LECTURE NOTES

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UNIT I

Concepts of Management- Administration and Organization – Functions of Management – Evolution of Management Thought: Taylor's Scientific Management, Fayol's Principles of Management, Douglas McGregor's Theory X and Theory Y, Mayo's Hawthorne Experiments, Hertzberg's Two Factor Theory of Motivation, Maslow's Hierarchy of Human Needs – Systems Approach to Management. Organizational Structures- Functional – Divisional- Matrix etc., Basic concept related to Organization – Departmentation and Decentralization and their merits, demerits and Suitability
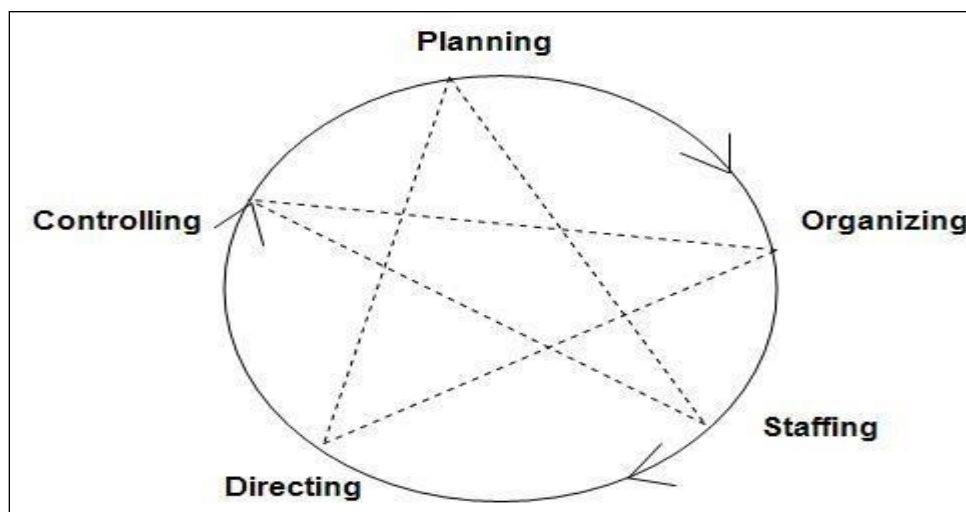
Management: Management is the art of getting things done to by a group of people with the effective utilisation of available resources

Functions of Management:
Management has been described as a social process involving responsibility for economical and effective planning & regulation of operation of an enterprise in the fulfillment of given purposes. It is a dynamic process consisting of various elements and activities. These activities are different from operative functions like marketing, finance, purchase etc. Rather these activities are common to each and every manger irrespective of his level or status.

Different experts have classified functions of management. According to *George & Jerry*, "There are four fundamental functions of management i.e. planning, organizing, actuating and controlling". According to Henry Fayol, "To manage is to forecast and plan, to organize, to command, & to control". Whereas Luther Gullick has given a keyword '**POSDCORB**' where P stands for Planning, O for Organizing, S for Staffing, D for Directing, Co for Co-ordination, R for reporting & B for Budgeting. But the most widely accepted are functions of management given by KOONTZ and O'DONNEL i.e. **Planning**, **Organizing**, **Staffing**, **Directing** and **Controlling**.

For theoretical purposes, it may be convenient to separate the function of management but practically these functions are overlapping in nature i.e. they are highly inseparable. Each function blends into the other & each affects the performance of others.

1. **Planning**

   It is the basic function of management. It deals with chalking out a future course of action & deciding in advance the most appropriate course of actions for achievement of pre-determined goals. According to KOONTZ, "Planning is deciding in advance - what to do, when to do & how to do. It bridges the gap from where we are & where we want to be". A plan is a future course of actions. It is an exercise in problem solving & decision making. Planning is determination of courses of action to achieve desired goals. Thus, planning is a systematic thinking about ways & means for accomplishment of pre-determined goals. Planning is necessary to ensure proper utilization of human & non-human resources. It is all pervasive, it is an intellectual activity and it also helps in avoiding confusion, uncertainties, risks, wastages etc.

2. **Organizing**

   It is the process of bringing together physical, financial and human resources and developing productive relationship amongst them for achievement of organizational goals. According to Henry Fayol, "To organize a business is to provide it with everything useful or its functioning i.e. raw material, tools, capital and personnel's". To organize a business involves determining & providing human and non-human resources to the organizational structure. Organizing as a process involves:

   - Identification of activities.
   - Classification of grouping of activities.
   - Assignment of duties.
   - Delegation of authority and creation of responsibility.
   - Coordinating authority and responsibility relationships.

3. **Staffing**

   It is the function of manning the organization structure and keeping it manned. Staffing has assumed greater importance in the recent years due to advancement of technology, increase in size of business, complexity of human behavior etc. The main purpose o staffing is to put right man on right job i.e. square pegs in square holes and round pegs in round holes. According to Kootz & O'Donell, "Managerial function of staffing involves manning the organization structure through proper and effective selection, appraisal & development of personnel to fill the roles designed un the structure". Staffing involves:

   - Manpower Planning (estimating man power in terms of searching, choose the person and giving the right place).
   - Recruitment, Selection & Placement.
   - Training & Development.
   - Remuneration.
   - Performance Appraisal.
   - Promotions & Transfer.

4. **Directing**

It is that part of managerial function which actuates the organizational methods to work efficiently for achievement of organizational purposes. It is considered life-spark of the enterprise which sets it in motion the action of people because planning, organizing and staffing are the mere preparations for doing the work. Direction is that inert-personnel aspect of management which deals directly with influencing, guiding, supervising, motivating sub-ordinate for the achievement of organizational goals. Direction has following elements:

- Supervision
- Motivation
- Leadership
- Communication

Supervision- implies overseeing the work of subordinates by their superiors. It is the act of watching & directing work & workers.

Motivation- means inspiring, stimulating or encouraging the sub-ordinates with zeal to work. Positive, negative, monetary, non-monetary incentives may be used for this purpose.

Leadership- may be defined as a process by which manager guides and influences the work of subordinates in desired direction.

Communications- is the process of passing information, experience, opinion etc from one person to another. It is a bridge of understanding.

5. Controlling

It implies measurement of accomplishment against the standards and correction of deviation if any to ensure achievement of organizational goals. The purpose of controlling is to ensure that everything occurs in conformities with the standards. An efficient system of control helps to predict deviations before they actually occur. According to *Theo Haimann*, "Controlling is the process of checking whether or not proper progress is being made towards the objectives and goals and acting if necessary, to correct any deviation". According to Koontz & O'Donell "Controlling is the measurement & correction of performance activities of subordinates in order to make sure that the enterprise objectives and plans desired to obtain them as being accomplished". Therefore controlling has following steps:

a. Establishment of standard performance.
b. Measurement of actual performance.
c. Comparison of actual performance with the standards and finding out deviation if any.
d. Corrective action.

Scientific management concept

Scientific management concept is one of the principles of management and is also known as classical theory. This principle is propounded by Fredrick Winslow Taylor (F.W Taylor) – the father of management. He was born in USA in 1856. He joined Midvale steel company where he

worked as a machine shop worker for two years as gang boss for some years and as chief engineer at the age of 28.he also joined Bethlehem steel company where he served for a long time. Later he devoted his time to develop the concept of scientific management.

He noticed that there were much disorder and wastage of human as well as other resources at work place. The managers and staffs had no concept about systematic and efficient performance of task. And all were following traditional ways of doing work. So he tried to remove these problems through the development of new concept. Thus the scientific management concept was developed.

Contributions of F.W Taylor

While working in Midvale Company as a manager Taylor observed that employees were not performing as per their capacity of productivity. And he considered that this condition was occurring because of no care towards the waste. Taylor worked towards the experiments at his work place to increase the worker's efficiency so that maximum output could be achieved by utilizing effort at maximum level.

1. **Scientific task setting:-** Taylor observed that the management does not know exactly the works – pieces of work- volume of works- which are to be performed by the workers during a fixed period of time- which is called working day. In a working day how much work is to be done by a worker but be fixed by a manager and the task should be set every day. The process of task setting requires scientific technique. To make a worker do a quantity of work in a working day is called scientific task setting

2. **Differential payment system:-** under this system, a worker received the piece rate benefit which will attract the workers to work more for more amount of wages and more incentives would be created to raise the standardization of output to promote the workers to produce more and perform more task than before and utilize waste time to earn more wages.

3. **Reorganization of supervision:-** concepts of separation of planning and doing and functional foremanship were developed. Taylor opines that the workers should only emphasize in planning or in doing. There should be 8 foreman in which 4 are for planning and 4for doing. For planning they were route clerk, instruction cord clerk, time and cost clerk and disciplinarian. And for doing they were speed boss, gang boss, repair boss and inspector.

4. **Scientific recruiting and training:-**staffs and workers should be selected and employed on scientific basis. Management should develop and train every workers by providing proper knowledge and training to increase their skills and make them effective

5. **Economy:-** efficient cost accounting system should be followed to control cost which can minimize the wastages and thoroughly reduced and thus eliminated.

6. **Mental revolution:-** Taylor argued that both management and workers should try to understand each other instead of quarrelling for profits and benefits which would increase production, profit and benefits.

Contribution of Henri Fayol

　　　　Henri Fayol was real father of modern Management. Henri Fayol is the French industrialist in 1841-1925. He was a mining engineer in. Henri Fayol spent his entire working career in French industry; French cool and iron combine of commentary fourchambault. Henri Fayol developed a general theory of Business Administration.

　　　　Henri Fayol was concerned the principles of organization and the function of

management. Fayol laid the foundation of management as a separate body of knowledge. He always insisted that if scientific forecasting and proper methods are used in management than company can get satisfactory results. According to Fayol, management was not personal talent; it is a knowledge base skill.

Henri Fayol's Administrative Management is based on six admin activities. They are-

1. **Technical:** Production and manufacture
2. **Managerial :** Planning, controlling, co-ordination
3. **Commercial:** Purchasing and selling
4. **Financial:** Use of capital
5. **Accounting:** Asset, Liabilities, cost, profits
6. **Security:** Protection of goods and Person

Fayol's fourteen Principles of management

Fayol derived the following fourteen principles.-

☐ **Division of work:** Division of work means specialization. Each job and work should be divided into small task and should be assigned to specialist of it.

☐ **Authority and responsibility:** Authority means right to give order and command while responsibility means to accomplish objective.

☐ **Discipline:** Discipline is required at every level in every organization. Fayol stated discipline in terms of obedience, application, and respect to superiors.

☐ **Unity of command:** A subordinate should receive order from only one boss.

☐ **Unity of direction:** It means that all the works of an organization must work together to accomplish a common objective in under one plan and head.

☐ **Subordination of individual interest to common interest:** Worker follows the common interest of organization rather than individual.

☐ **Remuneration:** Remuneration should be fair and adequate. It includes both types of incentives financial as well as non-financial.

☐ **Centralization:** There should be one central point in organization which exercises overall direction and control of all the parts.

☐ **Scalar Chain:** Scalar chain is the chain or line of command from superior to subordinates.

