the layout, go to step 5. Else, go to step 3.

Step 5: Compute the total score of the layout.

Step 6: If the total score required is the acceptable score, then go to step7, else go tostep2.

Step 7: Print the current layout and the corresponding score.

Computerized Relationship Layout Planning (CORELAP)

This algorithm is based on Muther's procedure given in systematic Layout Planning. A computer algorithm was developed by R.C. Lee. Interactive version was developed by James

Moore.

Input requirements;

- Number of departments and their area.
- Closeness relationship as given by REL-chart.
- Weighted rating for REL-chart entries. Optional input information
- Scale of output.
- Building length to width ratio.
- Department pre-assignment.

General approach is to select the most critical department first, and place it at the centre of the layout. After the first department is placed, then the department having highest closeness relationship with the department which is already placed is selected and placed in the best location adjacent to the previously placed departments. CORELAP builds the layout from centre. The final layout will not have a regular rectangular shape. The user has to modify it slightly to suit the situation. Final score of the layout is developed by using the closeness values and rectilinear distances between all pairs of the departments.

CORELAP algorithm: the following are the major steps of CORELAP algorithm.

- Defining basic data.
- Determination of placement of order.
- Placement of departments in the layout.
- Finding the total score of the layout.

LINE BALANCING is useful tool. Line-balancing strategy is to make production lines stretchy enough to absorb external and internal indiscretion. This strategy involves setting a planned rate of production for necessary materials to be fabricated within a particular time frame.

Additionally, successful line balancing requires assuring that every line segment's production quota can be met within the time frame using the available production capacity. This is an efficient device to develop the throughput of assembly lines and work cells while decreasing manpower requirements and expenses. Line-balancing is slightly different from assembly line balancing. There are two types of line balancing that include Static Balance and Dynamic Balance. Static Balance denotes long-term differences in capacity over a period of several hours or longer. Static imbalance results in underutilization of workstations, machines and people. Dynamic Balance refers to short-term differences in capacity such as over a period of

minutes, hours at most. Dynamic imbalance occurs from product mix changes and difference in work time dissimilar to product mix. The intent of Line balancing is to match the output rate to the production plan. This will help organization to make sure on-time delivery and avoids build-up of surplus inventory.

Line balancing operates under two circumstances:

Precedence Constraint: Products cannot progress to other station if it doesn‘t complete necessary task at that station. It should not across other station because certain part needs to be performed before other activities.

Cycle time Restriction: Cycle time is maximum time for products spend in every workstation. Different workstation has different cycle time.

Objective of Line Balancing: Following are major objectives of Line balancing procedure. It is used to:

- Manage the workloads among assemblers.
- Recognize the location of bottleneck.
- Decide number of workstation.
- Decrease production cost.
- Assigning task to each work station in such a way that there is little idle time.

Steps in Solving Line Balancing

There are four steps in solving line balancing

a. Drawing Precedence Diagram: Precedence diagram needs to be drawn to demonstrate a relationship between workstations. Certain process begins when previous process was done.

b. Determining Cycle Time: Cycle time is longest time allowed at each station. This can be expressed by this formula:

$$\text{Cycle time} = \frac{\text{Available time}}{\text{Desired output}}$$

This means the products need to leave the workstations before it reaches its cycle time.

c. Assigning tasks to workstation: The tasks distributions should be taken after completing a time cycle. It‘s good to allocate tasks to workstation in the order of longest task times.

$$\text{Number of work Stations} = \frac{\sum \text{ Task Time}}{\text{Desired Actual Time}}$$

d. Calculating an Efficiency Line: This is done to find effectiveness of the line. The formula is given by:

$$\text{Line Efficiency} = \frac{\text{Sum of task times}}{\text{Number of workstation X Desired cycle time}}$$

ASSEMBLY LINE BALANCING involved the action of assembles different parts together. It involves many production lines while normal Line-balancing may only involve one production line.

Assembly Line Balancing is the problem of assigning operations to workstations along an assembly line, in such a way that the assignment be best in some sense. Since introduction of assembly lines by Henry Ford, Line-balancing has been an optimization problem of important industrial importance. The efficiency difference between an optimal and a sub-optimal assignment can yield economies reaching huge amount per year. Line balancing technique was used normally in assembly line of the automotive industry which is called ALB. Most of the Small and Medium Industries do not use line balancing method in the production line.

What is Ranked Positional Weight Method: It is a method used for line development and balancing. It takes into account the precedence relationships as well as processing time of all tasks.

Ranked Positional Weight (RPW)

Step 1 - Calculate the weight of the position of each work elements.

Step 2 - Sort the elements according to the weight of the position of the largest to the smallest.

Step 3 – calculate the cycle time.

Step 4 – place the working element with the greatest weight on all the workstations do not violate precedence relationships and time station does not exceed the cycle time.
Step 5 – Repeat step 4, until all the elements are placed.
Step 6 - After forming a work station consisting of its elements, and then specify the value of efficient, balance delay, and its smoothest index.

COMSOAL: Today's highly competitive market influences the manufacturing industry to improve their production systems to become the optimal system in the shortest cycle time as possible. One of most common problems in manufacturing systems is the assembly line balancing problem. The assembly line balancing problem involves task assignments to workstations with optimum line efficiency. The line balancing technique, namely "COMSOAL", is an abbreviation of "Computer Method for Sequencing Operations for Assembly Lines". Arcus initially developed the COMSOAL technique in 1966, and it has been mainly applied to solve assembly line balancing problems. The most common purposes of COMSOAL are to minimize idle time, optimize production line efficiency, and minimize the number of workstations.

Objectives that should be gained balancing an assembly line are as follows;

- Regular material flow.
- Maximum usage of man power and machine capacity.
- Minimum process times.
- Minimizing slack times
- Minimizing workstations.
- Distribute slack times to workstations.
- Reduce production costs.

COMSOAL - PROCEDURE

1. The first step is creating the table, which presents all activities lists in order, considering by precedence relationships.
2. Secondly, selecting the available activities from the table that has no predecessor task, in other words all predecessor tasks of considering activity need to be finished.
3. Creating the available activities list.
4. Choosing activities from the available lists to the workstation until the total processing

time of all activities in the workstation is nearly or equal to the given cycle time.

5. The next step is recreating the new available activity list.

6. Repeating steps 2-5 until all activities are assigned into workstations.

7. The final step is keeping the possible solution and then repeating steps 1-5 to find the alternative solution, until the best solution is obtained.

SCHOOL OF BUSINESS ADMINISTRATION

I MBA – II SEMESTER

SBAA5204 – OPERATIONS MANAGEMENT – QUESTION BANK

UNIT – III

PART – A

<table>
<tr><th>S. No</th><th>Questions (5 marks)</th><th>CO</th><th>Level</th></tr>
<tr><td>1</td><td>Explain the objectives of plant location.</td><td>CO3</td><td>L2</td></tr>
<tr><td>2</td><td>Explain the recent trends in the location of industry.</td><td>CO3</td><td>L4</td></tr>
<tr><td>3</td><td>List out the plant layout benefits.</td><td>CO3</td><td>L4</td></tr>
<tr><td>4</td><td>Bring out features of CORELAP.</td><td>CO3</td><td>L3</td></tr>
<tr><td>5</td><td>TVS group of companies; manufactures of auto spares choose three factors and four sites.
<table><tr><td rowspan="2">Factor</td><td colspan="4">Potential sites</td></tr><tr><td>S1</td><td>S2</td><td>S3</td><td>S4</td></tr><tr><td>F1</td><td>3</td><td>6</td><td>8</td><td>2</td></tr><tr><td>F2</td><td>4</td><td>5</td><td>9</td><td>3</td></tr><tr><td>F3</td><td>7</td><td>2</td><td>6</td><td>3</td></tr></table>The sites were assigned ratings between 0-10 points against each factor; the sum of the site ratings was used to compare it with other sites.</td><td>CO3</td><td>L3</td></tr>
<tr><td>6</td><td>List out the advantages for process layout.</td><td>CO3</td><td>L2</td></tr>
<tr><td>7</td><td>Recall a short note on ranked positional weight method.</td><td>CO3</td><td>L3</td></tr>
<tr><td>8</td><td>Brief fixed position layout.</td><td>CO3</td><td>L3</td></tr>
<tr><td>9</td><td>“Layout expansion is very easy compared to layout revision”. Explain.</td><td>CO3</td><td>L4</td></tr>
<tr><td>10</td><td>Comsoal- give abbreviation and its objectives.</td><td>CO3</td><td>L4</td></tr>
</table>

PART – B

S. NO	Questions (10 marks)	CO	Level
1	Illustrate and explain the types of layout.	CO3	L5
2	Summarizes factors affecting in quantitative factors in plant location.	CO3	L4
3	Analysis the merits and demerits of locating a plant in sub urban area.	CO3	L4
4	Elucidate the procedure for CRAFT.	CO3	L4
5	Enumerate the procedure adopted for using ALDEP.	CO3	L5
6	Elaborate line balancing operates in two different circumstances.	CO3	L5

PART – C

CASE STUDY – (20 marks)

S. No	Questions (20 marks)	CO	Level
1	Alpha a four-wheeler company is a leading company in the south manufacturing chassis of bus/lorry in 600 acres of land with 3000 employees. The annual production capacity of the plant is 6000 chassis; The market research department projected its future demand to be 2.5 times the present capacity of the plant. So, the company took a decision to set up another plant in the north with a capacity of 75,000 chassis. It is in the process of procurement of the required land of 1,000 acres. The projected number of employees in the new factory would be 4,000. The productivity of any company mainly depends on the type of layout that is used to carry-out the activities to produce the product. so, the industrial engineering department of the exiting company is given the task of design the righty type of layout for the new company, All the sections of the automobile company will not have the same type of layout. The final assembly of chassis is done on a powered conveyer belt. This part of the company uses product layout which assembles the necessary subassemblies and components to form a full chassis. Questions: a .What do you suggest to Alpha company about this problem ?	CO3	L6

