ATME College of Engineering

13th K M Stone, Bannur Road, Mysore – 570028

A T M E
College of Engineering

DEPARTMENT OF CIVIL ENGINEERING

(ACADEMIC YEAR 2025-26)

SUBJECT: CONSTRUCTION MANAGEMENT & ENTREPRENEURSHIP

SUBJECT CODE: BCV501

SEMESTER: 5TH

INSTITUTE

Vision of the Institute

Development of academically excellent, culturally vibrant, socially responsible and globally competent human resources.

Mission of the Institute

- To keep pace with advancements in knowledge and make the students competitive and capable at the global level.
- To create an environment for the students to acquire the right physical, intellectual, emotional and moral foundations and shine as torchbearers of tomorrow's society.
- To strive to attain ever-higher benchmarks of educational excellence.

DEPARTMENT

Vision of the Department

To develop globally competent civil engineers who excel in academics, research and are ethically responsible for the development of the society.

Mission of the Department

- To provide quality education through faculty and state of the art infrastructure.
- To identify current problems in the society pertaining to Civil Engineering disciplines and to address them effectively and efficiently.
- To inculcate the habit of research and entrepreneurship in our graduates to address current infrastructure needs of society.

PROGRAM EDUCATIONAL OBJECTIVES (PEO's)

- Graduates who complete their UG course through our institution will be,
- **PEO l-** Engaged in professional practices, such as construction, environmental, geotechnical, structural, transportation, or water resources engineering by using technical, communication and management skills.
- **PEO 2-** Engaged in higher studies and research activities in various Civil Engineering fields and a life time commitment to learn ever changing technologies to satisfy increasing demand of sustainable infrastructural facilities
- **PEO 3-** Serve in a leadership position in any professional or community organization, or local/state engineering board
- **PEO 4-** Registered as a professional engineer or developed a strong ability leading to professional licensure being an entrepreneur.

PROGRAM SPECIFIC OUTCOMES (PSO's)

- **PSO1:** Provide necessary solutions to build infrastructure for all situations through Competitive plans, maps and designs with the aid of a thorough Engineering Survey and Quantity Estimation.
- **PSO2:** Assess the impact of anthropogenic activities leading to environmental imbalance on land, in water & in air and provide necessary viable solutions revamping water resources and transportation for a sustainable development

PROGRAM OUTCOMES (PO's)

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. 44

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE SYLLABUS:

Construction Management & Entrepreneurship	
Sub Code: **BCV503**	IA Marks: **50**
Hrs/ Week: **03**	Exam Hours: **03**
Total Hrs. 40	Exam Marks: **50**

Module -1

Planning and Scheduling Construction project formulation – construction management, define scope – scope management, types of project planning and its management, Statutory and regulatory requirements- layout and building plan approval, contract, Fire and Safety, Quality, Environmental, commencement certificate, legal and public policies. Schedule management – WBS, Bar Charts, Sequencing and Dependency, Network Diagram, Activity Duration, Critical Path Method, PERT, Case study. Cost Management - Creating schedules, Assigning Resources, Cost, Evaluation, Optimization and Tracking

Module -2

Resource Management: Basic concepts of resource management, class of labour, Wages & statutory requirement, Labour Production rate or Productivity, Factors affecting labour output or productivity.

Construction Equipment: Classification of Construction Equipment, estimation of productivity for: excavator, dozer, compactors, graders and dumpers. Estimation of ownership cost, operational and maintenance cost of construction equipment. Selection of construction equipment and basic concept on equipment maintenance.

Materials: Material Management functions, inventory Management.

Module -3

Contract and Procurement management Procurement – procurement types, planning, stages – procurement execution – sustainable procurement management Construction contract –formation, types, essential elements, contract law – tendering process contract award – Documentation – contractor and sub-contractor management –claims – disputes compensation – breach of contract – project completion and project closure.

Module -4

Quality, Safety and Risk Management Quality Management - Occupational Health, Safety and Environment, Barriers, Quality Management System – Chart and tools. Safety management - safety requirements, Safety and Health codes. Risk management - Process, Terminology, Identification, Analysis and Response Strategy Completion certificate, occupancy certificate, Facilities management.

Module -5

Introduction to Entrepreneurship – Characteristics of a Successful Entrepreneur, Understand the entrepreneurial journey, different entrepreneurial styles, personality traits, strengths, and weaknesses. 5M Model, Communication skills: communication breakdown- miscommunication and poor listening, rectification.

Business Planning Process: Business planning process, marketing plan, financial plan, project report and feasibility study, guidelines for preparation of model project report for starting a new venture. Introduction to international entrepreneurship opportunities, entry into international business, exporting, direct foreign investment, venture capital.