☐ **Order:** Only proper order can give an efficient management.

☐ **Equity:** Equity creates loyalty and devotion among the employees.

☐ **Stability of tenure personnel:** Security of job for an employee in an organization is very important and pre-requisite condition. Retaining productive employee should always a higher priority of management.

☐ **Esprit de corps:** Management should encourage harmony and proper understandings between workers. Fayol said that in union there is strength. Whole organization should work as a team.

☐ **Initiative:** Manager should be encouraged the employees Initiative for creative working.

Douglas McGregor's - Theory of Motivation

The eminent **psychologist Douglas McGregor** has given his theory of motivation called **Theory X** and **Theory Y**. He first presented his theory in a classic article titled '**The Human Side of Enterprise**'. He treated traditional approach to management as 'Theory X' and the professional approach to management as 'Theory Y'. His theory refers to two sets of **employees** based on the

perception of human nature. Here, theory X and theory Y are two sets of assumptions about the nature of employees. His theory is based on **human behavior**.

Theory X:

Theory X is based on traditional assumptions about people (employees). Here, the conventional approach of management is used as a base. It suggests the following features of an average human being/employee (assumptions about human nature):

Assumptions of Theory X:

1. The average human being is inherently lazy by nature and desires to work as little as possible. He dislikes the work and will like to avoid it, if he can.
2. He avoids accepting responsibility and prefers to be led or directed by some other.
3. He is self-centered and indifferent to organizational needs.
4. He has little ambition, dislikes responsibility, prefers to be led but wants security.
5. He is not very intelligent and lacks creativity in solving organizational problems.
6. He by nature resists changing of any type.

In the case of such employees, self-motivation is just not possible. They will work only when there is constant supervision on them. A manager has to persuade, punish or reward such workers in order to achieve organizational goals.

Theory Y:

Theory Y is based on modern or progressive or professional approach. Here, the assumptions about people i.e. employees are quite different.

Assumptions of Theory Y:

1. Work is as natural as play, provided the work environment is favorable. Work may act as a source of satisfaction or punishment. An average man is not really against doing work.
2. People can be self-directed and creative at work if they are motivated properly.
3. Self-control on the part of people is useful for achieving organizational goal. External control and threats of punishment alone do not bring out efforts towards organizational objectives.
4. People have capacity to exercise imagination and creativity.
5. People are not by nature passive or resistant to organizational needs. They have become so as a result of experience in organisations.
6. An average human being learns under proper conditions. He is also willing to accept responsibility.
7. The intellectual capacity of an average human being is utilised partially under the conditions of modern industrial life.

Final Glance on Theory X and Theory Y:

Such types of people (employees) are self-motivated and McGregor recommends that they be motivated by encouraging participation so as to get team work. Theory Y assumes that people are not by nature, lazy and unreliable. They can be self-directed and creative at work, if properly motivated. It is for the management to unleash this potential in individuals (employees). Theory Y emphasizes creating opportunities, removing obstacles, providing guidance and

encouraging growth. By using these tools, the management can integrate individual goals of employees with those of the Organisation.

The assumptions in Theory X and Theory Y are fundamentally distinct. Theory X is static, rigid, conservative and pessimistic. Theory Y is optimistic, dynamic, flexible and progressive. It suggests self direction and the integration of individual needs with organizational needs. On the other hand, more importance is given to external control imposed by the superior on the subordinate in the Theory X.

Hawthorne Experiment:
In 1927, a group of researchers led by Elton Mayo and Fritz Roethlisberger of the Harvard Business School were invited to join in the studies at the Hawthorne Works of Western Electric Company, Chicago. The experiment lasted up to 1932. The Hawthorne Experiments brought out that the productivity of the employees is not the function of only physical conditions of work and money wages paid to them. Productivity of employees depends heavily upon the satisfaction of the employees in their work situation. Mayo's idea was that logical factors were far less important than emotional factors in determining productivity efficiency. Furthermore, of all the human factors influencing employee behaviour, the most powerful were those emanating from the worker's participation in social groups. Thus, Mayo concluded that work arrangements in addition to meeting the objective requirements of production must at the same time satisfy the employee's subjective requirement of social satisfaction at his work place. The Hawthorne experiment consists of four parts. These parts are briefly described below:-

1. Illumination Experiment.
2. Relay Assembly Test Room Experiment.
3. Interviewing Programme.
4. Bank Wiring Test Room Experiment.

1. Illumination Experiment:
This experiment was conducted to establish relationship between output and illumination. When the intensity of light was increased, the output also increased. The output showed an upward trend even when the illumination was gradually brought down to the normal level. Therefore, it was concluded that there is no consistent relationship between output of workers and illumination in the factory. There must be some other factor which affected productivity.

2. Relay Assembly Test Room Experiment:
This phase aimed at knowing not only the impact of illumination on production but also other factors like length of the working day, rest hours, and other physical conditions. In this experiment, a small homogeneous work-group of six girls was constituted. These girls were friendly to each other and were asked to work in a very informal atmosphere under the supervision of a researcher. Productivity and morale increased considerably during the period of the experiment. Productivity went on increasing and stabilized at a high level even when all the improvements were taken away and the pre-test conditions were reintroduced. The researchers concluded that socio-psychological factors such as feeling of being important, recognition, attention, participation, cohesive work-group, and non-directive supervision held the key for higher productivity.

3. Mass Interview Programme:
The objective of this programme was to make a systematic study of the employees' attitudes which would reveal the meaning which their "working situation" has for them. The researchers interviewed a large number of workers with regard to their opinions on work, working conditions and supervision. Initially, a direct approach was used whereby interviews asked questions considered important by managers and researchers. The researchers observed that the replies of the workmen were guarded. Therefore, this approach was replaced by an indirect technique, where the interviewer simply listened to what the workmen had to say. The findings confirmed the importance of social factors at work in the total work environment.

4. Bank Wiring Test Room Experiment:
This experiment was conducted by Roethlisberger and Dickson with a view to develop a new method of observation and obtaining more exact information about social groups within a company and also finding out the causes which restrict output. The experiment was conducted to study a group of workers under conditions which were as close as possible to normal. This group comprised of 14 workers. After the experiment, the production records of this group were compared with their earlier production records. It was observed that the group evolved its own production norms for each individual worker, which was made lower than those set by the management. Because of this, workers would produce only that much, thereby defeating the incentive system. Those workers who tried to produce more than the group norms were isolated, harassed or punished by the group. The findings of the study are:-

- Each individual was restricting output.
- The group had its own "unofficial" standards of performance.
- Individual output remained fairly constant over a period of time.
- Informal groups play an important role in the working of an organization.

Contributions of the Hawthorne Experiment:
    He born in Australia and trained in psychology, Elton Mayo is generally recognized as "Father of Human Relations Approach", and his associates conducted their studies in the Hawthorne plant of the western electrical company, U.S.A., between 1927 and 1930. According to them, behavioural science methods have many areas of application in management. The important features of the Hawthorne Experiment are:-
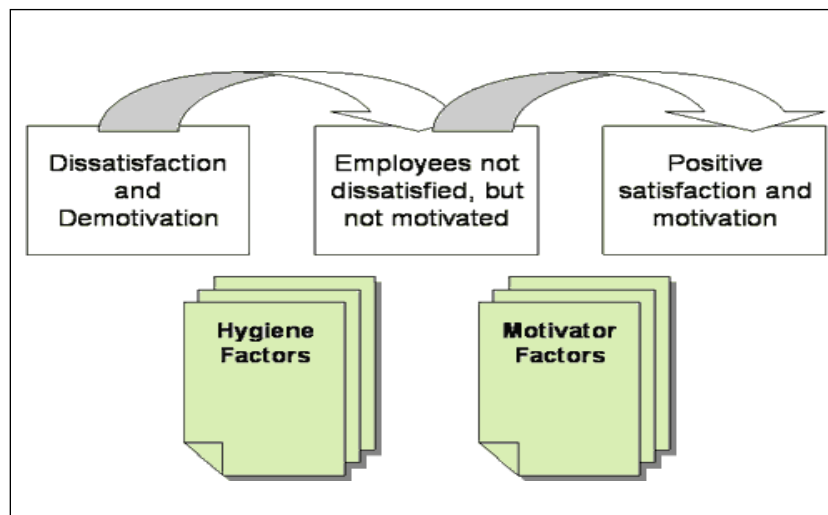
1. A business organization is basically a social system. It is not just a techno-economic system.
2. The employer can be motivated by psychological and social wants because his behaviour is also influenced by feelings, emotions and attitudes. Thus economic incentives are not the only method to motivate people.
3. Management must learn to develop co-operative attitudes and not rely merely on command.
4. Participation becomes an important instrument in human relations movement. In order to achieve participation, effective two-way communication network is essential.

5. Productivity is linked with employee satisfaction in any business organization. Therefore management must take greater interest in employee satisfaction.
6. Group psychology plays an important role in any business organization. We must therefore rely more on informal group effort.
7. The neo-classical theory emphasizes that man is a living machine and he is far more important than the inanimate machine. Hence, the key to higher productivity lies in employee morale. High morale results in higher output.

Motivation Theory – Herzberg:
In 1959, Frederick Herzberg, a behavioural scientist proposed a two-factor theory or the motivator-hygiene theory. Herzberg analysed the job attitudes of 200 accountants and engineers who were asked to recall when they had felt positive or negative at work and the reasons why.

From this research, Herzberg suggested a two-step approach to understanding employee motivation and satisfaction.

Hygiene Factors
Hygiene factors are based on the need to for a business to avoid unpleasantness at work. If these factors are considered inadequate by employees, then they can cause dissatisfaction with work. Hygiene factors include:
      - Company policy and administration
      - Wages, salaries and other financial remuneration
      - Quality of supervision
      - Quality of inter-personal relations
      - Working conditions
      - Feelings of job security

Motivator Factors
Motivator factors are based on an individual's need for personal growth. When they exist, motivator factors actively create job satisfaction. If they are effective, then they can motivate an individual to achieve above-average performance and effort. Motivator factors include:

- Status
- Opportunity for advancement
- Gaining recognition
- Responsibility
- Challenging / stimulating work
- Sense of personal achievement & personal growth in a job

There is some similarity between Herzberg's and Maslow's models. They both suggest that needs have to be satisfied for the employee to be motivated. However, Herzberg argues that only the higher levels of the Maslow Hierarchy (e.g. self-actualisation, esteem needs) act as a motivator. The remaining needs can only cause dissatisfaction if not addressed.

Applying Hertzberg's model to de-motivated workers
What might the evidence of de-motivated employees be in a business?
- Low productivity
- Poor production or service quality
- Strikes / industrial disputes / breakdowns in employee communication and relationships
- Complaints about pay and working conditions
According to Herzberg, management should focus on rearranging work so that motivator factors can take effect. He suggested three ways in which this could be done:
- Job enlargement
- Job rotation
- Job enrichment

Supportive Evidence
      The study focusing on the Two-Factor Theory has been repeated 16 times in various populations and work settings, according to Herzberg. The results of the latter two-factor theory studies had been in agreement with the findings of the original study. This proves that the Two-Factor Theory deserves being one of the well-regarded theories on job attitudes, particularly in intrinsic motivation of employees.