<table>
<tr><td></td><td>b. What is suitable layout for Alpha company to extend?</td><td></td><td></td></tr>
<tr><td>2</td><td>A company has to decide on location of a new plant. It has three locations A, B and C whose data is furnished below. Use a suitable criterion to advice the company on the best choice.
<table>
<tr><td></td><td colspan="3">Locations</td></tr>
<tr><td>Data</td><td>A (Rs.)</td><td>B (Rs.)</td><td>C(Rs.)</td></tr>
<tr><td>Wages and salaries</td><td>20,000</td><td>20,000</td><td>20,000</td></tr>
<tr><td>Power & water supply</td><td>20,000</td><td>30,000</td><td>25,000</td></tr>
<tr><td>Raw materials</td><td>80,000</td><td>75,000</td><td>60,000</td></tr>
<tr><td>Total initial investment</td><td>2,00,000</td><td>3,00,000</td><td>2,50,000</td></tr>
<tr><td>Distribution expenses</td><td>50,000</td><td>40,000</td><td>60,000</td></tr>
<tr><td>Miscellaneous expenses</td><td>40,000</td><td>25,000</td><td>30,000</td></tr>
<tr><td>Expected sales per year</td><td>2,25,000</td><td>2,50,000</td><td>2,25,000</td></tr>
</table></td><td>CO3</td><td>L6</td></tr>
</table>

TEXT / REFERENCE BOOKS

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SCHOOL OF MANAGEMENT STUDIES

UNIT – IV – OPERATIONS MANAGEMENT– SBAA5204

IV. QUALITY CONTROL

Quality Control – Objectives, Importance, Quality Control Techniques – Control Charts - $\bar{x}$ Chart, R Chart, P Chart, C Chart – Acceptance Sampling – Work Study – Method Study, Time Study - Human factors in job design – Ergonomics – Work Environment and Workers Safety.

QUALITY CONTROL - CONCEPT

Quality does not mean the quality of manufactured product only. It may refer to the quality of the process (i.e., men, material, and machines) and even that of management. Where the quality manufactured product referred as or defined as, "Quality of product as the degree in which it fulfills the requirement of the customer. It is not absolute but it judged or realized by comparing it with some standards".

Quality begins with the design of a product in accordance with the customer specification further it involved the established measurement standards, the use of proper material, selection of suitable manufacturing process etc., quality is a relative term and it is generally used with reference to the end use of the product.

Crosby defined as, "Quality is conformance to requirement or specifications".

Juran defined as, "Quality is fitness for use". The Quality of a product or service is the fitness of that product or service for meeting or exceeding its intended use as required by the customer.

Quality Control (QC) may be defined as, "a system that is used to maintain a desired level of quality in a product or service". It is a systematic control of various factors that affect the quality of the product. It depends on materials, tools, machines, type of labor, working conditions etc.

QC is a broad term, it involves inspection at particular stage but mere inspection does not mean QC. As opposed to inspection, in quality control activity emphasis is placed on the quality future production. Quality control aims at prevention of defects at the source, relies on effective feedback system and corrective action procedure. Quality control uses inspection as a valuable tool.

According to Juran, "Quality control is the regulatory process through which we measure actual quality performance, compare it with standards, and act on the difference".

Another definition of quality control is from ANSI/ASQC standard (1978) quality control is defined as, "The operational techniques and the activities which sustain a quality of

product or service that will satisfy given needs; also the use of such techniques and activities".

Alford and Beatty define QC as, "In the broad sense, quality control is the mechanism by which products are made to measure up to specifications determined from customers, demands and transformed into sales engineering and manufacturing requirements, it is concerned with making things right rather than discovering and rejecting those made wrong".

Objectives of Quality Control:

The objectives of quality control may be stated as follows:

1. To take the necessary corrective steps to keep the quality of the product from dropping below the desired level during manufacturing.
2. To analyze the trend and extent of quality deviation in a part or product during manufacture and to determine the cause of such deviation by statistical techniques when it cannot reasonably be attributed to chance.
3. To avoid as far as reasonably possible, having products reach the customer which are of lower quality than that which is considered acceptable.
4. To establish standards of quality those are readily acceptable to the customer and economical to maintain.

Some of the importance or benefits of quality control are:

- Encourages quality consciousness
- Satisfaction of consumers
- Reduction in production cost
- Most effective utilization of resources.
- Reduction in inspection costs
- Increased goodwill
- Higher morale of employees
- Improved employer-employee relations
- Improved techniques and methods of production
- Facilitates price fixation
- Increased sales

STATISTICAL QUALITY CONTROL - CONCEPT

In the highly competitive market today, the main objective of manufacturers or producers is to achieve quality assurance in manufacturing and service organizations. In order to achieve this objective, different statistical tools have been developed, which are useful for controlling the quality of products vis-avis the specifications or standard. The technique of using statistical tools for controlling product quality vis-a-vis the specifications is known as Statistical Quality Control (SQC).

Statistical quality control is defined as the technique of applying statistical methods based on the theory of probability and sampling to establish quality standard and to maintain it in the most economical manner.

Elements of SQC:

The following are the main elements of SQC:

a) Sample Inspection: We know that 100% inspection needs huge expenditure of time, money, labor and resources. Further, if the nature of the product is such that it is completely destroyed during the process of inspection, e.g., a bulb, candle, ammunition, food, etc., 100% inspection is not practicable. Therefore, SQC is based on sampling inspection. In sampling inspection method, some items or units (called sample) are randomly selected from the process and then each and every unit of the sample is inspected.

b) Use of Statistical Methods: Some commonly used statistical tools such as random sampling, mean, range, standard deviation, mean deviation, standard error and concepts such as probability, binomial distribution, Poisson distribution, normal distribution, etc., are used in SQC. Since, quality control method involves extensive use of statistics; it is termed as Statistical Quality Control.

c) Fundamental Objective: The fundamental objective of SQC is to decide whether the unit produced is according to its specifications or not. If the unit produced is not according to its specifications and there is a variation in quality, it becomes necessary to trace the causes of variation and eliminate them if possible.

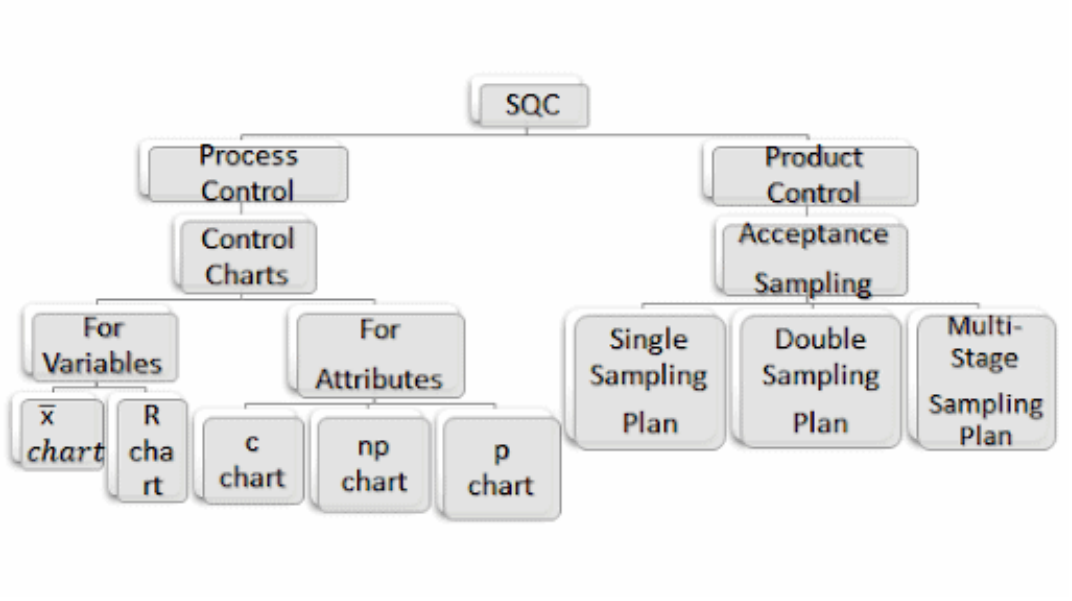
d) Decision Making: With the help of SQC, we decide whether the quality of the product or the process of manufacturing/producing goods is under control or not.

e) Specifications, Production and Inspection: SQC method helps in deciding about the specifications, production and inspection of a product.

Techniques of Statistical Quality Control:

The important techniques used for statistical quality control can be broadly classified into two categories:

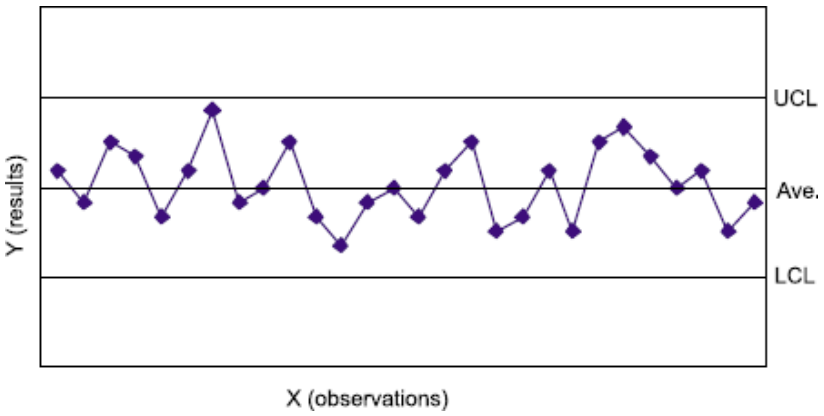
- Statistical Process Control (SPC) or simply Process Control, and
- Product Control.