List of Course Outcomes (RBT)	Program Outcomes													Program Specific Outcomes	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	Total	PSO 1	PSO 2
CO-1(L2)	2	2	2	-	1	1	-	1	-	2	-	1	12	1	-
CO-2(L3)	1	2	1	-	-	-	-	-	-	2	1	1	8	1	-
CO-3(L4)	1	1	-	-	-	1	1	-	-	1	-	1	6	1	-
CO-4(L4)	1	1	1	-	-	1	1	1	1	1	1	1	10	1	-
CO-5(L4)	2	-	-	-	-	1	-	1	1	1	1	1	8	1	
Total	**7**	**6**	**4**	**-**	**1**	**4**	**2**	**2**	**2**	**7**	**3**	**5**	**44**	**5**	**-**

MODULE 1

1.1 MANAGEMENT:

1.1.1 CHARACTERISTICS OF MANAGEMENT

1.1.2 FUNCTIONS OF MANAGEMENT

1.1.3 IMPORTANCE AND PURPOSE OF PLANNING PROCESS

1.1.4 TYPES OF PLANS

1.2 CONSTRUCTION PROJECT FORMULATION:

1.2.1 INTRODUCTION TO CONSTRUCTION MANAGEMENT

1.2.2 PROJECT ORGANIZATION

1.2.3 MANAGEMENT FUNCTIONS IN CONSTRUCTION PROJECT

1.2.4 MANAGEMENT STYLES

1.3 CONSTRUCTION PLANNING AND SCHEDULING:

1.3.1 INTRODUCTION, TYPES OF PROJECT PLANS

1.3.2 WORK BREAKDOWN STRUCTURE

1.3.3 PROJECT SCHEDULING

1.1 MANAGEMENT

Management is a knowledge consisting of concepts, principles, functions and processes. The knowledge is used for achieving organizational objectives by effective utilization of resources and co-ordinated human efforts.

It is a process of planning, organizing, staffing, directing and controlling human efforts to achieve organizational objectives effectively.

1.1.1 CHARACTERISTICS OF MANAGEMENT

- **Management as a continuous process:** Management can be considered as a process because it consists of planning, organizing, activating and controlling the resources of an organization. So they are used to the best advantage in achieving the objectives of the organization.
- **Management as a discipline:** It continuously discovers many aspects of business enterprises and also passes on the verified knowledge to the practitioners of the managerial process.
- **Management as a career:** As a career or occupation, management is a broad concept. Management itself can be regarded as a career, but it also presents a variety of interesting and challenging careers focused on specialized occupations in the fields such as marketing, finance and personnel.
- **Management as an Applied Science:** Even though management is a science so far as it possesses a systematized body of knowledge and uses scientific methods of research, it is not an exact science, like natural sciences which deal with living phenomena such as botany and medicine. Hence, management is definitely a social science like economics or psychology and has the same institutions which these and other social sciences have.
- **Universal Application:** Management is a universal activity, applied to any form of activity, economic or otherwise.
- **Goal Oriented:** Management has the task of attaining certain objectives. The success or failure of the management depends on how far it is able to attain the desired goals. It is judged by the extent to which it achieves its targets.
- **Guidance:** The main task of the management is guidance in the utilization of material and human resources in the best possible way. Through optimum utilization of resources it has to ensure that the objectives are attained. The essential element of management is that it gets the work done by coordinating the performance of those who actually perform diverse and specific jobs.

- **Divorced from proprietorship:** Management does not signify proprietorship. In earlier days, management and enterprise were lumped into the same factor. It now refers to a specialized group of people who have acquired the ability to carry out a project.
- **Management is a human activity:** Management functions are discharged only by individuals. No corporate body or an artificial being can perform the work of a management. Although it is an activity which may be performed by an individual it cannot be seen. It can only be felt.
- **Management signifies authority:** Since the essence of management is to direct, guide and control, it has to have authority. Authority is the power to compel others to work and behave in a particular manner. Management cannot discharge its function without authority. It is the foundation of management. Since management has authority it stands at a higher pedestal.
- **Leadership:** The management has to lead a team of workers. It must be capable of inspiring, motivating and winning their confidence.
- **Balancing effectiveness and efficiency:** Effectiveness means achieving targets and objectives on time. Efficiency refers to optimum or best utilization of resources. Management always tries to balance both and get the work done successfully. Only effectiveness and only efficiency is not enough for an organization.