Maslow's hierarchy of needs:
Maslow's Hierarchy of Needs is a "content theory" of motivation"
Maslow's theory consisted of two parts:
(1) The classification of human needs, and
(2) Consideration of how the classes are related to each other

The classes of needs were summarised by Maslow as follows:

How does the Hierarchy Work?
- A person starts at the bottom of the hierarchy (pyramid) and will initially seek to satisfy basic needs (e.g. food, shelter)

- Once these physiological needs have been satisfied, they are no longer a motivator. the individual moves up to the next level

- Safety needs at work could include physical safety (e.g. protective clothing) as well as protection against unemployment, loss of income through sickness etc)

- Social needs recognise that most people want to belong to a group. These would include the need for love and belonging (e.g. working with colleague who support you at work, teamwork, communication)

- Esteem needs are about being given recognition for a job well done. They reflect the fact that many people seek the esteem and respect of others. A promotion at work might achieve this

- Self-actualisation is about how people think about themselves - this is often measured by the extent of success and/or challenge at work

Maslow's model has great potential appeal in the business world. The message is clear - if management can find out which level each employee has reached, then they can decide on suitable rewards.

Problems with the Maslow Model
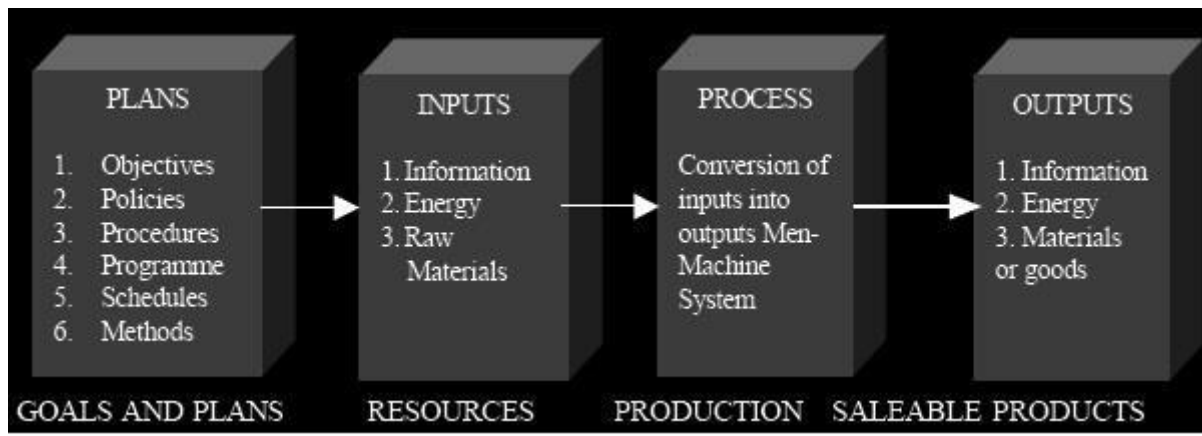There are several problems with the Maslow model when real-life working practice is considered:

- Individual behaviour seems to respond to several needs - not just one

- The same need (e.g. the need to interact socially at work) may cause quite different behaviour in different individuals

- There is a problem in deciding when a level has actually been "satisfied"

- The model ignores the often-observed behaviour of individuals who tolerate low-pay for the promise of future benefits

- There is little empirical evidence to support the model. Some critics suggest that Maslow's model is only really relevant to understanding the behaviour of middle-class workers in the UK and the USA (where Maslow undertook his research).

System Approach to Management:
Systems approach to management also called as the modern theory of Management. Modern theory considers an organization as an adaptive system which has to adjust to changes in its environment. An organization is now defined as a structured process in which individuals interact for attaining objectives.

Meaning of "System": The word system is derived from the Greek word meaning to bring together or to combine. A system is a set of interconnected and inter-related elements or component parts to achieve certain goals. A system has three significant parts:

1. Every system is goal-oriented and it must have a purpose or objective to be attained.
2. In designing the system we must establish the necessary arrangement of components.
3. Inputs of information, material and energy are allocated for processing as per plan so that the outputs can achieve the objective of the system.

The significant features or concepts of systems approach may be outlined as follows:

1. Sub-Systems: They are the parts that make up the whole. Each system may also be a sub-system of still larger whole. For example an electronic goods company is a system, but it becomes a sub-system of the electronic goods industry, which is a larger whole.

2. Interrelatedness of Sub Systems: It is probably the distinguishing characteristics of a system, which means that a manager cannot change on sub-system without affecting the rest because the

sub-systems interact with each other and therefore are dependent on each other. For example, the solution to a problem of the Production Department (a subsystem) will have an impact on other departments (subsystems) such as Marketing and Finance – say, if it is decided to increase the production by 50% of the present output, then marketing efforts will have to be further geared to sell the enhanced production and more finances will have to be arranged for additional production.

3. Synergy: It means that the whole is greater than the sum of its part. In other words, systems approach results in synergic effect which means that $2 + 2$ – More than 4.

4. Open System: Open system means that which interacts which its environment and closed system is that which does not interact with its environment being self-sustained. The emphasis of systems approach is an open system. It believes that most of the organizations are open systems because they depend for their inputs (i.e., money, materials, men, information etc.) on the society. In addition, the organisation sells their outputs (i.e. goods and services) to the customers in the society. Thus, if an organisation wishes to survive, it must respond to its environment – customers and suppliers.

5. System Boundary: Each system has its boundary that separates it from the environment.

6. Environment: All systems operate, within an environment, which, for an organisation, might include customers or clients, competitors, suppliers, investors, government and regulatory government agencies, unions etc. Environment includes things that are significant to the organisation, but are largely beyond its control.

7. Flows: A system has flows of information, methods and energy including human energy. These enter the system as inputs, undergo transformation process and exit as outputs.

8. Feedback: It is the assessment of work done, identification of deviations and taking of corrective action.

9. Central Functions or Purpose: There is always a central function or purpose of a system against which the efforts of the organisation and its subsystem can be evaluated or measured.

In a nutshell, systems approach attempts to view organisation as a unified, purposeful system composed of interrelated parts. It gives manager a way of looking at the organization as a whole and as a part of the larger, external environment. The organizations are viewed as procuring and transforming inputs into outputs. The organizations are also viewed as extremely complex entities subject to changes from within and outside. In order to meet the various needs of such as organizations, a balanced and integrated approach to management is required.

At the heart of the system approach lays the following:

- Management information system (MIS)
- Communicating network for collection, analysis and flow of information and quantitative data so as to facilitate planning and control.

- Decision making system as the primary means of balancing the different parts of the organization.
- Integration of activities and departments with a view to making the best use of scare resources.
- Sub-System of management – the managers should try to adapt and cope with environmental changes.

Critical Evaluation
The systems approach may be critically evaluation as follows:

(A) Contributions(Advantages)

Systems theory has made the following contributions.
1. It provides a manager a way of thinking about the job of managing and unfolds an opportunity to him for looking it the organization as a whole and for achieving overall effectiveness.

2. It provides a unified focus to organizational efforts – a direction towards which people should strive.

3. It draws attention of managers to an important factor and that is the environment in which an organization works. The interaction with the environment is dynamic.

4. It includes within it focus both micro and macro aspects of the organizations. Hence it serves a multi-level and multi-dimensional approach.

5. It implies that the modern manager should have analytical orientation should be expert in motivating to achieve goals and open mandate to receive and respect new ideas, i.e. creativity and innovation.

6. It also implies that management education must seek to develop the ability to work with and motivate others.

7. The feedback mechanism provides an opportunity to rearrange organizations part according to the change in the environment.

(B) Limitations
The system theories have been criticized on the following grounds.

1. Systems theory is not a complete explanation of the whole organizational system. It does not explain how the sub-system of the specific organization is uniquely related in a given environment.

2. The conceptional framework for understanding organization provided by system theory is too abstract.

3. It does not really offer any new thing. Managers do understand interrelationship between different parts and the influence of environment on organization and it sub-systems. What is

necessary for a manager to know as to how the sub-system of a specific organization are uniquely related in a given environment and thus how best to deal with a particular problem? This is not answered by the system approach.

Conclusion

Though facing several criticisms, the system theory provides a framework for integrating much, if not all, of knowledge of management thought. It provides a unified focus to the organizational efforts. Its major contribution results from its strong emphasis on the interrelatedness are mutuality of the part of an organization. It has really opened new vistas for managers of today's world.

Departmentation:

The division of labour divides the jobs into smaller activities. In order to coordinate these activities, they are grouped together. The basis by which these activities are grouped together are known as departmentalisation

It may be defined as the process of forming departments or grouping activities of an organisation into a number of separate units for the purpose of efficient functioning. This term vary a great deal between different organisations. For example, in business undertaking, terms are division, department and section; in Government these are called branch, department and section; in military, regiment, battalion groups and company.

The impact of Departmentation is a delineation of executive responsibilities and a grouping of operating activities. Every level in the hierarchy below the apex is departmentalised and each succeeding lower level involves further departmental differentiation

The major benefits of departmentalisation are:

Specialisation: Departmentation leads to the benefits of specialisation as various organisational activities are grouped according to their relation with the specific functions or objectives. Every departmental manager specialises in the tasks assigned to him.

Administrative control: Departmentation helps in effective managerial control because the standards of performance for each and every department can be laid down precisely. Every department has a specific objective. This also facilitates keeping expenditure within limits

Fixation of responsibility: Since organisation work is divided into manageable units, and authority and responsibility are precisely defined, it is easier to fix the accountability of different managers for the performance of various tasks

Freedom or autonomy: The departments created through Departmentation are semi-autonomous units. Their heads are given a sufficient degree of authority to run their departments. This increases the efficiency of the departments.

Development of managers:

Departmentation helps in the development of managerial personnel by providing them opportunities to take independent decisions and initiative. The executives can develop

themselves for promotion to higher jobs.

Span of Control:
The Departmentation reflects the types of jobs which are grouped together. Different persons are involved in performing these jobs. They are required to be supervised closely.
Span of control refers to the number of individuals a manager can effectively supervise. Thus, it is expected that the span of control, that is, the number of subordinates directly reporting to a superior should be limited so as to make supervision and control effective. This is because executives have limited time and ability.
It is sometimes suggested that the span of control should neither be too wide nor too narrow. In other words, the number of subordinates should not be too large or too small. The number of subordinates cannot be easily determined because the nature of jobs and capacity of individuals vary from one organisation to another. Moreover, the actual span of supervision affects the organisation in different ways. A wide span results in fewer levels of supervision and facilitates communication. It permits only general supervision due to the limited availability of time. Narrow span, on the other hand, requires multiple levels of supervision and hence longer time for communication. It is more expensive and complicates the process of communication. A narrow span, however enables managers to exercise close supervision and control.
Although there are certain limits to the span of control, the tendency in recent years has been to avoid specifying absolute number because it has been recognised that the ideal span depends on a number of factors. Some of the important factors are discussed below:

Nature of the Work: If the work is simple and repetitive, the span of control can be wider. However, if the work requires close supervision the span of control must be narrow.