CONTROL CHARTS

It distinguishes special causes of variations from common causes of variation. They are used to monitor and control process on an ongoing basis. A typical control chart plots a selected quality characteristic found from sub-group of observations as a function of sample number. Characteristics such as sample average, sample range and sample proportion of non-conforming units are plotted. The centre line on a control chart represents the average value of characteristics being plotted. Two limits know as the upper control limit (UCL) and lower control limit (LCL) are also shown on control charts. These limits are constructed so that if the process is operating under a stable system of chance causes, the problem of an observation falling outside these limits is quite small.

Control chart shows the performance of a process from two points of view. First, they show a snapshot of the process at the moment the data are collected. Second, they show the process trend as time progresses. Process trends are important because they help in identifying the out of- control status if it actually exists. Also, they help to detect variations outside the normal operational limits, and to identify the cause of variations.



Objectives of Control Charts:

- To secure information to be used in establishing or changing specifications or in determining whether the process can meet specifications or not.
- To secure information to be used on establishing or changing production procedures.
- To secure information to be used on establishing or changing inspection procedures or acceptance procedures or both.
- To provide a basis for current decision during production.
- To provide a basis for current decisions on acceptance for rejection of manufacturing or purchased product.
- To familiarize personnel with the use of control chart.

Characteristics of Control Charts:

A control chart is a time-ordered diagram to monitor a quality characteristic, consisting of:

- A nominal value, or centre line, the average of several past samples.
- Two control limits used to judge whether action is required, an upper control limit (UCL) and a lower control limit (LCL).
- Data points, each consisting of the average measurement calculated from a sample taken from the process, ordered overtime. By the Central Limit Theorem, regardless of the distribution of the underlying individual measurements, the distribution of the sample means will follow a normal distribution. The control limits are set based on the sampling distribution of the quality measurement

Benefits of Using Control Charts:

Following are the benefits of control charts:

- A control chart indicates when something may be wrong, so that corrective action can

be taken.

- The patterns of the plot on a control chart diagnosis possible cause and hence indicate possible remedial actions.
- It can estimate the process capability of process.
- It provides useful information regarding actions to take for quality improvement.

ACCEPTANCE SAMPLING:

This is another technique of statistical quality control. This is also referred as 'Sampling Inspection plan.' This method is usually followed after goods have been produced or are in the final stage of production. Thus, it can be said that it is a post mortem of the quality of the product that has already been produced.

Under this method, a sample of the product produced is selected at random to study in detail whether the product conforms to the pre-determined standards or not. A limited percentage of defective products are allowed. But it has been observed that sometimes the sample selected turns out to be good, but the lot represented by the sample may be defective or sub-standard. In order to have more accurate and exact results, more than one sample of the product should be selected for carrying out the Sampling Inspection Plan.

The technique Acceptance Sampling undertakes two limiting levels of quality namely;

- **The Acceptable Quality Level (AQL)** i.e. the least number or percentage of defective products that the buyer expects to purchase and the seller expects to sell and
- **The Lot Percentage Tolerance Defective (LPTD)** refers to that limit where the buyer wants to be certain about the rejection of the lot.

This technique can be greatly helpful for improving relations between vendor and the customer which may be adverse on account of disputes relating to quality. Both the parties may sit together and mutually decide the limits within which quality should be accepted.

Advantages of Statistical Quality Control:

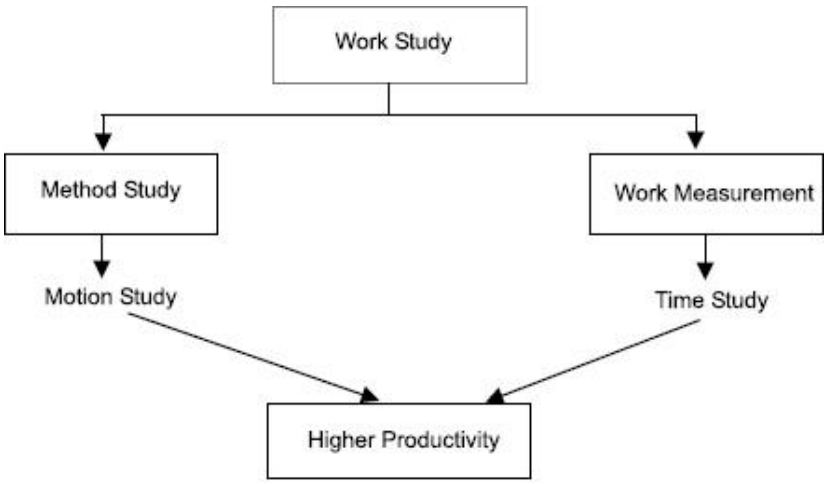
Following are the important benefits derived from the technique of statistical qualify control:

- **Lesser cost of inspection:** Statistical quality control is based on sampling technique which involves lesser cost of inspection thereby cost of production is considerably reduced.

- **Increase in profits:** By minimizing rejections, statistical quality control ensures the production of standard products which bring higher profits for the producer.
- **Setting tolerance limits:** Quality control charts clearly lay down the tolerances limits beyond which the product is to be rejected. The results shown by these charts are more authentic and correct.
- **Develops quality consciousness:** Statistical quality control is greatly helpful in developing the feeling of quality consciousness among the workers working in an organisation. This improves their functioning and reduces the number of defective operations undertaken by them,
- **Enhances reputation of the concern:** By adopting the techniques of statistical quality control, pre-determined quality of the product is achieved and consumers get desired quality products. This brings good name to the firm and increases its goodwill among the people.
- **Improved relations between vendor and customers:** It is greatly helpful in improving relations between supplier and the purchaser of material, by clearly fixing the tolerance limits with regard to quality of the goods supplied. This minimizes the possibility of any dispute between both the parties.

WORK STUDY - CONCEPT

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



Work study is a means of enhancing the production efficiency (productivity) of the firm by elimination of waste and unnecessary operations. It is a technique to identify non-value adding operations by investigation of all the factors affecting the job. It is the only accurate and systematic procedure oriented technique to establish time standards. It is going to contribute to the profit as the savings will start immediately and continue throughout the life of the product. Method study and work measurement is part of work study. Part of method study is motion study; work measurement is also called by the name 'Time study'.

Advantages of work study:

- It helps to achieve the smooth production flow with minimum interruptions.
- It helps to reduce the cost of the product by eliminating waste and unnecessary operations.
- Better worker-management relations.
- Meets the delivery commitment.
- Reduction in rejections and scrap and higher utilization of resources of the organization.
- Helps to achieve better working conditions.
- Better workplace layout.
- Improves upon the existing process or methods and helps in standardization and Simplification.
- Helps to establish the standard time for an operation or job which has got application in manpower planning, production planning.

Method study – Concept:

Method study enables the industrial engineer to subject each operation to systematic analysis. The main purpose of method study is to eliminate the unnecessary operations and to achieve the best method of performing the operation.

Method study is also called methods engineering or work design. Method engineering is used to describe collection of analysis techniques which focus on improving the effectiveness of men and machines.

According to British Standards Institution (BS 3138), "Method study is the systematic recording and critical examination or existing and proposed ways or doing work as a means or developing and applying easier and more effective methods and reducing cost."

Fundamentally method study involves the breakdown of an operation or procedure into its component elements and their systematic analysis. In carrying out the method study, the right attitude of mind is important.

The method study man should have:

- The desire and determination to produce results.
- Ability to achieve results.
- An understanding of the human factors involved.

Method study scope lies in improving work methods through process and operation analysis, such as:

- Manufacturing operations and their sequence.
- Workmen.
- Materials, tools and gauges.
- Layout of physical facilities and work station design.
- Movement of men and material handling.
- Work environment

Symbols used in method study:

Graphical method of recording was originated by Gilberth, in order to make the presentation of the facts clearly without any ambiguity and to enable to grasp them quickly and clearly. It is useful to use symbols instead of written description.

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

The improvement in efficiency is achieved through:

- Improved layout and design of workplace.
- Improved and efficient work procedures.
- Effective utilization of men, machines and materials.
- Improved design or specification of the final product.

Objectives of method study techniques are:

- To improve work methods and procedures.
- To determine the best sequence of doing work.
- To smoothen material flow with minimum of back tracking and to improve layout.
- To improve the working conditions and hence to improve labor efficiency.
- To reduce monotony in the work.
- To improve plant utilization and material utilization.
- Elimination of waste and unproductive operations.
- To reduce the manufacturing costs through reducing cycle time of operations.

The basic approach to method study consists of the following eight steps.

SELECT the work to be studied and define its boundaries.

RECORD the relevant facts about the job by direct observation and collect such additional data as may be needed from appropriate sources.

EXAMINE the way the job is being performed and challenge its purpose, place sequence and method of performance.

DEVELOP the most practical, economic and effective method, drawing on the contributions of those concerned.

EVALUATE different alternatives to developing a new improved method comparing the cost-effectiveness of the selected new method with the current method with the current method of performance.

DEFINE the new method, as a result, in a clear manner and present it to those concerned, i.e., management, supervisors and workers.

INSTALL the new method as a standard practice and train the persons involved in applying it.