1.1.2 FUNCTIONS OF MANAGEMENT

There are basically five primary functions of management. They are:

- Planning
- Organizing
- Staffing
- Directing
- Controlling

1. Planning

Planning is future oriented and determines an organization's direction. It is a rational and systematic way of making decisions today that will affect the future of the company. It is a kind of organized foresight as well as corrective hindsight. It involves the predicting of the future as well as attempting to control the events. It involves the ability to foresee the effects of current actions in the long run in the future.

An effective planning program incorporates the effect of both external as well as internal factors. The external factors are shortages of resources; both capital and material, general economic trend as far as interest rates and inflation are concerned, dynamic technological advancements, increased governmental regulation regarding community interests, unstable international political environments, etc. The internal factors that affect planning are limited growth opportunities due to saturation requiring diversification, changing patterns of work force, more complex organizational structures, decentralization etc

2. Organizing

Organizing requires a formal structure of authority and the direction and flow of such authority through which work subdivisions are defined, arranged and co-ordinated so that each part relates to the other part in a united and coherent manner so as to attain the prescribed objectives.

Thus the function of organizing involves the determination of activities that need to be done in order to reach the company goals, assigning these activities to the proper personnel, and delegating the necessary authority to carry out these activities in a co-ordinated and cohesive manner.

It follows, therefore, that the function of organizing is concerned with:

- Identifying the tasks that must be performed and grouping them whenever necessary
- Assigning these tasks to the personnel while defining their authority and responsibility.
- Delegating this authority to these employees
- Establishing a relationship between authority and responsibility
- Coordinating these activities

3. Staffing

Staffing is the function of hiring and retaining a suitable work-force for the enterprise both at managerial as well as non-managerial levels. It involves the process of recruiting, training, developing, compensating and evaluating employees, and maintaining this workforce with proper incentives and motivations. Since the human element is the most vital factor in the process of management, it is important to recruit the right personnel.

This function is even more critically important since people differ in their intelligence, knowledge, skills, experience, physical condition, age and attitudes, and this complicates the function. Hence, management must understand, in addition to the technical and operational competence, the sociological and psychological structure of the workforce.

4. Directing

The directing function is concerned with leadership, communication, motivation and supervision so that the employees perform their activities in the most efficient manner possible, in order to achieve the desired goals.

- The **leadership** element involves issuing of instructions and guiding the subordinates about procedures and methods.
- The **communication** must be open both ways so that the information can be passed on to the subordinates and the feedback received from them.
- **Motivation** is very important, since highly motivated people show excellent performance with less direction from superiors.
- **Supervising** subordinates would lead to continuous progress reports as well as assure the superiors that the directions are being properly carried out.

5. Controlling

The function of control consists of those activities that are undertaken to ensure that the events do not deviate from the per-arranged plans. The activities consist of establishing standards for work performance, measuring performance and comparing it to these set standards and taking corrective actions as and when needed, to correct any deviations.

The controlling function involves:

- Establishment of standard performance.
- Measurement of actual performance.
- Measuring actual performance with the pre-determined standard and finding out the deviations.
- Taking corrective action.

1.1.3 IMPORTANCE AND PURPOSE OF PLANNING PROCESS

- **Increases efficiency**: Planning makes optimum utilization of all available resources. It helps to reduce wastage of valuable resources and avoids their duplication. It aims to give the highest returns at the lowest possible cost. It thus increases the overall efficiency.
- **Reduces business-related risks**: There are many risks involved in any modern business. Planning helps to forecast these business-related risks. It also helps to take the necessary precautions to avoid these risks and prepare for future uncertainties in advance. Thus, it reduces business risks.

- **Facilitates proper coordination**: Often, the plans of all departments of an organization are well coordinated with each other. Similarly, the short-term, medium-term and long-term plans of an organization are also coordinated with each other. Such proper coordination is possible only because of efficient planning.
- **Aid in Organizing**: Organizing means to bring together all available resources. Organizing is not possible without planning. It is so, since, planning tells us the amount of resources required and when are they needed. It means that planning aids in organizing in an efficient way.
- **Gives right direction**: Direction means to give proper information, accurate instructions and useful guidance to the subordinates. It is impossible without planning. It is because planning tells us what to do, how to do it and when to do it. Therefore, planning helps to give a right direction.
- **Keeps good control**: With control, the actual performance of an employee is compared with the plans, and deviations (if any) are found out and corrected. It is impossible to achieve such a control without right planning. Therefore, planning becomes necessary to keep a good control.
- **Helps to achieve objectives**: Every organization has certain objectives or targets. It keeps working hard to fulfill these goals. Planning helps an organization to achieve these aims, but with some ease and promptness. Planning also helps an organization to avoid doing some random (done by chance) activities.
- **Motivates personnel**: A good plan provides various financial and non-financial incentives to both managers and employees. These incentives motivate them to work hard and achieve the objectives of the organization. Thus, planning through various incentives helps to motivate the personnel of an organization.
- **Encourages creativity and innovation**: Planning helps managers to express their creativity and innovation. It brings satisfaction to the managers and eventually success to the organization.
- **Helps in decision-making**: A manager makes many different plans. Then the manager selects or chooses the best of all available strategies. Making a selection or choosing something means to take a decision. So, decision-making is facilitated by planning.