Ability of the Manager: Some managers are more capable of supervising large number of people than others. Thus for a manager who possesses qualities of leadership, decision-making ability and communication skill in greater degree the span of control may be wider.
Efficiency of the Organisation: Organisations with efficient working systems and competent personnel can have larger span of control

Staff Assistants: When staff assistants are employed, contact between supervisors and subordinates can be reduced and the span broadened.

Time Available for Supervision: The span of control should be narrowed at the higher levels because top managers have less time available for supervision. They have to devote the major part of their work time in planning, organising, directing and controlling.

Ability of the Subordinates: Fresh entrants to jobs take more of a supervisor's time than trained persons who have acquired experience in the job. Subordinates who have good judgement, initiative, and a sense of obligation seek less guidance form the supervisor.

Degree of Decentralisation: An executive who personally takes many decisions is able to supervise fewer people than an executive who merely provides encouragement and occasional direction

It should be clear that the size of the span of control is related to numerous variables, and no

single limit is likely to apply in all cases. A variety of factors can influence the resulting number of employees comprising the optimum span of control in any particular organisation. The span of control also influence the creation of tall and flat structure. Let us learn the concept of tall and flat structure

Advantages and disadvantages of each type of Departmentation
Departmentation by time
Departmentation by enterprise function
Departmentation by territory or geography
Departmentation by customer categories
Departmentation by process or equipment
Departmentation by product
Matrix organization

Tall and Flat Organizational Structure:
A tall organisational structure would have many hierarchical levels there is a long distance between the top most manager and the bottom most manager. There are large number of job titles and a career path to the employee. Fewer numbers of subordinates a particular manager is required to guide, the organisational structure would be taller. Contrarily, a flat structure would have wide span of management. The number of hierarchy would be less. Larger the number of subordinates a particular manager is required to guide the organisational structure would be flatter. Choosing an appropriate span of management is important for two reasons. First, it affects efficiency. Too wide a span may mean that managers are over extended and subordinates are receiving too little guidance or control. When this happens, managers may be pressured to ignore or condone serious errors. In contrast, too narrow a span may mean that managers are underutilized.

Thus, the   extent   of division of work, the nature of delegation of authority, the process of Departmentation and the requirement of effective supervision i.e., span of control influence the designing of organisation structure.

Advantages and Disadvantages of Flat Organisations

Advantages of Flat Organisations	Disadvantages of Flat Organisations
Greater communication between management and workers.	Employees may have more than one manager as there are a number of managers at the same level in the Organization

Better team sprit as fewer management layers increase interraction between employees on different levels (layers).	May hinder the growth of the organisation especially if managers have wide spans of control.
Less bureaucracy and easier decision making	Structure limited to small organisations such as partnerships, co-operatives and private limited companies.
Fewer management layers may reduce costs as managers cost more than non managers. Also employees at higher levels in the organisation expect to be paid more than those on lower levels.	Lack of layers may reduce opportunities for high level strategic management.

Conclusion

There are a number of different organisational structures each with their advantages and disadvantages. The most appropriate structure will depend on the size of the business and the type of business. Flat structures work well for small businesses or those with a small number of job roles. However a business with a flat structure needs to ensure that each manager's span of control does not become too wide so that they can not manage their direct reports effectively.

Decentralisation:

Decentralisation means diffusion of authority. The dispersal of authority of decision-making to the lower level management is termed as decentralisation. Decentralisation of authority is a fundamental phase of delegation and the extent to which authority is not delegated is called centralisation. According to Fayol "Everything that goes to increase the importance of the subordinate's role is called decentralisation."

Decentralisation in relation to office denotes disperse of office services and activities. The necessity of decentralisation of office services occurs when official activities are performed at functional departmental level. Thus, decentralisation in relation to office may include departmentation of activities. When authority is dispersed, decentralisation is present.

The need for decentralisation is felt when the business grows in its size which necessiates diversification of office activities. Decentralisation occurs at the time of decisions of routine nature but if decisions are vital, the authority is not decentralised. The technological development, political factors, availability of managers also affects the degree of decentralisation. Decentralisation does not exist in its pure sense. There is a mixture of the two because some activities are centralised and some are decentralised. Advantages of Decentralisation

Advantages of Decentralisation:

1. Distribution of burden of top executive—Decentralisation enables to its executive to share his burden with others at lower levels because here authority is delegated. The top executive is relieved of some burden and concentrates his activities to think for the future of the organisation.
2. Increased motivation and morale — The morality of the employees are increased because of delegation of authority. Decentralisation helps to increase employees morale because it involves delegation. The employees are motivated to work.
3. Greater efficiency and output—Decentralisation gives emphasis on care, caution and

enthusiastic approach to the work which in turn results in increased efficiency and output. This is possible because it involves delegation of authority and responsibility.

4. Diversification of Activities—Decentralisation helps in diversification of activities. It crests more employment opportunities because new managers are to be entrusted with new assignments.

5. Better Co-ordination—The various operations and activities are co-ordinated in a decentralised set up.

6. Maintenance of Secrecy — Decentralisation enables to maintain secrecy without much cost and unnecessary trouble.

7. Facilitate effective control and quick decision-Decentralisation enables to measure the work according to standard easily and quickly. This facilitate taking up quick decision.

Disadvantages of Decentralisation:

A decentralised organisation suffers from the following disadvantages:

1. More cost—Decentralisation is costly because it encourages duplication of functions and equipments. As it is costly, it cannot be adopted by small organisations.

2. No specialisation — Specialisation suffers in decentralisation because everyone becomes jack-of-all-trades but master of none. So specialisation is affected.

3. Need more specialists-In decentralisation more specialists are needed. The services of specialists are not utilised effectively and efficiently, as they are large in numbers.

4. No uniform action — It becomes difficult to maintain uniformity in action because routine and methods differ from organisation to organisation and department to department.

5. No equitable distribution of work — It becomes difficult to distribute workload equitably among different employees.

UNIT-II

Plant Location: Definition, Factors affecting the Plant Location, Comparison of Rural and Urban sites, Selection of Plant Location – Types of Production; Plant Layout: Definition, Objectives, Types of Plant Layout - Materials Handling: Functions- Objectives – Types, Selection Criteria of Material Handling

Plant Location:

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) or effectiveness 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.

Need for Plant Location:

The need for select plant location due to following conditions such as

1. If an entrepreneur starts a new business.
2. When the current business until does not have any scope for expansion and it had outgrown its original facilities.
3. When a lease expires and landlord is not willing to extend its leasing contract.
4. In case of expansion of the business volume or the degree of market
5. If a firm thinks that there is a chance of decreasing the manufacturing cost by changing from one location to other location.
6. In other economic and social reasons such as improper labour supply, change of market conditions etc. for selecting a plant location.

It is very essential to consider all the economic factors influenced in plant location to select very difficult to select the place having all required facilities for starting a factory because there is some principles will be used such as cost of raw materials fabrication and the cost of marketing

of finished products minimum must be selected.

There is some other needs of plant location such as to start new organization such as existing organisation and location for existing organization and global location

I. To select existing organization:

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

1. **Identification of region:** The organizational objectives along with the various long-term considerations about marketing, technology, internal organizational 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.

2. **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 organization'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.

3. **Dimensional analysis:** If all the costs were tangible and quantifiable, the comparison and selection of a site is easy. The location with the least cost is selected. In most of the cases intangible costs which are expressed in relative terms than in absolute terms. Their relative merits and demerits of sites can also be compared easily. Since both tangible and intangible costs need to be considered for a selection of a site, dimensional analysis is used.

Dimensional analysis consists in computing the relative merits (cost ratio) for each of the cost items for two alternative sites. For each of the ratios an appropriate weightage by means of power is given and multiplying these weighted ratios to come up with a comprehensive figure on the relative merit of two alternative sites i.e.,

$C1^M$, $C2^M$… Cz^M is the different costs associated with a site M on the 'z' different cost items. $C1^N$, $C2^N$, …, Cz^N are the different costs associated with a site N and W1, W2, W3, …, Wz are the Weightage given to these cost items, then relative merit of the M and site N is given by:

$$\left(C_1^M / C_1^N\right)^{W_1} \times \left(C_2^M / C_2^N\right)^{W_2} ,\dots \left(C_z^M / C_z^N\right)^{W_z}$$

If this is > 1, site N is superior and vice-versa.

When starting a new factory, plant location decisions are very important because they have direct bearing on factors like, financial, employment and distribution patterns. In the long run, relocation of plant may even benefit the organization. But, the relocation of the plant involves stoppage of production, and also cost for shifting the facilities to a new location. In addition to these things, it will introduce some inconvenience in the normal functioning of the business. Hence, at the time of starting any industry, one should generate several alternate sites for locating the plant. After a critical analysis, the best site is to be selected for commissioning the plant. Location of warehouses and other facilities are also having direct bearing on the operational performance of organizations.

The existing firms will seek new locations in order to expand the capacity or to place the existing

facilities. When the demand for product increases, it will give rise to following decisions:
- Whether to expand the existing capacity and facilities.
- Whether to look for new locations for additional facilities.
- Whether to close down existing facilities to take advantage of some new locations.

II. In Case of Location Choice for Existing Organisation
    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:
    1. Plant manufacturing distinct products.
    2. Manufacturing plant supplying to specific market area.
    3. Plant divided on the basis of the process or stages in manufacturing.
    4. Plants emphasizing flexibility.
The different operations strategies under the above circumstances could be:
1. **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, delicates 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.

2. **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.

3. **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, labour 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.

4. **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?'

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.

Factors influencing in plant location:
It can be classified as two types such as general factors and specific factors such as
1. General factors:
 1. Availability of land for present and future needs and cost of land and land development and building etc.
2. Availability of inputs such as labour, raw materials etc.
3. Closeness to the market places.
4. Stability of demand and availability of communication facilities.
5. Availability of necessary modes of transportation like road, rail, airport and waterways.
6. Availability of infrastructure facilities such as power, water and financial institutions, banks etc.
7. Disposal of waste and effluent and their impact of environment.
8. Government support, grant, subsidy, tax structure.
9. Availability of housing facilities and recreational facilities.
10. Demographic factors like population, trained man power, academic institutions, standard of living, and income level etc. security, culture of society and fuel cost.

2. Specific Factors: A multinational company, desiring to set up plant should consider the following aspects in addition to the normal factors
 1. The economic stability of the country and the concern of the country towards outside investments are to be considered.
 2. The success of operation of the factory depends on the cultural factors, language and cultural differences which can present operating, control and even policy problems, units of measurement is also very important in international business.
 3. Analysis must be based on the factors like wage rate, policy, duties etc.
 4. The company can setup joint ventures with any leading local giants that will solve many

operational problems.

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

1. **General locational factors**, which include controllable and uncontrollable factors for all type of organizations.

2. **Specific locational factors** specifically required for manufacturing and service organizations. Location factors can be further divided into two categories:

Dominant factors are those derived from competitive priorities (cost, quality, time, and flexibility) and have a particularly strong impact on sales or costs. Secondary factors also are important, but management may downplay or even ignore some of them if other factors are more important.