MAINTAIN the new method and introduce control procedures to prevent a drifting back to the previous method of work.

Considerations for selection of method study:

The job should be selected for the method study based upon the following considerations:

- **Economic aspect:** The method study involves cost and time. If sufficient returns are not attained, the whole exercise will go waste. Thus, the money spent should be justified by the savings from it.

The following guidelines can be used for selecting a job:

- ✓ Bottleneck operations which are holding up other production operations.
- ✓ Operations involving excessive labor.
- ✓ Operations producing lot of scrap or defectives.
- ✓ Operations having poor utilization of resources.
- ✓ Backtracking of materials and excessive movement of materials.

- **Technical Aspects:** The method study man should be careful enough to select a job in which he has the technical knowledge and expertise. A person selecting a job in his area of expertise is going to do full justice.
- ✓ Other factors which favor selection in technical aspect are:
- ✓ Job having in consistent quality.
- ✓ Operations generating lot of scraps.
- ✓ Frequent complaints from workers regarding the job.

- **Human Considerations:** Method study means a change as it is going to affect the way in which the job is done presently and is not fully accepted by workman and the

union. Human considerations play a vital role in method study. **These are some of the situations where human aspect should be given due importance:**

- ✓ Workers complaining about unnecessary and tiring work.
- ✓ More frequency of accidents.
- ✓ Inconsistent earning.

WORK MEASUREMENT – CONCEPT:

Work measurement is also called by the name 'time study'. Work measurement is absolutely essential for both the planning and control of operations. Without measurement data, we cannot determine the capacity of facilities or it is not possible to quote delivery dates or costs. We are not in a position to determine the rate of production and also labor utilization and efficiency. It may not be possible to introduce incentive schemes and standard costs for budget control.

Objectives of Work Measurement:

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

- Comparing alternative methods.
- Assessing the correct initial manning (manpower requirement planning).
- Planning and control.
- Realistic costing.
- Financial incentive schemes.
- Delivery date of goods.
- Cost reduction and cost control.
- Identifying substandard workers.
- Training new employees.

Techniques of Work Measurement:

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

Repetitive work: The type of work in which the main operation or group of operations repeat continuously during the time spent at the job. These apply to work cycles of extremely short duration.

Non-repetitive work: It includes some type of maintenance and construction work, where the work cycle itself is hardly ever repeated identically.

Various techniques of work measurement are:

- Time study (stop watch technique),
- Synthesis,
- Work sampling,
- Predetermined motion and time study,
- Analytical estimating.

Time study and work sampling involve direct observation and the remaining are data based and analytical in nature.

Time study: A work measurement technique for recording the times and rates of working for the elements of a specified job carried out under specified conditions and for analyzing the data so as to determine the time necessary for carrying out the job at the defined level of performance. In other words measuring the time through stop watch is called time study.

Synthetic data: A work measurement technique for building up the time for a job or pans of the job at a defined level of performance by totaling element times obtained previously from time studies on other jobs containing the elements concerned or from synthetic data.

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

Predetermined motion time study (PMTS): A work measurement technique whereby times established for basic human motions (classified according to the nature of the motion and conditions under which it is made) are used to build up the time for a job at the defined level of performance. The most commonly used PMTS is known as Methods Time Measurement (MTM).

Analytical estimating: A work measurement technique, being a development of estimating, whereby the time required to carry out elements of a job at a defined level of performance is estimated partly from knowledge and practical experience of the elements concerned and partly from synthetic data.

Time study – concept:

Time study is also called work measurement. It is essential for both planning and control of operations. According to British Standard Institute time study has been defined as "The application of techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance."

Steps in Making Time Study:

Stop watch time is the basic technique for determining accurate time standards. They are economical for repetitive type of work. Steps in taking the time study are:

Select the work to be studied. **Obtain and record** all the information available about the job, the operator and the working conditions likely to affect the time study work. **Breakdown** the operation in to elements. An element is an instinct part of a specified activity composed of one or more fundamental motions selected for convenience of observation and timing. **Measure** the time by means of a stop watch taken by the operator to perform each element of the operation. Either continuous method or snap back method of timing could be used. At the same time, assess the operator's effective speed of work relative to the observer's concept of **'normal'** speed. This is called **performance rating**.

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

$$\text{Normal} = \frac{\text{Observed time} * \text{Rating}}{100}$$

Add the **suitable allowances** to compensate for fatigue, personal needs, and contingencies, to give **standard time** for each element. Compute **allowed time** for the entire job by adding elemental standard times considering frequency of occurrence of each element. Make a detailed job description describing the method for which the standard time is established.

Standard time is the time allowed to an operator to carry out the specified task under specified conditions and defined level of performance. The various allowances are added to the normal time as applicable to get the standard time.

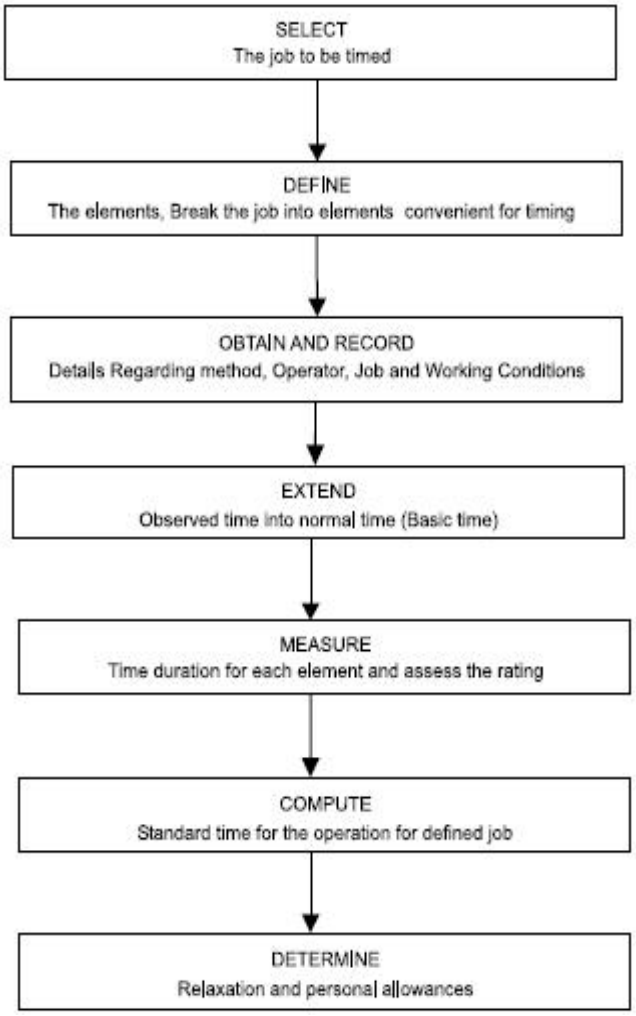
Standard time may be defined as the, amount of time required to complete a unit of work:

- Under existing working conditions,
- Using the specified method and machinery,
- By an operator, able to the work in a proper manner, and
- At a standard pace.

Thus basic constituents of standard time are:

- Elemental (observed time).
- Performance rating to compensate for difference in pace of working.
- Relaxation allowance.
- Interference and contingency allowance.

Steps in time and motion study:



Allowances – concept:

The normal time for an operation does not contain any allowances for the worker. It is impossible to work throughout the day even though the most practicable, effective method has been developed. Even under the best working method situation, the job will still demand the expenditure of human effort and some allowance must therefore be made for recovery

from fatigue and for relaxation. Allowances must also be made to enable the worker to attend to his personal needs.

The allowances are categorized as:

- Relaxation allowance,
- Interference allowance, and
- Contingency allowance.

RELAXATION ALLOWANCE

Relaxation allowances are calculated so as to allow the worker to recover from fatigue. Relaxation allowance is a addition to the basic time intended to provide the worker with the opportunity to recover from the physiological and psychological effects of carrying out specified work under specified conditions and to allow attention to personal needs. The amount of allowance will depend on nature of the job.

Relaxation allowances are of two types: fixed allowances and variable allowances. Fixed allowances constitute: Personal needs allowance: It is intended to compensate the operator for the time necessary to leave, the workplace to attend to personal needs like drinking water, smoking, washing hands. Women require longer personal allowance than men. A fair personal allowance is 5% for men, and 7% for women. Allowances for basic fatigue: This allowance is given to compensate for energy expended during working. A common figure considered as allowance is 4% of the basic time. Variable allowance is allowed to an operator who is working under poor environmental conditions that cannot be improved, added stress and strain in performing the job. The variable fatigue allowance is added to the fixed allowance to an operator who is engaged on medium and heavy work and working under abnormal conditions. The amount of variable fatigue allowance varies from organization to organization.

INTERFERENCE ALLOWANCE

It is an allowance of time included into the work content of the job to compensate the operator for the unavoidable loss of production due to simultaneous stoppage of two or more machines being operated by him. This allowance is applicable for machine or process controlled jobs. Interference allowance varies in proportion to number of machines assigned to the operator. The interference of the machine increases the work content.

CONTINGENCY ALLOWANCE

A contingency allowance is a small allowance of time which may be included in a standard time to meet legitimate and expected items of work or delays. The precise measurement of which is uneconomical because of their infrequent or irregular occurrence. This allowance provides for small unavoidable delays as well as for occasional minor extra work.

POLICY ALLOWANCE

Policy allowances are not the genuine part of the time study and should be used with utmost care and only in clearly defined circumstances. The usual reason for making the policy allowance is to line up standard times with requirements of wage agreement between employers and trade unions. The policy allowance is an increment, other than bonus increment, applied to a standard time (or to some constituent part of it, e.g., work content) to provide a satisfactory level of earnings for a specified level of performance under exceptional circumstances. Policy allowances are sometimes made as imperfect functioning of a division or part of a plant.