1.1.4 TYPES OF PLANS

The process of planning may be classified into different categories on the following basis:

i. Nature of Planning
ii. Time Horizon
iii. Scope and degree of details
iv. Frequency use

- **Classification based on Nature of Planning:**

a. Formal Planning:

Planning is formal when it is reduced to writing. When the numbers of actions are large it is good to have a formal plan since it will help adequate control. The term formal means official and recognised. Any planning can be done officially to be followed or implemented. Formal planning aims to determine the objectives of planning. It is the action that determines in advance what should be done.

Advantages:

1. Proper Cooperation among employees
2. Unity of Action
3. Economy
4. Proper coordination and control
5. Choosing the right objectives
6. Future plan.

b. Informal Planning:

An informal plan is one, which is not in writing, but it is conceived in the mind of the manager. Informal planning will be effective when the number of actions is less and actions have to be taken in short period.

- **Classification based on time horizon:**

a. Short term Planning:

Short term planning is the planning which covers less than two years. It must be formulated in a manner consistent with long-term plans. It is considered as tactical planning. Short-term plans are concerned with immediate future; it takes into account the available resources only and is concerned with the current operations of the business.

These may include plans concerning inventory planning and control employee training, work methods etc.

Advantages:

1. It can be easily adjustable.
2. Changes can be made and incorporated.
3. Easy to Gauge.
4. Only little resources required.

Disadvantages:

1. Very short period-left over things will be more.
2. Difficult to mobilizes the resources.
3. Communication cycle will not be completed.

b. Long-Term Planning:

Long-term planning usually converse a period of more than five years, mostly between five and fifteen years. It deals with broader technological and competitive aspects of the organisation as well as allocation of resources over a relatively long time period. Long-term planning is considered as strategic planning. Short-term planning covers the period of one year while long term planning covers 5-15 years. In between there may be medium-term plans. Usually, medium term plans are focusing on between two and five years. These may include plan for purchase of materials, production, labour, overhead expenses and so on.

Advantages:

1. Sufficient time to plan and implement.
2. Effective control.
3. Adjustment and changes may be made gradually.
4. Periodic evaluation is possible.
5. Thrust areas can be identified easily.
6. Weakness can be spotted and rectified then and there.

Disadvantages:

1. Prediction is difficult.
2. Full of uncertainties.
3. Objectives and Targets may not be achieved in full.
4. More resources required.

- **Classification based on the scope and degree of details:**

a. Strategic Planning:

The strategic planning is the process of determining overall objectives of the organisation and the policies and strategies adopted to achieve those objectives. It is conducted by the top management, which include chief executive officer, president, vice-presidents, General Manger etc. It is a long range planning and may cover a time period of up to 10 years. It basically deals with the total assessment of the organization's capabilities, its strengths and its weaknesses and an objective evaluation of the dynamic environment. The planning also determines the direction of the company it will be taking in achieving these goals.

b. Intermediate Planning:

Intermediate planning cover time frames of about 6 months to 2 years and is contemplated by middle management, which includes functional managers, department heads and product line mangers. They also have the task of polishing the top management's strategic plans. The middle management will have a critical look at the resources available and they will determine the most effective and efficient mix of human, financial and material factors. They refine the broad strategic plans into more workable and realistic plans.

c. Operational Planning:

Operational planning deals with only current activities. It keeps the business running. These plans are the responsibility of the lower management and are conducted by unit supervisors, foremen etc. These are short-range plans covering a time span from one week to one year. These are more specific and they determine how a specific job is to be completed in the best possible way. Most operational plans are divided into functional areas such as production, finance, marketing, personnel etc. Thus even though planning at all levels is important, since all levels are integrated into one, the strategic planning requires closer observation since it establishes the direction of the organisation.