General Locational Factors
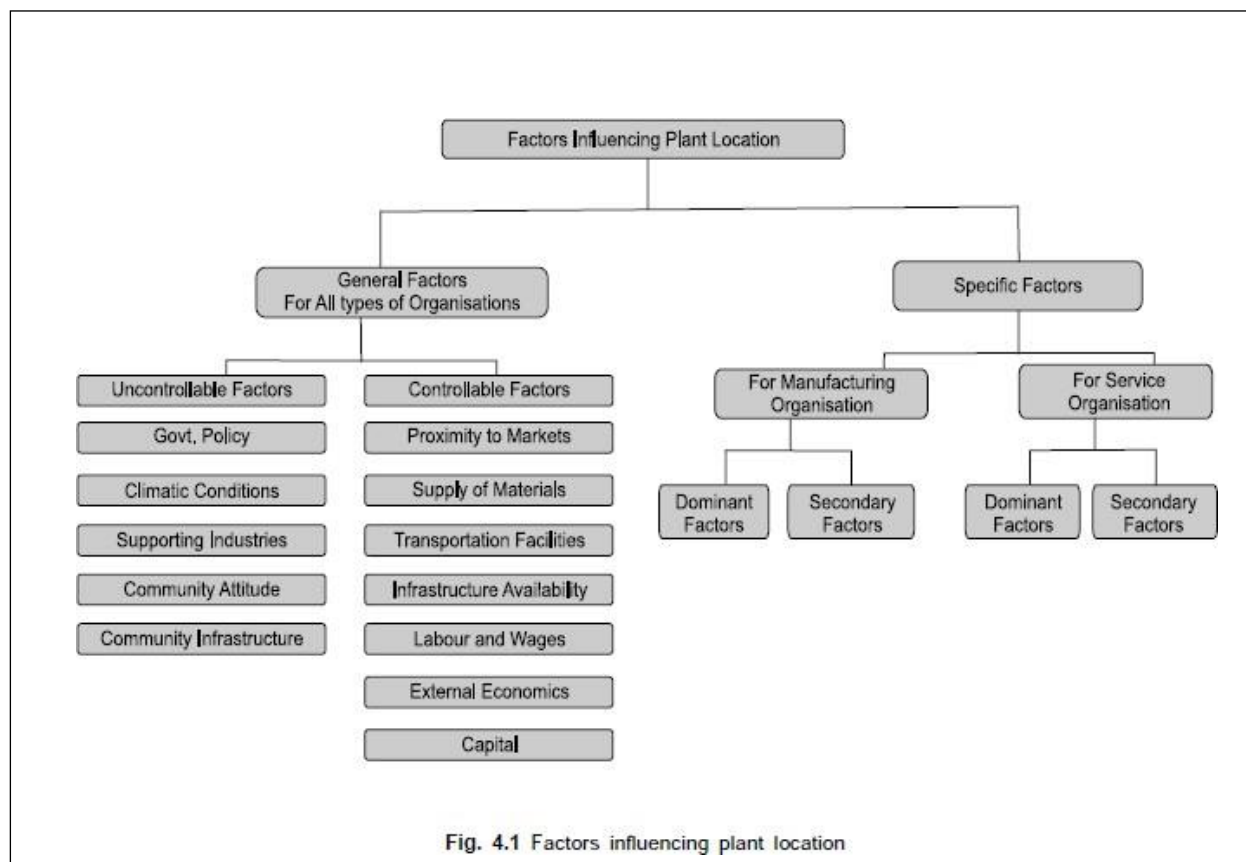Following are the general factors required for location of plant in case of all types of organizations.

CONTROLLABLE FACTORS
1. Proximity to markets
2. Supply of materials
3. Transportation facilities
4. Infrastructure availability
5. Labour and wages
6. External economies
.**UNCONTROLLABLE FACTORS**
8. Government policy
9. Climate conditions
10. Supporting industries and services
11. Community and labour attitudes
12. Community Infrastructure.

7. Capital

Fig. 4.1 Factors influencing plant location

DOMINANT FACTORS for Manufacturing Organization

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

1. Favourable labour climate
2. Proximity to markets
3. Quality of life
4. Proximity to suppliers and resources
5. Utilities, taxes, and real estate costs

SECONDARY FACTORS for Manufacturing Organization

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.

DOMINANT FACTORS for Service Organization

The factors considered for manufacturers are also applied to service providers, with one important addition — the impact of location on sales and customer satisfaction. Customers usually look about how close a service facility is, particularly if the process requires considerable customer contact.

PROXIMITY TO CUSTOMERS

Location is a key factor in determining how conveniently customers can carry on business with

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.

LOCATION OF COMPETITORS

One complication in estimating the sales potential at different location is the impact of competitors. Management must not only consider the current location of competitors but also try to anticipate their reaction to the firm's new location. Avoiding areas where competitors are already well established often pays. However, in some industries, such as new-car sales showrooms and fast-food chains, locating near competitors is actually advantageous. The strategy is to create a critical mass, whereby several competing firms clustered in one location attract more customers than the total number who would shop at the same stores at scattered locations. Recognizing this effect, some firms use a follow –the leader strategy when selecting new sites.

SECONDARY FACTORS

Retailers also must consider the level of retail activity, residential density, traffic flow, and site visibility. Retail activity in the area is important, as shoppers often decide on impulse to go shopping or to eat in a restaurant. Traffic flows and visibility are important because businesses customers arrive in cars. Visibility involves distance from the street and size of nearby buildings and signs. High residential density ensures night time and weekend business when the population in the area fits the firm's competitive priorities and target market segment.

Mathematical model for plant location

Various models are available which help to identify the ideal location. Some of the popular models are:
1. Factor rating method
2. Weighted factor rating method
3. Load-distance method
4. Centre of gravity method
5. Break-even analysis.

1. Factor rating Method or Location factor rating method:

The process of selecting a new facility location involves a series of following steps:
1. Identify the important location factors.
2. Rate each factor according to its relative importance, i.e., higher the ratings is indicative of prominent factor.
3. Assign each location according to the merits of the location for each factor.
4. Calculate the rating for each location by multiplying factor assigned to each location with basic factors considered.
5. Find the sum of product calculated for each factor and select best location having highest total score.

Problem: 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

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

2. Weighted factor rating method:

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.

Problem: 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 factor's weight by its score and adding the results:

Weighted score location $1 = 25 \times 3 + 25 \times 4 + 25 \times 3 + 15 \times 1 + 10 \times 5$
$$= 75 + 100 + 75 + 15 + 50 = 315$$
Weighted score location $2 = 25 \times 5 + 25 \times 3 + 25 \times 3 + 15 \times 2 + 10 \times 3$
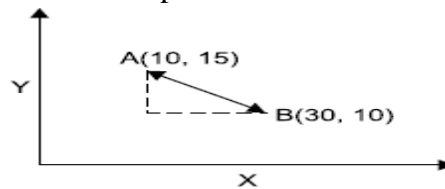$$= 125 + 75 + 75 + 30 + 30 = 335$$
Location 2 is the best site based on total weighted scores.

3. Load-distance Method:

The load-distance method is a mathematical model used to evaluate locations based on proximity factors. The objective is to select a location that minimizes the total weighted loads moving into and out of the facility. The distance between two points is expressed by assigning the points to grid coordinates on a map. An alternative approach is to use time rather than distance.

DISTANCE MEASURES

Suppose that a new warehouse is to be located to serve Delhi. It will receive inbound shipments from several suppliers, including one in Ghaziabad. If the new warehouse were located at Gurgaon, what would be the distance between the two facilities? If shipments travel by truck, the distance depends on the highway system and the specific route taken. Computer software is available for calculating the actual mileage between any two locations in the same county. However, for load-distance method, a rough calculation that is either Euclidean or rectilinear distance measure may be used. Euclidean distance is the straight-line distance, or shortest possible path, between two points.

Fig: Distance between point A and point B

The point A on the grid represents the supplier's location in Ghaziabad, and the point B represents the possible warehouse location at Gurgaon. The distance between points A and B is the length of the hypotenuse of a right triangle, or

$$d_{AB} = \sqrt{((XA - XB)^2 + (YA - YB)^2)}$$

where,

dAB = distance between points A and B

XA = x-coordinate of point A

YA = y-coordinate of point A

XB = x-coordinate of point B

YB = y-coordinate of point B

Rectilinear distance measures distance between two points with a series of 90° turns as city blocks. Essentially, this distance is the sum of the two dashed lines representing the base and side of the triangle in figure. The distance travelled in the x-direction is the absolute value of the difference in x-coordinates. Adding this result to the absolute value of the difference in the y-coordinates gives

$$D_{AB} = |XA - XB| + |YA - YB|$$

Problem: The new Health-care facility is targeted to serve seven census tracts in Delhi. The table given below shows the coordinates for the centre of each census tract, along with the projected populations, measured in thousands. Customers will travel from the seven census tract centres to the new facility when they need health-care. Two locations being considered for the new facility are at (5.5, 4.5) and (7, 2), which are the centres of census tracts C and F. Details of seven census tract centres, co-ordinate distances along with the population for each centre are given below. If we use the population as the loads and use rectilinear distance, which location is better in terms of its total load-distance score?

Sl. No.	Census tract	(x, y)	Population (I)
1	A	(2.5, 4.5)	2
2	B	(2.5, 2.5)	5
3	C	(5.5, 4.5)	10
4	D	(5, 2)	7
5	E	(8, 5)	10
6	F	(7, 2)	20
7	G	(9, 2.5)	14

SOLUTION: Calculate the load-distance score for each location. Using the coordinates from the above table. Calculate the load-distance score for each tract.

Using the formula $DAB = |XA - XB| + |YA - YB|$

Summing the scores for all tracts gives a total load-distance score of 239 when the facility is located at (5.5, 4.5) versus a load-distance score of 168 at location (7, 2). Therefore, the location in census tract F is a better location.

Census tract	(x, y)	Population (I)	Locate at (5.5, 4.5)		Locate at (7, 2)	
			Distance (d)	Load-distance	Distance (d)	Load-distance
A	(2.5, 4.5)	2	3 + 0 = 3	6	4.5 + 2.5 = 7	14
B	(2.5, 2.5)	5	3 + 2 = 5	25	4.5 + 0.5 = 5	25
C	(5.5, 4.5)	10	0 + 0 = 0	0	1.5 + 2.5 = 4	40
D	(5, 2)	7	0.5 + 2.5 = 3	21	2 + 0 = 2	14
E	(8, 5)	10	2.5 + 0.5 = 3	30	1 + 3 = 4	40
F	(7, 2)	20	1.5 + 2.5 = 4	80	0 + 0 = 0	0
G	(9, 2.5)	14	3.5 + 2 = 5.5	77	2 + 0.5 = 2.5	35
			Total	239	Total	168

4. Centre of Gravity:

Centre of gravity is based primarily on cost considerations. This method can be used to assist managers in balancing cost and service objectives. The centre of gravity method takes into account the locations of plants and markets, the volume of goods moved, and transportation costs in arriving at the best location for a single intermediate warehouse.