HUMAN FACTORS IN JOB DESIGN – CONCEPT

"Human factors refer to environmental, organisational and job factors, and human and individual characteristics, which influence behaviour at work in a way which can affect health and safety".

This definition includes three interrelated aspects that must be considered: the job, the individual and the organisation:

- **The job:** including areas such as the nature of the task, workload, the working environment, the design of displays and controls, and the role of procedures. Tasks should be designed in accordance with ergonomic principles to take account of both human limitations and strengths. This includes matching the job to the physical and the mental strengths and limitations of people. Mental aspects would include perceptual, attention and decision making requirements.
- **The individual:** including his/her competence, skills, personality, attitude, and risk perception. Individual characteristics influence behaviour in complex ways. Some characteristics such as personality are fixed; others such as skills and attitudes may be changed or enhanced.

- **The organisation:** including work patterns, the culture of the workplace, resources, communications, leadership and so on. Such factors are often overlooked during the design of jobs but have a significant influence on individual and group behaviour.

In other words, human factors is concerned with what people are being asked to do (the task and its characteristics), who is doing it (the individual and their competence) and where they are working (the organisation and its attributes), all of which are influenced by the wider societal concern, both local and national.

ERGONOMICS – CONCEPT:

Ergonomics is the science which deals with the relationship between man and his working environments. It takes care of factors governing the physical and mental strains. Ergonomics consists of words 'Ergo' (which means work), and 'Nomos' (which means 'Natural Laws'). This can also be termed as 'Human Engineering'.

Ergonomics (or Human Engineering) is defined by I.L.O. (International Labour Organisation) as **"the application of human biological sciences in conjunction with engineering sciences to the worker and his working environment so as to obtain maximum satisfaction for the worker which, at the same time, enhances productivity".**

The task of ergonomics is to develop such conditions for workers, which are necessary to reduce physical workload, to improve working postures, facilitate instrument handling, and thus improves the quality of working life, reduce fatigue, maximize efficiency of production operators and to minimize human errors.

Ergonomics helps to study the effect of working environment on health and safety and in turn on productivity. The workers' interest in the job to a greater extent depends on how comfortable and safe is the workplace.

Objectives of Ergonomics:

Objective of the study of ergonomics is:

- To optimize the integration of man and machine in order to increase productivity with accuracy.
- To take care of the factors governing the physical and mental strain (i.e. fatigue) so as to get maximum satisfaction for the worker this at the same time enhances the productivity.
- Attempts to minimize the risk of injury, illness, accidents and errors without compromising productivity.

- To improve the design of machine at the initial design stage or later whenever the existing product or process is modified.

Thus ergonomics helps in:

- Developing most comfortable conditions related to climate, lighting, ventilation and noise level;
- Reducing the physical work load;
- Improving working postures and reducing efforts of certain movements;
- Making the handling of machine levers and controls easy;
- Increasing safety.

Design of Workplace:

Backaches, necaches, and other muscular strains due to bad seating and incorrect working posture are common in industry, where most of the jobs are performed by the operators either in sitting or standing in a fixed posture for a long duration.

The interaction of the operator with the immediate workspace around him is influenced by many factors such as seat design, the working desk and adjacent machine. These factors are responsible for the position and postures of the users and, hence their efficiency.

Factors Considered in the Work Place Design:

1. Purpose of operation.
2. Product design-value analysis.
3. Materials related factors, like.

- Space required, quantity of items, size, etc. for raw, finished and scrap materials.
- Rate of production.
- Inspection requirement.

4. Equipment related factors, like

- Size.
- Utility, service requirements.
- Auxiliary equipment.
- Number of machines, and space required.
- Nature of process.
- Noise, pollution, vibration, safety hazards etc.

5. Material handling methods.
6. Space related factors; like
   - Aisles.
   - Ceiling height required.
   - Space utilization.
7. Operated related factors:
   - Sitting or standing.
   - Level of comfort.
   - Movement required.
   - Number of operators.
   - Supervision requirement.
8. Working Conditions:
   - Noise, lighting, heating and Ventilation.
   - Dust, Vibration, window location.
9. Method related factors:
   - Direction of flow.
   - Floor levels.
   - Location of items.
   - Material movement.
   - Safety requirement.
   - Operation sequence.
   - Tools and material locations.
   - Production rate.
   - Auxiliary services.

WORK ENVIRONMENT – CONCEPT:

The work environment refers to the conditions which surround the work place where the worker performs his/her works.

Work factors:

- **Lighting :** lightings should be designed that the employee worker in complete comfort with minimum of eye strain and physical fatigue noise it mean s unwanted sound noise is barrier to workers productivity and wellbeing, every attempt should be made to curb the noise level to its minimum.

- **Vibration:** It should affect performance on target tracking ideally vibrations should be minimized at source thermal conditions human physiology needs a condition of constant temperatures ventilation cool and fresh of air is vital to make an occupied space.
- **Comfortable:** Good house-keeping makes work area look pleasant and more satisfying and reduces fatigue and discomfort.
- **Selection of colors:** Colors influence the workers feelings of warmth and sense of ensure and well being.
- **Amenities:** Amenities should be provided to the workmen without giving them a feeling of generosity examples; canteen should supply good quality food, clean drinking workers safety.

Industrial accidents result from multiplicity of factors, but these have to be traced to their root causes, invariably the fault lies with the management of the organization. The most important function of a healthy and safety programmes is to identify the potential hazards provide safety facilities and equipment‘s and take prompt remedial action. All employees should be given through guidance in safety methods of work

Health and safety policies:

A health and safety policy is a written statement by an employer stating the company's commitment for the protection of the health and safety of employees and to the public. It is an endorsed commitment by management to its employees regarding their health and safety. A health and safety program contains the health and safety elements of an organization, objectives which make it possible for the company to achieve its goal in the protection of its workers at the workplace.

Section 4(1) of the Occupational Health and Safety Regulations specify the minimum requirements to be contained in a health and safety program. Some of the requirements specified in the regulation may not be applicable to every workplace. However, each employer should carry out their own health and safety risk assessment, in consultation with the occupational health and safety committee, to determine what hazards are present at the workplace. Once the hazards have been identified, controls for exposure to these hazards should be detailed in the health and safety program.

Reasons for health and safety programs or policies in workplace:

There are several reasons why workplaces need a health and safety policy or program, including:

- To clearly demonstrate management's full commitment to their employee's health and safety.
- To show employees that safety performance and business performance are compatible.
- To clearly state the company's safety beliefs, principles, objectives, strategies and processes to build buy-in through all levels of the company.
- To clearly outline employer and employee accountability and responsibility for workplace health and safety.
- To comply with the Occupational Health and Safety Act; and
- To set out safe work practices and procedures to be followed to prevent workplace injuries and illnesses.

Examples of Health and Safety Policies:

Many organizations such as Occupational Health and Safety Branches, Workers' Health, Safety and Compensation Boards, and safety consultants provide good examples of a health and safety policy. For your convenience, the provincial Workers' Health, Safety and Compensation Commission have provided a sample of a health and safety policy below. This is for your viewing and assistance in developing your own health and safety policy. The workers' health and safety representative or the occupational health and safety committees should be consulted when establishing your health and safety policy or programs.

Safety education:

This can include fire drills at a school, proper use of equipment (such as forklifts, scaffolds/ladders, or harnesses) and protective gear (such as hard hats, gloves or safety glasses). It can also include knowing the locations of the fire exits, first aid kit, and fire extinguishers, as well as the overall safety procedures.

Strategies for preventing accidents:

- Personal selection
- Safety trainings
- Environmental factors
- Safety campaigns
- Safety habits

SCHOOL OF BUSINESS ADMINISTRATION

I MBA – II SEMESTER

SBAA5204 – OPERATIONS MANAGEMENT – QUESTION BANK

UNIT – IV

PART – A

S. No	Questions (5 marks)	CO	Level
1	Explain statistical quality control (SQC). List out the various techniques employed.	CO4	L4
2	State the characteristics of control chart.	CO4	L3
3	Give the reason for undertaking time study analysis.	CO4	L3
4	Bring out the benefits of control chart.	CO4	L4
5	"Method study helps in better production goals for employees" Elaborate.	CO4	L4
6	"Inspection is the life blood of quality control" – Discuss.	CO4	L5
7	Discuss how performance rating calculated.	CO4	L4
8	Mention the importance of ergonomics.	CO4	L5
9	Explain pre-determined motion time study.	CO4	L4
10	Explain acceptance sampling.	CO4	L5

PART – B

S. No	Questions (10 marks)	CO	Level
1	"Good working conditions lead to higher productivity" describe.	CO4	L5
2	"Accidents are caused not only due to unsafe acts but also due to unsafe condition-discuss.	CO4	L6
3	Elaborate basic consideration for selection of method study.	CO4	L5
4	Summarize the basic procedure of method study.	CO4	L6
5	Analyze the techniques of work measurements.	CO4	L5
6	Elucidate categories of allowances.	CO4	L5

PART – C

CASE STUDY – (20 marks)