(iv) Classification based on Frequency of Use:

a. Standing Plan:

Standing plan is one, which is designed to be used over and over again. Objectives, policies procedures, methods, rules and strategies are included in standing plans. Its nature is

mechanical. It helps executives to reduce their workload. Standing plan is also called routine plan. Standing or routine plan is generally long range.

b. Single Use Plan:

Single use plan is one, which sets a course of action for a particular set of circumstances and is used up once the particular goal is achieved. They may include programme, budgets, projects and schedules. It is also called specific planning. Single use plan is short range.

1.2 CONSTRUCTION PROJECT FORMULATION

As outlined by the Project Management Institute, project management is the coordination and monitoring of labour and resources for the duration of a project. Although project management originated in the information technology field, any industry that undertakes complex initiatives uses the practice to manage resources. The construction industry applies project management to build structures for many purposes, such as:

- Agricultural production
- Public use
- Environmental sustainability
- Industrial manufacturing
- Institutional occupation
- Residential dwellings

Each build consists of many interrelated tasks. To keep the projects on track and on schedule, project managers leverage their communication skills, expertise and troubleshooting acumen.

Phase 1: Pre-project Conception and Decision-making

Construction projects start out as developers' conceived visions or necessities. During this phase, the property owner determines concept feasibility and chooses the best method to complete, or deliver, the structure. This process includes deciding whether to hire individual contractors and architects or a full service firm, as well as whether to pay a fixed price for what it cost to erect the structure.

If the property owner is not familiar with this process, they will hire a consultant to oversee the pre-project plans. While cost estimates emerge at this stage, it is important to note that it is impossible to develop a firm estimate until an engineer drafts the blueprints and itemizes all required resources.

Phase 2: Project Planning and Design

It is common practice to divide this phase into three stages. First, the project manager conducts a feasibility study to determine if the build fulfills the property owner's vision within acceptable financial parameters. Next, highly skilled engineers complete a diagram outlining how the project components interrelate and detailed blueprints of mechanical features such as the landscape, structural, gas, electrical and plumbing components. Finally, the designer outlines legal items such as contracts, permits and zoning specifications. By the time the project planning and design phase ends, the property owner and consultant have completely outlined the project and are prepared to select a contractor and execute the build.

Phase 3: Estimating Cost of Labor, Materials and Equipment

With fully outlined specifications, the cost estimator calculates all project expenses. The labor estimate includes contractor or union rates, taxes, benefits and potential overtime. Next, the estimator determines material costs based on current market rates, including delivery or pick up expenses and exchange rates for imported materials. Additionally, the estimator calculates indirect expenses, such as permit fees, temporary structures and administrative costs.

Phase 4: Selecting Contractors

Now that the property owner has completely outlined the project specifications, they select contractors through open bidding or by choosing from a handful of builders meeting specific criteria. If necessary, the owner or consultant will institute a pre-qualification process to screen out unqualified candidates. Potential contractors review the build specifications to determine whether the job is profitable. If so, they research the best ways to complete the project phases and then prepare a proposal for the property owner. Finally, the owner will choose the winning bidder among contractors who submitted acceptable proposals.

Phase 5: Project Mobilization

Once the property owner chooses a contractor, the bid winner must complete several tasks before commencing with the project. They must outline their planned activities to secure instruments such as bonds, licenses and insurance and review the cost estimate to familiarize themselves with projected expenses for reference during ongoing construction. The contractor also determines work site layout details – such as delivery entrances, site security, temporary structure placements and materials and equipment storage and then begins the build.

Phase 6: Operation and Construction

This phase involves three broad processes, task tracking and management; resource allocation and control; and recordkeeping and communication. Task tracking and management falls under five basic classifications:

1. Cost monitoring
2. Quality control
3. Schedule performance
4. Troubleshooting
5. Worksite safety

The contractor begins the project by securing sufficient skilled labor, assigning tasks and making sure that enough material is on-site to begin work. Throughout the project, the contractor must document all progress, plan deviations and other relevant information.

Phase 7: Termination and Closure

Toward the end of the build, the contractor must complete several tasks before delivering the final project by notifying the property owner that the structure is ready for use. The contractor must complete all final clean up, finishing work, initial use preparations and inspections, as well as remove all temporary structures and relieve all labor and contractors from further responsibilities. After completing these tasks, the contractor must prepare final documentation proving that the construction company has completed all agreed upon work and secured all licenses and permits for the project and structure before requesting final payment.

The contractor must also provide the property owner with blueprints outlining all changes from the original plan, available operational manuals and included building warranties. Finally, the contractor transfers this documentation to the owner's administrative department and, if it is part of the agreement, trains staff members on how to operate and maintain the structure mechanical features.