The centre of gravity is defined to be the location that minimizes the weighted distance between the warehouse and its supply and distribution points, where the distance is weighted by the number of tones supplied or consumed. The first step in this procedure is to place the locations on a coordinate system. The origin of the coordinate system and scale used are arbitrary, just as long as the relative distances are correctly represented. This can be easily done by placing a grid over an ordinary map. The centre of gravity is determined by the formula.

$$C_X = \frac{\sum D_{ix} \cdot W_i}{\sum W_i} \qquad C_Y = \frac{\sum D_{iy} \cdot W_i}{\sum W_i}$$

Where, C_x = x-coordinate of the centre of gravity
C_y = y-coordinate of the centre of gravity
D_{ix} = x-coordinate of location i

D_{iy} = y-coordinate of location i

Problem: The new Health-care facility is targeted to serve seven census tracts in Delhi. The table given below shows the coordinates for the centre of each census tract, along with the projected populations measured in thousands. Customers will travel from the seven census tract centres to the new facility when they need health-care. Two locations being considered for the new facility are at (5.5, 4.5) and (7, 2), which are the centres of census tracts C and F. Details of seven census tract centres, coordinate distances along with the population for each centre are given below. Find the target area's centre of gravity for the Health care medical facility

Sl. No.	Census tract	(x, y)	Population (l)
1	A	(2.5, 4.5)	2
2	B	(2.5, 2.5)	5
3	C	(5.5, 4.5)	10
4	D	(5, 2)	7
5	E	(8, 5)	10
6	F	(7, 2)	20
7	G	(9, 2.5)	14

SOLUTION: To calculate the centre of gravity, start with the following information, where population is given in thousands.

Sl. No.	Census tract	(x, y)	Population (l)	Lx	Ly
1	A	(2.5, 4.5)	2	5	9
2	B	(2.5, 2.5)	5	12.5	12.5
3	C	(5.5, 4.5)	10	55	45
4	D	(5, 2)	7	35	14
5	E	(8, 5)	10	80	50
6	F	(7, 2)	20	140	40
7	G	(9, 2.5)	14	126	35
		Total	68	453.50	205.50

Next we find C_x and C_y.

$$C_x = 453.5/68 = 6.67$$
$$C_y = 205.5/68 = 3.02$$

The centre of gravity is (6.67, 3.02). Using the centre of gravity as starting point, managers can now search in its vicinity for the optimal location.
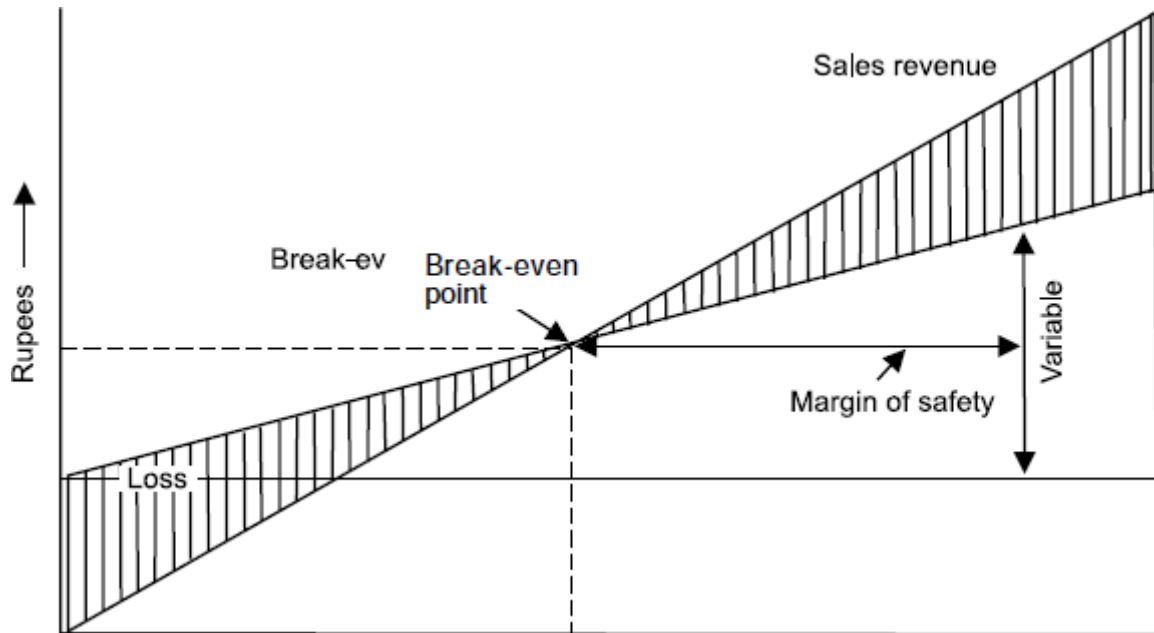
5. Break-even Analysis:

Break even analysis implies that at some point in the operations, total revenue equals total cost. Break even analysis is concerned with finding the point at which revenues and costs agree exactly. It is called 'Break even Point'. The Figure portrays the Break Even Chart: Breakeven point is the volume of output at which neither a profit is made nor a loss is incurred.

The Break Even Point (BEP) in units can be calculated by using the relation:

$$BEP = \frac{\text{Fixed Cost}}{\text{Contribution per unit}} = \frac{\text{Fixed Cost}}{\text{Selling Price} - \text{Variable Cost per unit}} = \frac{F}{S-V} \text{ units}$$

The Break Even Point (BEP) in Rs. can be calculated by using the relation:

$$BEP = \frac{\text{Fixed Cost}}{\text{PV Ratio}} = \frac{\text{Fixed Cost}}{\left\{\dfrac{\text{Sales} - \text{Variable Cost}}{\text{Sales}}\right\}} = \frac{F}{\phi} \text{ Rs.}$$

Fig: Units of output or percentage of capacity

Plotting the break even chart for each location can make economic comparisons of locations. This will be helpful in identifying the range of production volume over which location can be selected.

Problem: Potential locations X, Y and Z have the cost structures shown below. The ABC company has a demand of 1,30,000 units of a new product. Three potential locations X, Y and Z having following cost structures shown are available. Select which location is to be selected and also identify the volume ranges where each location is suited?

	Location X	Location Y	Location Z
Fixed Costs	Rs. 150,000	Rs. 350,000	Rs. 950,000
Variable Costs	Rs. 10	Rs. 8	Rs. 6

SOLUTION: Solve for the crossover between X and Y:

$$10X + 150,000 = 8X + 350,000$$
$$2X = 200,000$$
$$X = 100,000 \text{ units}$$

Solve for the crossover between Y and Z:

$$8X + 350,000 = 6X + 950,000$$
$$2X = 600,000$$
$$X = 300,000 \text{ units}$$

Therefore, at a volume of 1, 30,000 units, Y is the appropriate strategy. From the graph we can interpret that location X is suitable up to 100,000 units, location Y is suitable up to between 100,000 to 300,000 units and location Z is suitable if the demand is more than 300,000 units.
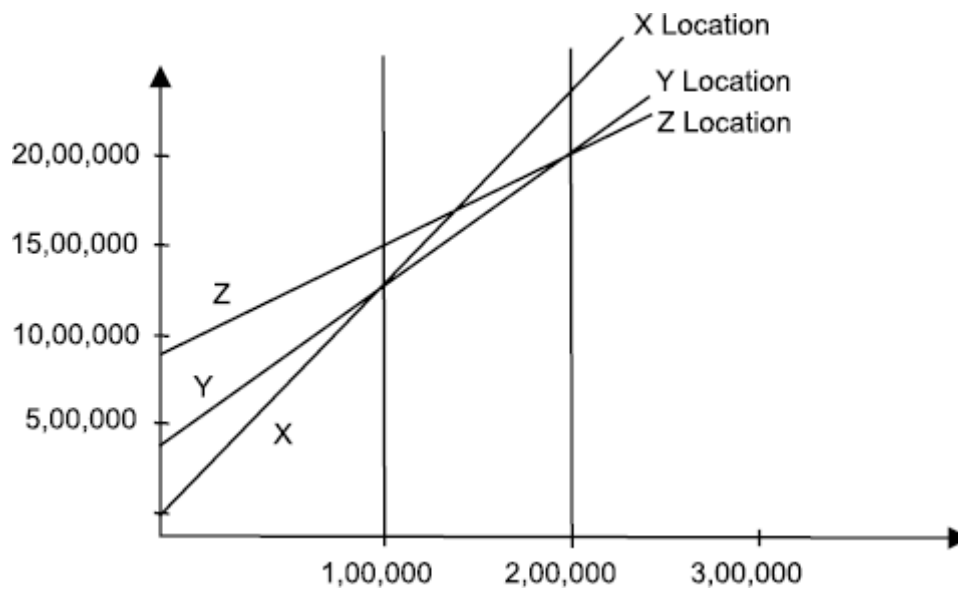
Figure: BEP chart

PLANT LAYOUT

The term 'Plant layout' refers to the physical arrangement of production facilities. It is the configuration of departments, work centres and equipment in the conversion process. It is a floor plan of the physical facilities, which are used in production.

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

Objectives of Plant Layout

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

The objectives of plant layout are:

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

CLASSIFICATION OF LAYOUT

Layouts can be classified into the following five categories:

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

1. Process layout

Process layout is recommended for batch production. All machines performing similar type of operations

are grouped at one location in the process layout e.g., all lathes, milling machines, etc. are grouped in the shop will be clustered in like groups.

Thus, in process layout the arrangement of facilities are grouped together according to their functions. A typical process layout is shown in Fig. 4.5. The flow paths of material through the facilities from one functional area to another vary from product to product. Usually the paths are long and there will be possibility of backtracking.

Process layout is normally used when the production volume is not sufficient to justify a product layout. Typically, job shops employ process layouts due to the variety of products manufactured and their low production volumes.

Milling Machines	Lathe		Assembly	
▼ Welding	→ Grinding	Inspection	Shipping & Receiving	Painting ▼

Process Layout

Advantages
1. In process layout machines are better utilized and fewer machines are required.
2. Flexibility of equipment and personnel is possible in process layout.
3. Lower investment on account of comparatively less number of machines and lower cost of general purpose machines.
4. Higher utilization of production facilities.
5. A high degree of flexibility with regards to work distribution to machineries and workers.
6. The diversity of tasks and variety of job makes the job challenging and interesting.
7. Supervisors will become highly knowledgeable about the functions under their department.
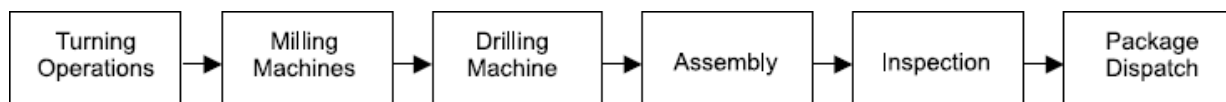
Limitations
1. Backtracking and long movements may occur in the handling of materials thus, reducing material handling efficiency.
2. Material handling cannot be mechanised which adds to cost.
3. Process time is prolonged which reduce the inventory turnover and increases the inprocess inventory.
4. Lowered productivity due to number of set-ups.
5. Throughput (time gap between in and out in the process) time is longer.
6. Space and capital are tied up by work-in-process.