<table>
<tr><th>S. No</th><th>Questions (20 marks)</th><th>CO</th><th>Level</th></tr>
<tr><td>1</td><td>The Assam Gas Cracker Project conceived as part of the Assam Accord signed in 1985 is yet to see the light of the day. It has been plagued by a host of problems starting from location to economic viability. Originally planned at Tengakhat, it was later shifted to a place called Lepetkata. The project is now being implemented by GAIL (a Government of India enterprise) as the lead promoter (70% share) with another public enterprise OIL (20% share) and the Government of Assam as minor Himadri Barman, Centre for Management Studies, Dibrugarh University, Dibrugarh 786 004 (Assam) Downloaded from http://himadri.cmsdu.org 2 partners. GAIL had to be brought in after India’s largest private sector enterprise Reliance Industries backed out of the project saying that it was economically unviable. The land acquisition for the project (as of mid 2008) is yet to be completed and there is still a lot of uncertainty regarding the availability of raw materials for production. In the meantime, the project cost has spiraled many times over to INR 50 billion, which is likely to go up further.
(a) Discuss the importance of Project Management in the light of the above situation.
(b) As a project manager employed with GAIL, what would be your line of action to see to it that the project is not delayed any further?
(c) Why do projects suffer from time and cost overruns?</td><td>CO4</td><td>L6</td></tr>
<tr><td>2</td><td>Ten samples (each of size 100) of a component were inspected. The results of the inspection are given below.
<table><tr><td>Sample No:</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr><tr><td>No. Of defects</td><td>2</td><td>0</td><td>4</td><td>3</td><td>1</td><td>2</td><td>3</td><td>1</td><td>1</td><td>2</td></tr></table>
Draw the relevant control chart taking 3 sigma limits.</td><td>CO4</td><td>L6</td></tr>
</table>

TEXT / REFERENCE BOOKS

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- R. B. Kanna, Production and Operations Management, PHI Learning Private Ltd, 2nd edition, 2015.
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SCHOOL OF MANAGEMENT STUDIES

UNIT – V – OPERATIONS MANAGEMENT – SBAA5204

IV. MATERIALS MANAGEMENT AND INVENTORY CONTROL

Aggregate Planning – Nature, Strategies, Methods - Material Requirement Planning (MRP-I) – Manufacturing Resource Planning (MRP-II) – Inventory – Types of Inventory - Deterministic demand model – EOQ - Continuous and Periodic review Inventory models- Selective Inventory Control – ABC, VED, FSN Techniques.

AGGREGATE PLANNING – CONCEPT:

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.

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;

- A 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.

- 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.

Importance of Aggregate Planning:

- Aggregate planning plays an important part in achieving long-term objectives of the organization. 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

Aggregate Planning Strategies:

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

- **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.
- **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.

- **Hybrid Strategy:** As the name indicates, the Hybrid strategy is an integration of both level and chase strategies to get a better result. It maintains a sufficient balance between stock level, recruiting, termination and production rate. In the hybrid strategy of aggregate planning, the organizations build up inventory before rising demands. It uses backorders to level with high peak periods. It can easily cover short-term peaks by hiring workers temporarily or by subcontracting production. Hiring, lay-off and reassigning workers is a normal part of the hybrid strategy.

Techniques of Aggregate Planning:

Various techniques are used to perform the task of aggregate planning. Usually, there are two categories**: Informal trial-and-error techniques and mathematical techniques.** In practice, informal techniques are more commonly used. However, a substantial amount of research has been done to mathematical techniques, but still, they are not as extensively used, they often serve as a basis for comparing the effectiveness of alternative techniques for aggregate planning.

There are several steps in general procedure for aggregate planning:

- Determine demand for each period.
- Determine capacities (regular time, overtime, subcontracting) for each period.
- Identify company or departmental policies that are pertinent (e.g., maintain a safety stock of 5 percent of demand, maintain a reasonably stable workforce).
- Determine unit costs for regular time, overtime, subcontracting, holding inventories, back orders, layoffs, and other relevant costs.
- Develop alternative plans and compute the cost for each activity.
- If satisfactory plans emerge, select the one that best satisfies objectives. Otherwise, return to step 5.
- The advantages associated with aggregate planning include-
- It helps the organization in dealing with production facilities in a lean manner.
- The process helps to develop effective strategic plan as well as relationships with distributors and suppliers. It also assists in making developing accurate market research
- The planning helps in the optimization of inventory.
- An essential advantage is that it serves as a useful tool for making viable forecasts

about product demand.

- It helps to adjust capacity so that it can meet demands.
- The aggregate planning process helps to calculate capacity, for instance, how many units can be produced daily or in a week or a month.
- It helps the organization to identify the best options so that it can meet the demands easily.
- It assists in knowing about the inefficiencies that exist within the organization
- It helps to determine resources for instance amount of raw materials on hand, availability of total machine hours and the total number of workers along with products in progress, packaging materials, and tools required for manufacturing finished goods.
- An advantage of the planning process is that it helps to project demand and figure out the units in need for the short-term by factoring in advertising campaigns, special pricing, and promotions.
- It encourages the optimized utilization of space.

MATERIAL REQUIREMENTS PLANNING – CONCEPT:

Material Requirements Planning (or MRP) is a method that is used for the purpose of calculating the components and the materials, which in turn will be needed for the sake of making a product. Ideally, one can say that it has three broad, main steps.

They would be as follows:

- Taking note of the materials' inventory and the components which are readily available on hand.
- To identify the additional ones this would be required for the sake of seamless working of the manufacturing and production processes.
- Scheduling of production or the purchase of raw materials and components, as there might be a need to ensure that there are no unwanted delays in the production pipeline.

"Materials Requirement Planning (MRP) is a technique for determining the quantity and timing for the acquisition of dependent demand items needed to satisfy master production schedule requirements."

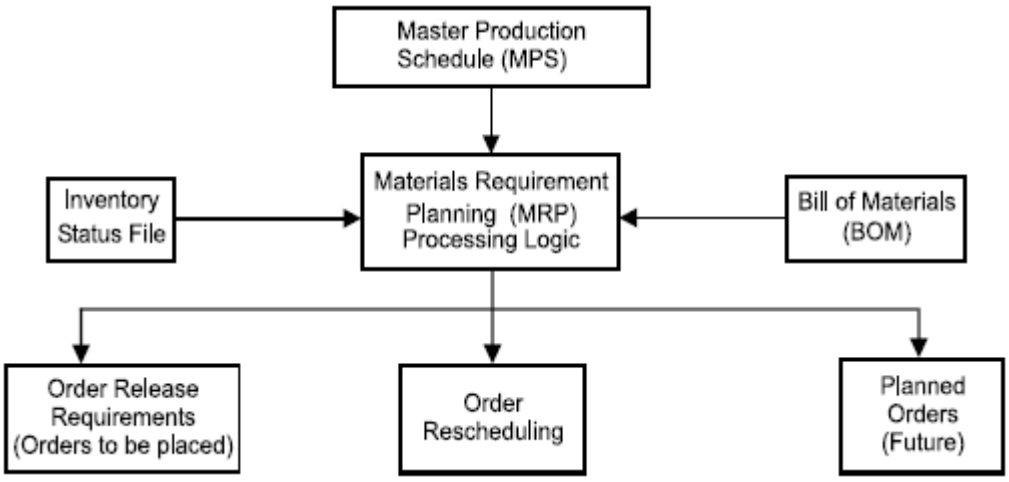
Objectives of Material Requirement Planning:

- **Inventory reduction:** MRP determines how many components are required when they are required in order to meet the master schedule. It helps to procure the materials/ components as and when needed and thus avoid excessive build up of inventory.
- **Reduction in the manufacturing and delivery lead times:** MRP identifies materials and component quantities, timings when they are needed, availabilities and procurements and actions required to meet delivery deadlines. MRP helps to avoid delays in production and priorities production activities by putting due dates on customer job order.
- **Realistic delivery commitments:** By using MRP, production can give marketing timely information about likely delivery times to prospective customers.
- **Increased efficiency:** MRP provides a close coordination among various work centers and hence help to achieve uninterrupted flow of materials through the production line. This increases the efficiency of production system.

MRP Process:

The inputs to the MRP system are: (1) A master production schedule, (2) An inventory status file and (3) Bill of materials (BOM). Using these three information sources, the MRP processing logic (computer programme) provides three kinds of information (output) for each product component: order release requirements, order rescheduling and planned orders.

MRP system



MASTER PRODUCTION SCHEDULE (MPS): MPS is a series of time phased quantities for each item that a company produces, indicating how many are to be produced and when. MPS is initially developed from firm customer orders or from forecasts of demand before

MRP system begins to operate. The MRP system whatever the master schedule demands and translates MPS end items into specific component requirements. Many systems make a simulated trial run to determine whether the proposed master can be satisfied.

INVENTORY STATUS FILE: Every inventory item being planned must have an inventory status file which gives complete and up to date information on the on-hand quantities, gross requirements, scheduled receipts and planned order releases for an item. It also includes planning information such as lot sizes, lead times, safety stock levels and scrap allowances.

BILL OF MATERIALS (BOM): BOM identifies how each end product is manufactured, specifying all subcomponents items, their sequence of build up, their quantity in each finished unit and the work centers performing the buildup sequence. This information is obtained from product design documents, workflow analysis and other standard manufacturing information.

What is Manufacturing Resource Planning?

Manufacturing Resource Planning (MRP II) is an integrated information system used by businesses. Manufacturing Resource Planning (MRP II) evolved from early Materials Requirement Planning (MRP) systems by including the integration of additional data, such as employee and financial needs.

The system is designed to centralize, integrate, and process information for effective decision making in scheduling, design engineering, inventory management, and cost control in manufacturing.

Both MRP and MRP II are seen as predecessors to Enterprise resource planning (ERP), which is a process whereby a company, often a manufacturer, manages and integrates the important parts of its business.

An ERP management information system integrates areas such as planning, purchasing, inventory, sales, marketing, finance, and human resources. ERP is most frequently used in the context of software, with many large applications having been developed to help companies implement ERP.