1.2.1 INTRODUCTION TO CONSTRUCTION MANAGEMENT

Construction management (CM) is a professional service that uses specialized, project management techniques to oversee the planning, design, and construction of a project, from its beginning to its end. The purpose of Construction Management is to control a project's time / delivery, cost and quality sometimes referred to as a project management triangle or triple constraints. Construction management is compatible with all project delivery systems

and Public Private Partnerships. Professional construction managers may be reserved for lengthy, large-scale, high budget undertakings (commercial real estate, transportation infrastructure, industrial facilities and military infrastructure) called capital projects.

1.2.1.1 Importance of Construction Management:

1. Construction management refers to the responsibility of overseeing the entire project from start to finish.
2. It involves wide range of tasks, from managing communications between the architect and the project owner to inspecting on-site work for quality and safety compliance.
3. Construction management professionals are also involved in the small details that can make or break your project.
4. By ensuring effective communication between all parties involved in the project and overseeing everything from on-site safety to contract administration.
5. Construction management team will help project run smoothly. A quality team will get project completed on time and on budget, providing a great return on investment.

1.2.1.2 Necessity of construction Management:

1. To check the wastage of material and labour.
2. To arrange the completion of the work in the minimum possible time.
3. To effect the economy in the cost of construction by adopting new techniques of construction and supervision.
4. To improve the quality and speed of work by using modern equipment and machinery on the construction.

1.2.1.3 Objectives of Construction Management:

The main objectives of construction management are:

1. Completing the work within estimated budget and specified time.
2. Maintaining a reputation for high quality workmanship
3. Taking sound decisions and delegation of authority
4. Developing an organization that works as a team.

1.2.2 PROJECT ORGANIZATION

A project organisation is one, in which a project structure is created as a separate unit or division within a permanent functional structure; drawing specialists and workers from various functional departments who work under the overall leadership, control and co-ordinate the project manager to complete projects of a technical and costly nature.

1.2.2.1 PRINCIPLES OF ORGANISATION

- **Objective:** The enterprise should set up certain aims for the achievement of which various departments should work. A common goal so devised for the business as a whole and the organization is set up to achieve that goal. In the absence of a common aim, various departments will set up their own goals and there is a possibility of conflicting objectives for different departments. So there must be an objective for the organization.
- **Specialization:** The organization should be set up in such a way that every individual should be assigned a duty according to his skill and qualification. The person should continue the same work so that he specializes in his work. This helps in increasing production in the concern.
- **Co-ordination:** The co-ordination of different activities is an important principle of the organization. There should be some agency to co-ordinate the activities of various departments. In the absence of co-ordination there is a possibility of setting up different goals by different departments. The ultimate aim of the concern can be achieved only if proper co-ordination is done for different activities.
- **Authority and Responsibility:** The authority flows downward in the line. Every individual is given authority to get the work done. Though authority can be delegated but responsibility lies with the man who has been given the work. If a superior delegates his authority to his subordinate, the superior is not absolved of his responsibility, though the subordinate becomes liable to his superior. The responsibility cannot be delegated under any circumstances.
- **Span of Control:** Span of control means how many subordinates can be supervised by a supervisor. The number of subordinates should be such that the supervisor should be able to control their work effectively. Moreover, the work to be supervised should be of the same nature. If the span of control is disproportionate, it is bound to affect the efficiency of the workers because of slow communication with the supervisors.

- **Balance:** The principle means that assignment of work should be such that every person should be given only that much work which he can perform well. Some person is over worked and the other is under-worked, then the work will suffer in both the situations. The work should be divided in such a way that everybody should be able to give his maximum.
- **Principle of Continuity:** The organization should be amendable according to the changing situations. Everyday there are changes in methods of production and marketing systems. The organization should be dynamic and not static. There should always be a possibility of making necessary adjustments.
- **Uniformity:** The organization should provide for the distribution of work in such a manner that the uniformity is maintained. Each officer should be in-charge of his respective area so as to avoid dual subordination and conflicts.
- **Unity of Command:** There should be a unity of command in the organization. A person should be answerable to one boss only. If a person is under the control of more than one person then there is a like-hood of confusion and conflict. He gets contradictory orders from different superiors. This principle creates a sense of responsibility to one person. The command should be from top to bottom for making the organization sound and clear. It also leads to consistency in directing, coordinating and controlling.
- **Efficiency:** The organization should be able to achieve enterprise objectives at a minimum cost. The standards of costs and revenue are pre-determined and performance should be according to these goals. The organization should also enable the attainment of job satisfaction to various employees.