2. Product layout

In this type of layout, machines and auxiliary services are located according to the processing sequence of the product. If the volume of production of one or more products is large, the facilities can be arranged to achieve efficient flow of materials and lower cost per unit. Special purpose machines are used which perform the required function quickly and reliably.

The product layout is selected when the volume of production of a product is high such that a separate production line to manufacture it can be justified. In a strict product layout, machines are not shared by different products. Therefore, the production volume must be sufficient to achieve satisfactory utilization of the equipment. A typical product layout is shown in figure.

Turning Operations	→	Milling Machines	→	Drilling Machine	→	Assembly	→	Inspection	→	Package Dispatch

Product layout

Advantages
1. The flow of product will be smooth and logical in flow lines.
2. In-process inventory is less.
3. Throughput time is less.
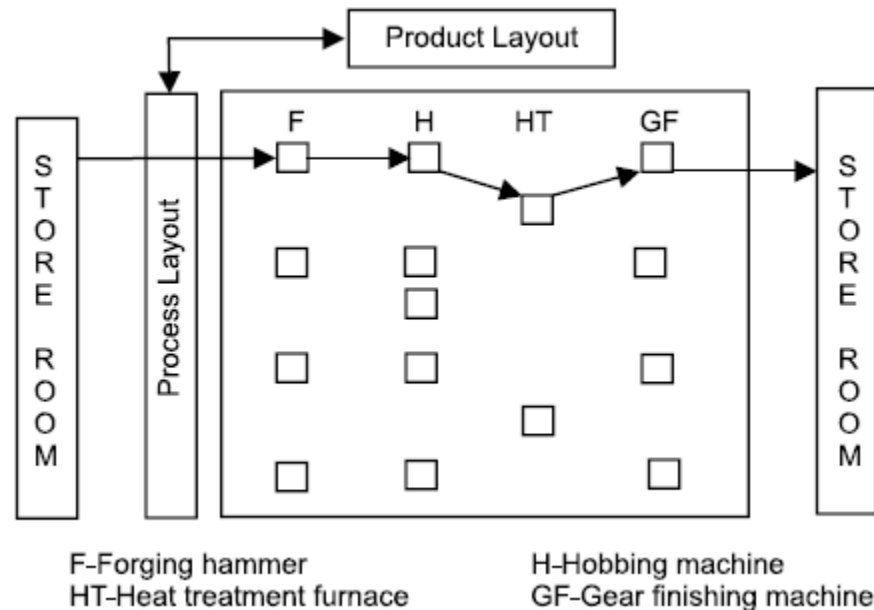4. Minimum material handling cost.

5. Simplified production, planning and control systems are possible.
6. Less space is occupied by work transit and for temporary storage.
7. Reduced material handling cost due to mechanised handling systems and straight flow.
8. Perfect line balancing which eliminates bottlenecks and idle capacity.
9. Manufacturing cycle is short due to uninterrupted flow of materials.
10. Small amount of work-in-process inventory.
11. Unskilled workers can learn and manage the production.

Limitations
1. A breakdown of one machine in a product line may cause stoppages of machines in the downstream of the line.
2. A change in product design may require major alterations in the layout.
3. The line output is decided by the bottleneck machine.
4. Comparatively high investment in equipments is required.
5. Lack of flexibility. A change in product may require the facility modification.
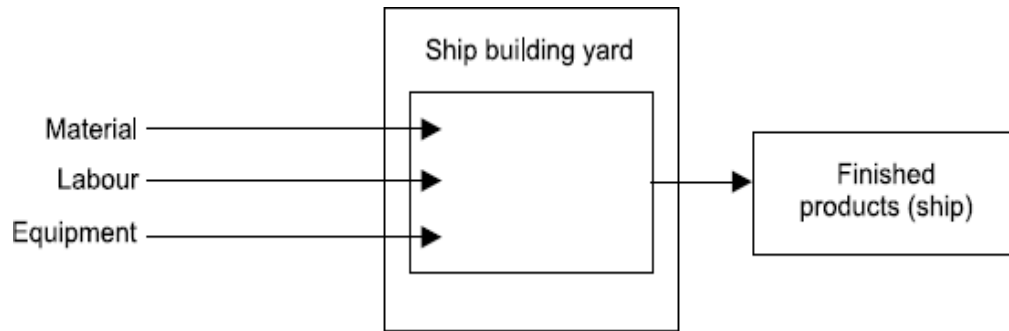
3. Combination Layout

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

F-Forging hammer   H-Hobbing machine
HT-Heat treatment furnace   GF-Gear finishing machine

Combining layout for making different types of size and gears

4. Fixed Position Layout

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

Fixed Position Layout

Advantages

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

Disadvantages

1. Personal and equipment movement is increased
2. It is also result in duplicate equipment.
3. Requires great skill for personnel and general supervision.
4. It is also result in increased space and greater work-in-process.

5. Group Layout (or Cellular Manufacturing Layout)

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

Group Technology (GT) is the analysis and comparisons of items to group them into families with similar characteristics. GT can be used to develop a hybrid between pure process layout and pure flow line (product) layout. This technique is very useful for companies that produce variety of parts in small batches to enable them to take advantage and economics of flow line layout.

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

Thus group layout is a combination of the product layout and process layout. It combines the advantages of both layout systems. If there are m-machines and n-components, in a group layout (Group Technology Layout), the m-machines and n-components will be divided into distinct number of machine-component cells (group) such that all the components assigned to a cell are almost processed within that cell itself. Here, the objective is to minimize the intercell movements.

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

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

In-group technology layout, the objective is to minimize the sum of the cost of transportation and the cost of equipments. So, this is called as multi-objective layout. A typical process layout is shown in figure.

Advantages of Group Technology Layout

Group Technology layout can increase—

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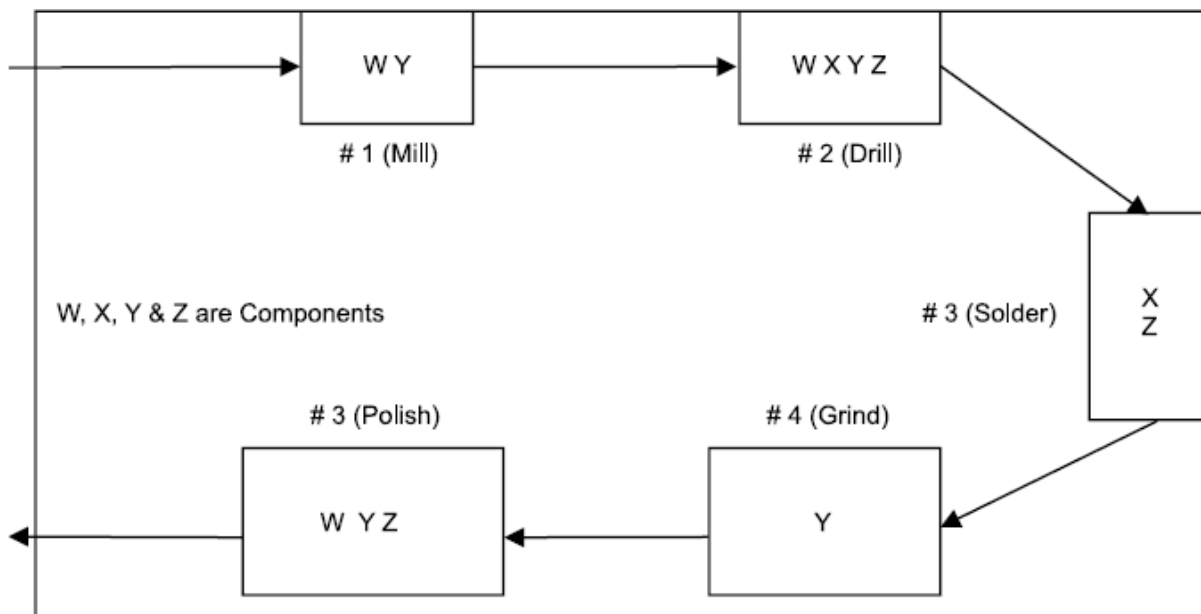4. Customer service.
It can decrease the—
1. Paper work and overall production time.
2. Work-in-progress and work movement.
3. Overall cost.

Disadvantages of Group Technology Layout
1. Involves less manufacturing flexibility
2. Increases the machine down time as machine as grouped as cells which may not be functional throughout the production process
3. Duplicate parts of equipment are used as it is very difficult for transferring the parts between cells causing the rise in production inefficiencies.

Suitability of cellular layout:
1. Cellular layout helps in producing products having different parts.
2. It can apply in the work centers having easily movable machine tools.
3. It is used when the production of a product is independent of its capacity.

Group Layout or Cellular Manufacturing Layout

UNIT – III

Work Measurement (Time study)

Work measurement refer to the estimation of standard time, that is the time allowed for completing one piece of job using the given method. This is the time taken by an average experienced worker for the job with provisions for delays beyond the workers control.

Definition: Time study is a technique to estimate the time to be allowed to a qualified and well-trained worker working at a normal pace to complete a specified task.

There are several techniques used for estimation of standard time in industry. These include time study, work sampling, standard data, and predetermined time systems.

Application
Standard times for different operations in industry are useful for several applications like

- Estimating material machinery and equipment requirements.
- Estimating the production cost per unit as an input to
  ™Preparation of budgets
  ™Determination of selling price
  ™Make or buy decision
- Estimating manpower requirements.
- Estimating delivery schedules and planning the work
- Balancing the work of operators working in a group.
- Estimating performance of workers and use as basis for incentive payment to those direct and in director labur who show greater productivity.

Time Study Procedure
The procedure for time study can best be described step-wise, which are self explanatory.

Step 1: Define objective of the study. This involves statement of the use of the result, the precision desired, and the required level of confidence in the estimated time standards.

Step 2: Analyse the operation to determine whether standard method and conditions exist and whether the operator is properly trained. If need is felt for method study or further training of operator, the same may be completed before starting the time study.

Step 3: Select Operator to be studied if there is more than one operator doing the same task.

Step 4: Record information about the standard method, operation, operator, product, equipment, quality and conditions.

Step 5: Divide the operation into reasonably small elements.

Step 6: Time the operator for each of the elements. Record the data for a few number of cycles. Use the data to estimate the total numbers of observations to be taken.

Step 7: Collect and record the data of required number of cycles by timing and rating the operator.

Step 8: For each element **calculate** the representative watch time. Multiply it by the rating factory to get

normal time.

Normal time = Observed time * Rating factor

Add the normal time of various elements to obtain the normal time for the whole operation.

Step 9: Determine allowances for various delays from the company's policy book or by conducting an independent study.

Step 10: Determine standard time by adding allowances to the normal time of operation.

Standard time = Normal time + allowances

Time Study Equipment

The following equipment is needed for time study work.
• Timing device
• Time study observation sheet
• Time study observation board
• Other equipment

Timing Device
The stop watch and the electronic timer are the most widely used timing devices used for time study. The two perform the same function with the difference that electronics timer can measure time to the second or third decimal of a second and can keep a large volume of time data in memory.