Understanding Manufacturing Resource Planning (MRP II)

MRP II is a computer-based system that can create detailed production schedules using real-time data to coordinate the arrival of component materials with machine and labor availability. MRP II is used widely by itself, but it's also used as a module of more extensive enterprise resource planning (ERP) systems.

MRP II is an extension of the original materials requirements planning (MRP I) system.

Materials requirements planning (MRP) is one of the first software-based integrated information systems designed to improve productivity for businesses.

A materials requirements planning information system is a sales forecast-based system used to schedule raw material deliveries and quantities, given assumptions of machine and labor units required to fulfill a sales forecast.

By the 1980s, manufacturers realized they needed software that could also tie into their accounting systems and forecast inventory requirements. MRP II was provided as a solution, which included this functionality in addition to all the capabilities offered by MRP I.

MRP I vs. MRP II:

For all intents and purposes, MRP II has effectively replaced MRP I software. Most MRP II systems deliver all of the functionality of an MRP system. But in addition to offering master production scheduling, bill of materials (BOM), and inventory tracking, MRP II provides functionality within logistics, marketing, and general finance.

For example, MRP II is able to account for variables that MRP is not including machine and personnel capacity providing a more realistic and holistic representation of a company's operating capabilities. Many MRP II solutions also offer simulation features that allow operators to enter variables and see the downstream effect. Because of its ability to provide feedback on a given operation, MRP II is sometimes referred to as a closed-loop system.

MRP I included the following three major functionalities:

- master production scheduling
- bill of materials
- inventory tracking

MRP II includes those three, plus the following:

- machine capacity scheduling
- demand forecasting
- quality assurance
- general accounting

MRP II systems are still in wide use by manufacturing companies today and can either be

found as stand-alone solutions or as part of an enterprise resource planning (ERP) system. Enterprise Resources Planning (ERP) software systems are regarded as the successors of MRP II software. ERP suites include applications well outside the scope of manufacturing. These can include everything from human resources and customer relationship management to enterprise asset management.

Meaning of Inventory:

Inventory generally refers to the materials in stock. It is also called the idle resource of an enterprise. Inventories represent those items which are either stocked for sale or they are in the process of manufacturing or they are in the form of materials, which are yet to be utilized. The interval between receiving the purchased parts and transforming them into final products varies from industries to industries depending upon the cycle time of manufacture. It is, therefore, necessary to hold inventories of various kinds to act as a buffer between supply and demand for efficient operation of the system. Thus, an effective control on inventory is a must for smooth and efficient running of the production cycle with least interruptions.

Reasons for Keeping Inventories:

- **To stabilize production:** The demand for an item fluctuates because of the number of factors, e.g., seasonality, production schedule etc. The inventories (raw materials and components) should be made available to the production as per the demand failing which results in stock out and the production stoppage takes place for want of materials. Hence, the inventory is kept to take care of this fluctuation so that the production is smooth.
- **To take advantage of price discounts:** Usually the manufacturers offer discount for bulk buying and to gain this price advantage the materials are bought in bulk even though it is not required immediately. Thus, inventory is maintained to gain economy in purchasing.
- **To meet the demand during the replenishment period:** The lead time for procurement of materials depends upon many factors like location of the source, demand supply condition, etc. So inventory is maintained to meet the demand during the procurement (replenishment) period.
- **To prevent loss of orders (sales):** In this competitive scenario, one has to meet the delivery schedules at 100 per cent service level, means they cannot afford to miss the

delivery schedule which may result in loss of sales. To avoid the organizations have to maintain inventory.

- **To keep pace with changing market conditions:** The organizations have to anticipate the changing market sentiments and they have to stock materials in anticipation of non- availability of materials or sudden increase in prices. Sometimes the organizations have to stock materials due to other reasons like suppliers minimum quantity condition, seasonal availability of materials or sudden increase in prices.

Meaning of Inventory Control:

Inventory control is a planned approach of determining what to order, when to order and how much to order and how much to stock so that costs associated with buying and storing are optimal without interrupting production and sales.

Inventory control basically deals with two problems:

(i) When should an order be placed? (Order level), and

(ii) How much should be ordered? (Order quantity).

These questions are answered by the use of inventory models. The scientific inventory control system strikes the balance between the loss due to non-availability of an item and cost of carrying the stock of an item. Scientific inventory control aims at maintaining optimum level of stock of goods required by the company at minimum cost to the company.

Objectives of Inventory Control:

- To ensure adequate supply of products to customer and avoid shortages as far as possible.
- To make sure that the financial investment in inventories is minimum (i.e., to see that the working capital is blocked to the minimum possible extent).
- Efficient purchasing, storing, consumption and accounting for materials is an important objective.
- To maintain timely record of inventories of all the items and to maintain the stock within the desired limits.
- To ensure timely action for replenishment.
- To provide a reserve stock for variations in lead times of delivery of materials.
- To provide a scientific base for both short-term and long-term planning of materials.

Benefits of Inventory Control:

- It is an established fact that through the practice of scientific inventory control, following are the benefits of inventory control:
- Improvement in customer's relationship because of the timely delivery of goods and service.
- Smooth and uninterrupted production and, hence, no stock out.
- Efficient utilization of working capital. Helps in minimizing loss due to deterioration, obsolescence damage and pilferage.
- Economy in purchasing.
- Eliminates the possibility of duplicate ordering.

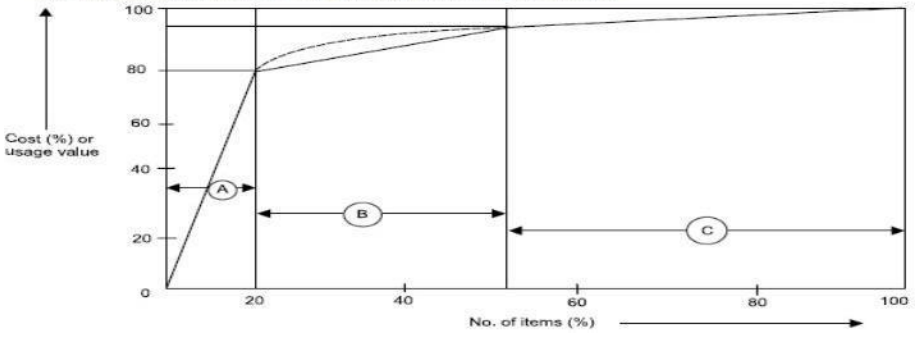
Techniques of Inventory Control:

In any organization, depending on the type of business, inventory is maintained. When the number of items in inventory is large and then large amount of money is needed to create such inventory, it becomes the concern of the management to have a proper control over its ordering, procurement, maintenance and consumption. The most widely used method of inventory control is known as ABC analysis. In this technique, the total inventory is categorized into three sub- heads and then proper exercise is exercised for each sub-heads.

- **ABC analysis:** In this analysis, the classification of existing inventory is based on annual consumption and the annual value of the items. Hence we obtain the quantity of inventory item consumed during the year and multiply it by unit cost to obtain annual usage cost. The items are then arranged in the descending order of such annual usage cost. The analysis is carried out by drawing a graph based on the cumulative number of items and cumulative usage of consumption cost.

Category	*Percentage of items*	*Percentage of annual consumption value*
A	10–20	70–80
B	20–30	10–25
C	60–70	5–15

The classification of ABC analysis is shown by the graph



Once ABC classification has been achieved, the policy control can be formulated as follows:

A-Item: Very tight control, the items being of high value. The control need be exercised at higher level of authority.

B-Item: Moderate control, the items being of moderate value. The control need be exercised at middle level of authority.

C-Item: The items being of low value, the control can be exercised at gross root level of authority, i.e., by respective user department managers.

- **HML analysis:** In this analysis, the classification of existing inventory is based on unit price of the items. They are classified as high price, medium price and low cost items.
- **VED analysis:** In this analysis, the classification of existing inventory is based on criticality of the items. They are classified as vital, essential and desirable items. It is mainly used in spare parts inventory.
- **FSN analysis:** In this analysis, the classification of existing inventory is based consumption of the items. They are classified as fast moving, slow moving and non-moving items.
- **SDE analysis:** In this analysis, the classification of existing inventory is based on the items.
- **GOLF analysis:** In this analysis, the classification of existing inventory is based sources of the items. They are classified as Government supply, ordinarily available, local availability and foreign source of supply items.
- **SOS analysis:** In this analysis, the classification of existing inventory is based nature of supply of items. They are classified as seasonal and off-seasonal items.

For effective inventory control, combination of the techniques of ABC with VED or ABC with HML or VED with HML analysis is practically used.

Inventory Model:

ECONOMIC ORDER QUANTITY (EOQ):

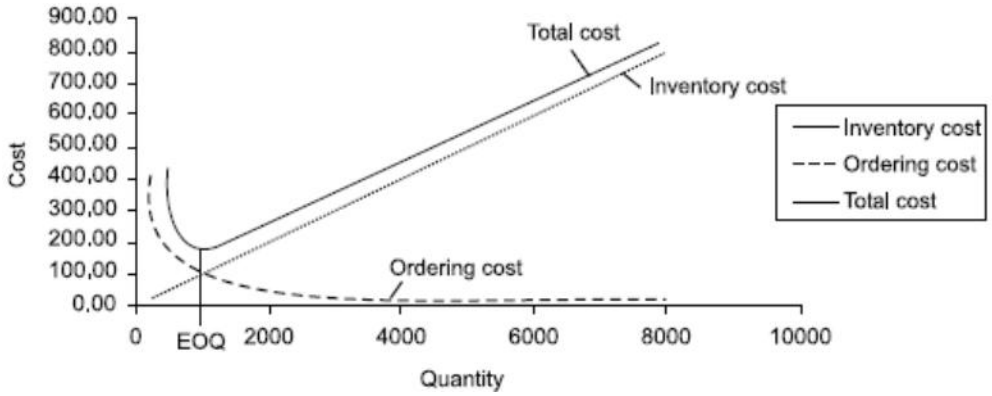
Inventory models deal with idle resources like men, machines, money and materials. These models are concerned with two decisions: how much to order (purchase or produce) and when to order so as to minimize the total cost.