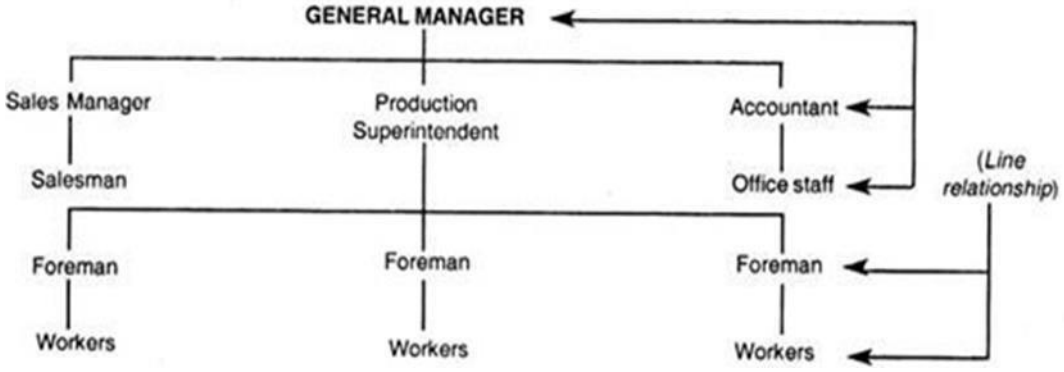
1.2.2.2 TYPES OF ORGANIZATION

According to different methods of distribution of authorities and responsibilities, the organisations are of following types:

- Line or Scalar Organisation
- Functional Organisation
- Line and Staff Organisation
- Line, Staff and Functional Organisation

1. LINE OR MILITARY ORGANISATION:

This type of organisation is also known as departmental or military type of organisation. In this type of organisation business activities is divided into three groups, namely finance and accounts, production and sales. Each of this department is sub-divided into certain self-contained departments, i.e., sections. Each departmental head has sole control over his section and has full authority to select his labour, staff, purchase of raw materials, stores and to set the standards of output, etc. Foreman of each shop trains new men and supervises the quality of output. In such a system superior exercises a direct authority over his subordinates who become entirely responsible for their performance to the commanding superior. No operation is under two bosses:



This is known as military type organisation, because in military discipline is of high order. Orders and instructions issued from the top have to be followed by the lowers. Similarly in this type of organisation, order of General Manager are to be carried out, without any say by subordinates and hence no chances of shifting of responsibility as in military and hence known as military type organisation. In this organisation, the flow of authority moves from top to bottom in vertical lines, therefore, this is also called line or military organisation.

Advantages:

1. A clear-cut division of authority and responsibility, hence no scope of shifting the responsibility.
2. Strong in discipline.
3. It permits quick decisions.
4. As responsibility of each individual is fixed, hence faults can be easily and quickly known.
5. Everybody from top to bottom remains busy like a machine and hence total cost of product will be less.
6. It is simple to understand.
7. Flexible and able to extend or contract.

Disadvantages:

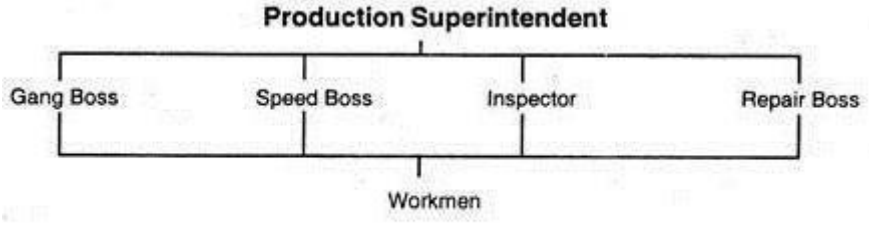
1. It requires different departmental heads to be expert in their respective functions, hence lack of specialisation.
2. Departmental heads are over-burdened with various routine jobs, hence no time for further expansion and planning.
3. Certain people become key points and they are loaded maximum with work.
4. Chances of accidents, wastage of material and labour are more because of insufficient knowledge of all the work by one man.
5. Chances of delay in reaching the orders of General Manager or any other departmental head upto the workers and, therefore, possibility of distortion, due to long channel.
6. Over-burdened foreman may not be able to give sufficient time for each job and will cause wastage and error.
7. It has no means of rewarding good workers.

Applications:

1. Such organisations are suitable for factories of small and medium size, in which sub-ordinate and operational staff is not too much.
2. Suitable for continuous process such as sugar, paper, oil refining, spinning and weaving industries etc.
3. Suitable where labour problems are not difficult to solve.
4. Suitable where automatic plants are used.

2. FUNCTIONAL ORGANISATION:

The difficulties in finding all round qualified man to be foreman in the line organisation are overcome with this type of organisation. He is replaced by various functionalized people.