Time Study Observation Sheet
It is a printed form with space provided for nothing down the necessary information about the operation being studied like name of operation, drawing number, name of the operator, name of time study person, and the date and place of study. Space are provided in the form for writing detailed description of the process (element-wise), recording stop-watch readings for each element of the process, performance rating(s) of the operator, and computation Figure 2 Shows a typical time study observation sheet.

Time Study Board
It is a light -weight board used for holding the observation sheet and stopwatch in position. It is of size slightly larger than that of observation sheet used. Generally, the watch is mounted at the center of the top edge or as shown in Figure 3 near the upper right-hand corner of the board. The board has a clamp to hold the observation sheet. During the time study, the board is held against the body and the upper left arm by the time study person in such a way that the watch could be operated by the thumb/index finger of the left hand.
Watch readings are recorded on the observation sheet by the right hand.

Other Equipment
This includes pencil, eraser and device like tachometer for checking the speed, etc.

Normal Performance
There is no universal concept of Normal Performance. However, it is generally defined as the working rate of an average qualified worker working under capable supervision but not under any incentive wage payment scheme. This rate of working is characterized by the fairly steady exertion of reasonable effort, and can be maintained day after day without undue physical or mental fatigue.

The level of normal performance differs considerably from one company to another. What company a calls 100 percent performance, company B may call 80 percent, and company C may call 125 percent and so on. It is important to understand that the level that a company selects for normal performance is not critical but maintaining that level uniform among time study person and constant with the passage of time within the

company is extremely important.

There are, of course, some universally accepted benchmark examples of normal performance, like dealing 52 cards in four piles in 0.5 minute, and walking at 3 miles per hour (4.83 km/hr). In order to make use of these benchmarks, it is important that a complete description about these be fully understood, like in the case of card dealing, what is the distance of each pile with respect to the dealer, technique of grasping, moving and disposal of the cards.

Some companies make use of video films or motion pictures for establishing what they consider as normal speed or normal rate of movement of body members. Such films are made of typical factory jobs with the operator working at the desired normal pace. These films are reported to be useful in demonstrating the level of performance expected from the operators and also for training of time study staff.

Performance Rating
During the time study, time study engineer carefully observes the performance of the operator. This performance seldom conforms to the exact definition of normal or standard.

Therefore, it becomes necessary to apply some 'adjustment' to the mean observed time to arrive at the time that the normal operator would have needed to do that job when working at an average pace. This 'adjustment' is called **Performance Rating.**

Determination of performance rating is an important step in the work measurement procedures. It is based entirely on the experience, training, and judgment of the workstudy engineer. It is the step most subjective and therefore is subject to criticism.

It is the procedure in which the time study engineer compares the performance of operator(s) under observation to the Normal Performance and determines a factor called **Rating Factor.**

$$\text{Rating factor} = \frac{\text{Observed performance}}{\text{Normal performance}}$$

System of Rating
There are several systems of rating, the performance of operator on the job. These are
    1. Pace Rating
    2. Westinghouse System of Rating
    3. Objective Rating
    4. Synthetic Rating
A brief description of each rating method follows.

Pace Rating
Under this system, performance is evaluated by considering the rate of accomplishment of the work per unit time. The study person measures the effectiveness of the operator against the concept of normal performance and then assigns a percentage to indicate the ratio of the observed performance to normal or standard performance.
In this method, which is also called the speed rating method, the time study person judges the operators speed of movements, i.e. the rate at which he is applying himself, or in other words "how fast" the operator the motions involved.

Westinghouse System of Rating
This method considers four factors in evaluating the performance of the operator : Skill, effort, conditions and Consistency.
Skill may be defined as proficiency at following a given method. It is demonstrated by co ordination of mind and hands. A person's skill in given operation increases with his experience on the job, because increased familiarity with work bring speed, smoothness of motions and freedom from hesitations.

The Westinghouse system lists six classes of skill as poor fair, average, good, excellent in a Table1. The time study person evaluates the skill displayed by the operator and puts it in one of the six classes. As equipment % value of each class of skill is provided in the table, the rating is translated into its equivalent percentage value, which ranges from +15 % (for super skill) to – 22 % (for poor skill).

In a similar fashion, the ratings for effort, conditions, and consistency are given using Table2 for each of the factors. By algebraically combining the ratings with respect to each of the four factors, the final performance-rating factor is estimated.

Objective Rating
In this system, speed of movements and job difficulty are rated separately and the two estimates are combined into a single value. Rating of speed or pace is done as described earlier, and the rating of job difficulty is done by selecting adjustment factors corresponding to characteristics of operation with respect to (i) amount of body used, (ii) foot pedals, (iii) bimanual ness, (iv) eye-hand co ordination, (v) handling requirements and (vi) weight handled or resistance encountered Mundel and Danner have given Table of % values (adjustment factor) for the effects of various difficulties in the operation performed.
For an operation under study, the numerical value for each of the six factors is assigned, and the algebraic sum of the numerical values called job difficulty adjustment factor is estimated.

The rating factor R can be expressed as
$$R = P \times D$$
Where: P = Pace rating factor, D = Job difficulty adjustment factor.

Synthetic Rating
This method of rating has two main advantages over other methods that (i) it does not rely on the judgment of the time study person and (ii) it give consistent results.
The time study is made as usual. Some manually controlled elements of the work cycle are selected. Using a PMT system (Pre-determined motion time system), the times for these elements are determined. The times of these elements are the performance factor is determined for each of the selected elements.
Performance or Rating Factor, $R = P / A$
Where P = Predetermined motion time of the element,
        A = Average actual Observed time of the element.
The overall rating factor is the mean of rating factors determined for the selected elements, which is applied uniformly to all the manually controlled elements of the work cycle.

Example: A work cycle has been divided into 8 elements and time study has been conducted. The average observed times for the elements are as:

Element No.	1	2	3	4	5	6	7	8
Element Type	M	M	P	M	M	M	M	M
Average actual time(minutes)	0.14	0.16	0.30	0.52	0.26	0.45	0.34	0.15

M = Manually Controlled, P = Power Controlled
Total observed time of work cycle = **2.32 min**.
Suppose we select elements number 2, 5 and 8 (These must be manually controlled elements). By using some PMT system, suppose we determine the times of these elements as

Elements No.	2	5	8
PMT System times (mins)	0.145	0.255	0.140

Rating factor for element 2 = 0.145 / 0.16 = **90.06%**
Rating factor for element 5 = 0.255 / 0.26 = **98.08%**
Rating factor for element8 = 0.140 / 0.15 = **96.66%**
The mean of the rating factors of selected elements = **94.93%** or say **95%** is the rating factor that will be used for all the manual elements of the work cycle.
The normal time of the cycle is calculated as given in the following table.

Element No.	1	2	3	4	5	6	7	8
Element Type	M	M	P	M	M	M	M	M
Averageactual time(min)	0.14	0.16	0.30	0.52	0.26	0.45	0.34	0.15
PMT system time(min)		0.145			0.255			0.14
Performance Rating Factor	95	95	100	95	95	95	95	95

Normal Cycle Time = 0.95(0.14 + 0.16 + 0.52 + 0.26 + 0.45 + 0.34 + 0.15) + 1.00(0.30)
               = 1.92 + 0.30 = **2.22 minutes**

Allowances
The readings of any time study are taken over a relatively short period of time. The normal time arrived at, therefore does not include unavoidable delay and other legitimate lost time, for example, in waiting for materials, tools or equipment; periodic inspection of parts; interruptions due to legitimate personal need, etc. It is necessary and important that the time study person applies some adjustment, or allowances to compensate for such losses, so that fair time standard is established for the given job.

Allowances are generally applied to total cycle time as some percentage of it, but sometimes these are given separately as some % for machine time and some other % for manual effort time. However no allowance are given for interruptions which maybe due to factor which are within the operator's control or which are avoidable.

UNIT IV
INVENTORY CONTROL

1. Introduction

Inventory is defined as the list of movable goods which are necessary to manufacture a product and to maintain the equipments and machinery in good working order/condition.

Classification

Broadly Classified into

• Direct inventory

• Indirect inventory

i. Direct inventory

It plays direct role in the manufacture of product such as:

• Raw materials

• Inprocess inventories (= work in progress)

• Purchased parts (purchasing of some components instead of manf. in the plant)

• Inished goods.

ii. Indirect inventory

it helps the raw materials to get converted into finished part. such as:

ϖ Tools

ϖ Supplies

- miscellaneous consumable – brooms, cotton, wool, jute, etc.

- welding electrode, solders etc.

- abrasive mat – emery cloth, sand paper etc.

- brushes, maps, etc.

- oil greases etc.

- general office supplies – candles, sealing wax etc.

- printed forms such as – envelope, letter heads, quotation forms etc.

Inventory control

Inventory control means – making the desired items of required quality and quantity available to various departments/section as & when they need.

(c) Relevant costs

The relevant costs for how much & when decisions of normal inventory keeping one:

1. Cost of capital

Since inventory is equivalent to locked-up working capital the cost of capital is an important relevant cost. this is the opportunity cost of investing in inventory.

2. Space cost

Inventory keeping needs space and therefore, how much and when question of inventory keeping are related to space requirements. This cost may be the rent paid for the space.

3. Materials handling cost

The material need to be moved within the warehose and the factory and the cost associated with the

internal movement of materials (or inventory) is called materials handling cost.

4. Obsolescence, spoilage or Deterioration cost

If the inventory is procured in a large quantity, there is always a risk of the item becoming absolute due to a change in product design or the item getting spoiled because of natural ageing process. Such cost has a relation to basic question of how much and when?

5. Insurance costs

There is always a risk of fire or theft of materials. a firm might have taken insurance against such mishaps and the insurance premium paid are the relevant cost.

6. Cost of general administration

Inventory keeping will involve the use of various staffs. with large inventories, the cost of general administration might go up.

7. Inventory procurement cost

Cost associated with the procurement activities such as tendering, evaluation of bids, ordering, follow-up the purchase order, receipt and inspection of materials etc. is called inventory procurement cost.

(c) Basic EOQ model

EOQ = Economic Order Quantity.

EOQ represent the size of the order (or lot size) such that the sum of carrying cost (due to holding the inventory) and ordering cost is minimum. it is shown by point A of figure 2.1.

As mentioned earlier, the two most important decisions related to inventory control are:

• When to place an order? &

• How much to order?

In 1913, F.W. Harris developed a rule for determining optimum number of units of an item to purchase based on some fundamental assumptions. This model is called Basic Economic Order Quantity model. it has broad applicability.

Assumptions

The following assumptions are considered for the sake of simplicity of model.

1) Demand (D) is assumed to be uniform.

2) The purchase price per unit (P) is independent of quantity ordered.

3) The ordering cost per order (Co) is fixed irrespective of size f lot.

4) The carrying cost/holding cost (Cc) is proportional to the quantity stored.

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

6) The lead time (LT) for deliveries (i.e. the time of ordering till the material is delivered) is constant and is known with certainty.