For the first decision how much to order, there are two basic costs are considered namely, inventory carrying costs and the ordering or acquisition costs. As the quantity ordered is increased, the inventory carrying cost increases while the ordering cost decreases. The 'order quantity' means the quantity produced or procured during one production cycle. Economic order quantity is calculated by balancing the two costs. Economic Order Quantity (EOQ) is that size of order which minimizes total costs of carrying and cost of ordering.

i.e., Minimum Total Cost occurs when Inventory Carrying Cost = Ordering Cost Economic order quantity can be determined by two methods:

Tabulation method.

Algebraic method



Determination of EOQ by Tabulation (Trial & Error) Method:

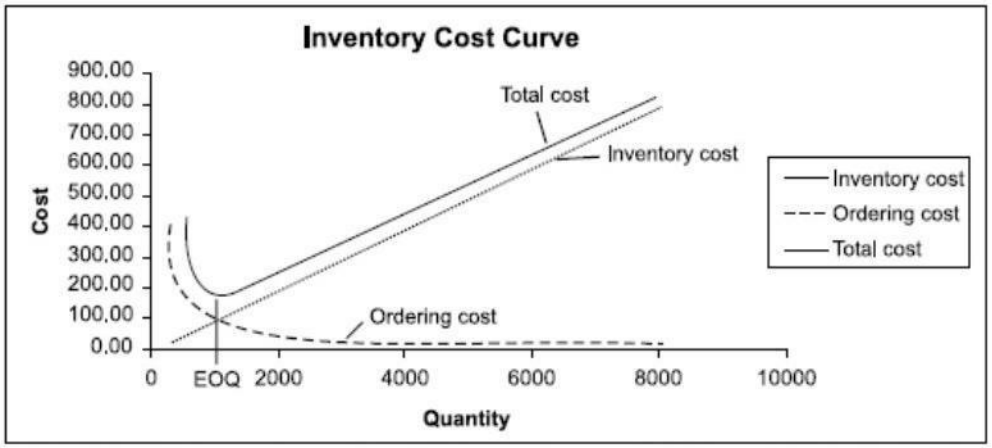
This method involves the following steps:

- Select the number of possible lot sizes to purchase.
- Determine average inventory carrying cost for the lot purchased.
- Determine the total ordering cost for the orders placed.
- Determine the total cost for each lot size chosen which is the summation of inventory carrying cost and ordering cost.
- Select the ordering quantity, which minimizes the total cost

The XYZ Ltd. carries a wide assortment of items for its customers. One of its popular items has annual demand of 8000 units. Ordering cost per order is found to be Rs. 12.5. The carrying cost of average inventory is 20% per year and the cost per unit is Re. 1.00. Determine the optimal economic quantity and make your recommendations.

SOLUTION:

No. of orders/ year (1)	*Lot size (2)*	*Average inventory (3)*	*Carrying cost (4)*	*Ordering cost (5)*	*Total cost/ year (6) =(4) + (5)*
1	8000	4000	800.00	12.5	812.50
2	4000	2000	400.00	25	425.00
4	2000	1000	200.00	50	250.00
8	1000	500	100.00	100	200.00
12	666.667	333.333	66.67	150	216.67
16	500	250	50.00	200	250.00



The table and the graph indicates that an order size of 1000 units will gives the lowest total cost among the different alternatives. It also shows that minimum total cost occurs when carrying cost is equal to ordering cost.

Determination of EOQ by Analytical Method:

In order to derive an economic lot size formula following assumptions are made:

Demand is known and uniform.

Let D denotes the total number of units purchase/produced and Q denotes the lot size in each production run.

Shortages are not permitted, i.e., as soon as the level of the inventory reaches zero, the inventory is replenished.

Production or supply of commodity is instantaneous.

Lead-time is zero. Set-up cost per production run or procurement cost is C3.Inventory carrying cost is C1 = CI, where C is the unit cost and I is called inventory carrying cost

The most economic point in terms of total inventory cost exists where,

Inventory carrying cost = Annual ordering cost (set-up cost)

Average inventory = 1/2 (maximum level + minimum level)

$= (Q + 0)/2 = Q/2$

Total inventory carrying cost = Average inventory × Inventory carrying cost per unit

i.e., Total inventory carrying cost = $Q/2 \times C_1 = QC_1/2$ ...(1)

Total annual ordering costs = Number of orders per year × Ordering cost per order

i.e., Total annual ordering costs = $(D/Q) \times C_3 = (D/Q)C_3$ ...(2)

Now, summing up the total inventory cost and the total ordering cost, we get the total inventory cost C(Q).

i.e., Total cost of production run = Total inventory carrying cost + Total annual ordering costs

$C(Q) = QC_1/2 + (D/Q)C_3$ (cost equation) ...(3)

But, the total cost is minimum when the inventory carrying costs becomes equal to the total annual ordering costs. Therefore,

$$QC_1/2 = (D/Q)C_3$$

or $$QC_1 = (2D/Q)C_3 \quad \text{or} \quad Q^2 = 2C_3D/C_1$$

or $$Q = \sqrt{\frac{2C_3D}{C_1}}$$

i.e., Optimal quantity (EOQ), $$Q_0 = \sqrt{\frac{2C_3D}{C_1}} \quad ...(4)$$

expressed as a percentage of the value of the average inventory.

$$\text{Optimum number of orders, } (N_0) = \frac{D}{Q_0} \quad ...(5)$$

$$\text{Optimum order interval, } (t_0) = \frac{365}{N_0} \text{ in days} = \frac{1}{N_0} \text{ in years or } (t_0) = \frac{Q_0}{D} \quad ...(6)$$

$$\text{Average yearly cost (TC)} = \sqrt{2C_3DC_1} \quad ...(7)$$

ILLUSTRATION 4: *An oil engine manufacturer purchases lubricants at the rate of Rs. 42 per piece from a vendor. The requirements of these lubricants are 1800 per year. What should be the ordering quantity per order, if the cost per placement of an order is Rs. 16 and inventory carrying charges per rupee per year is 20 paise.*

SOLUTION: Given data are:

Number of lubricants to be purchased, D = 1800 per year

Procurement cost, C_3 = Rs. 16 per order

Inventory carrying cost, CI = C_1 = Rs. 42 × Re. 0.20 = Rs. 8.40 per year

Then, optimal quantity (EOQ), $$Q_0 = \sqrt{\frac{2C_3D}{C_1}}$$

$$Q_0 = \sqrt{\frac{2 \times 16 \times 1800}{8.4}} = 82.8 \text{ or } 83 \text{ lubricants (approx).}$$

SBAA5204 – OPERATIONS MANAGEMENT – QUESTION BANK

UNIT – V

PART – A

S. No	Questions (5 marks)	CO	Level
1	List down the objectives inventory control.	CO5	L3
2	Mention the importance of inventory control.	CO5	L3
3	Define aggregate planning and its objectives.	CO5	L5
4	Explain the benefits of inventory control.	CO5	L4
5	Bring out the meaning of BOM.	CO5	L3
6	Give the conditions required for MRP.	CO5	L3
7	Expand FSN and bring out its importance.	CO5	L3
8	Indicate the significance of inventories management.	CO5	L5
9	Discuss an MRP system which helps management to monitor the performance of the inventory system.	CO5	L5
10	Explain the different selective inventory control techniques.	CO5	L5

PART – B

S. No	Questions (10 marks)	CO	Level
1	Summarize MRP I and MRP II system in detail.	CO5	L5
2	Enumerate techniques of inventory control.	CO5	L6
3	"Ideal inventory management brings the cost of the product down" Explain.	CO5	L5
4	Compare and contrast any ABC & VED inventory techniques.	CO5	L6
5	Elucidate ABC analysis in operation management	CO5	L5
6	Generalize the lead time in inventory really important how can mismanaging lead time cost a company money	CO5	L6

PART – C

CASE STUDY – (20 marks)

S. No	Questions (20 marks)	CO	Level
1	A local distributor for a national tyre company expects to sell approximately 9600 steel belted radial tyres of a certain size and tread design next year. Annual carrying cost is Rs.160 per tyre and ordering cost is Rs.750. The distributor operates 288 days a year. What is the Economic Order Quantity (EOQ)?	CO5	L6
2	Ashok Leyland has the good market share of trucks and passenger transport vehicles across India. The production capacity of AL is overall 8000 trucks per month in south India and North and West part of India manufactures around 20000 trucks. Market demand surges due to recession and the requirement has surged to 8000 trucks overall India. But the management believes the market will boom and they need to maintain around 40000 trucks for the 2 months despite of surge in the sales. The demand is estimated to surge @ 8% and during the boom it will be around 26% increase. The alternate for the company is to hold the inventory for 2 months and it will be ready to observe the inventory holding cost which accounts 15% of their working capital. Otherwise management could not able to supply the trucks in time to the customers. Now the management has to take the decision on the following factors. 1. How much inventory they should keep during recession and boom period? 2. What should be production capacity to be maintained in both south and north factories? Please note demand overall India.	CO5	L6

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