Functional Organisation

This system is advantageous because each supervisor is specialised in a particular field and he attends to one factor in all the departments. In this, specialised people like chemists, purchasers, engineers, designers etc. are employed under the production superintendent and

everybody is supposed to give his functionalized advice to all other foreman (bosses) and workers. Every foreman (boss) will go to individual worker for his related function.

Advantages:

1. Due to specialisation quality of work is better.
2. This system provides more specialised knowledge and guidance to individual workers through experts.
3. It helps mass production by standardization and specialisation.
4. If any operation needs improvement, it can be improved even upto the last moment.
5. Considerable expansion of the factory is possible.
6. Since for every operation expert guidance is there, hence wastage of material will be minimum which will reduce prime cost.
7. Unnecessary overloading of responsibilities will not be there, as was in the case of line organisation.
8. No special knowledge of workers is required as the instructions are supplied by drawing and experts.

Disadvantages:

1. It is complicated from control point of view as every functionalized expert feels himself to be superior to the other and there is no one-man control over the workers. Therefore, it makes discipline problem difficult to solve among lower level.
2. By employing high waged experts, the total cost of job may become high.
3. As line workers will not be using their skill, their initiative cannot be utilized.
4. The failure of any of the expert will largely affect the production because, if any expert tells wrong operation, there is no other body to correct him. This will result in large wastage of material.
5. Proper co-ordination of the work of different departments is required but it is difficult to maintain as everybody is working individually.

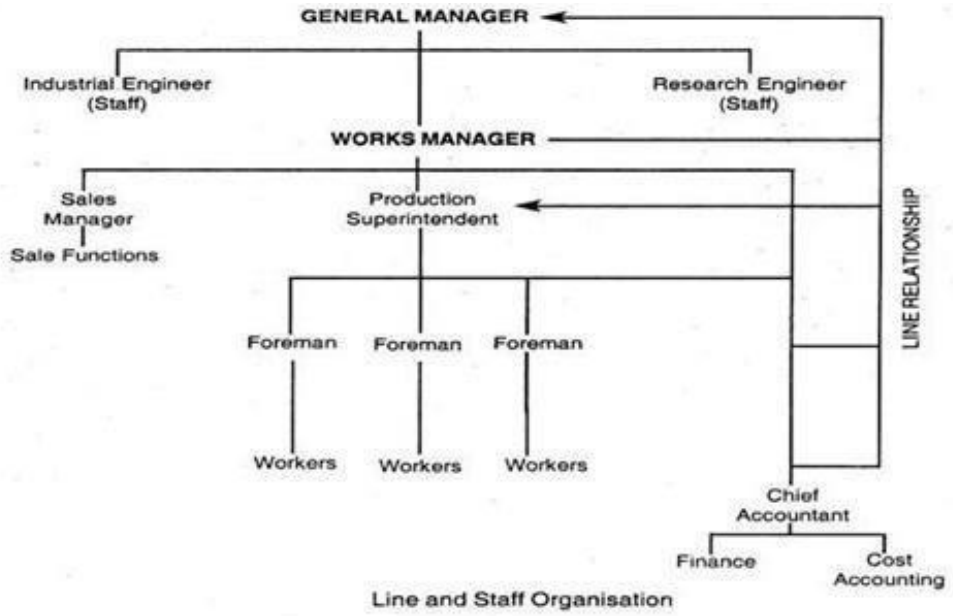
Application:

In practice a pure functionalized system is rarely found. In fact, a factory where responsibilities are divided on a functional basis, line relationship may also exist. This is suitable for large manufacturing concerns which are capable of expansion in future.

3. LINE AND STAFF ORGANISATION:

In a firm of large size operating on big scale, managers cannot give careful attention to every part of management. They are unable to think and plan. They are busy with ordinary task of production and selling. Hence 'Some Staff is deputed to do other works like investigation, research, recording, planning and advising to managers.

The line maintains discipline and stability. Staff provides expert information and helps to improve the overall efficiency. Thus the staffs are 'thinkers' while lines are 'doers'. A staff man usually controls one function of business of which he is an expert. Usually the staff has no administrative authority, but an expert in some phase of operation. He reports to the executive and gives the advice on the subject of his specialty.



Line and Staff Organisation

Advantages:

1. It is a planned specialised system.
2. Quality of product will be better.
3. Wastage will be less.
4. Expert knowledge is available.
5. Sufficient time is available to general manager for future planning and expansion.
6. Discipline problem is solved because of line relationship.

Disadvantages:

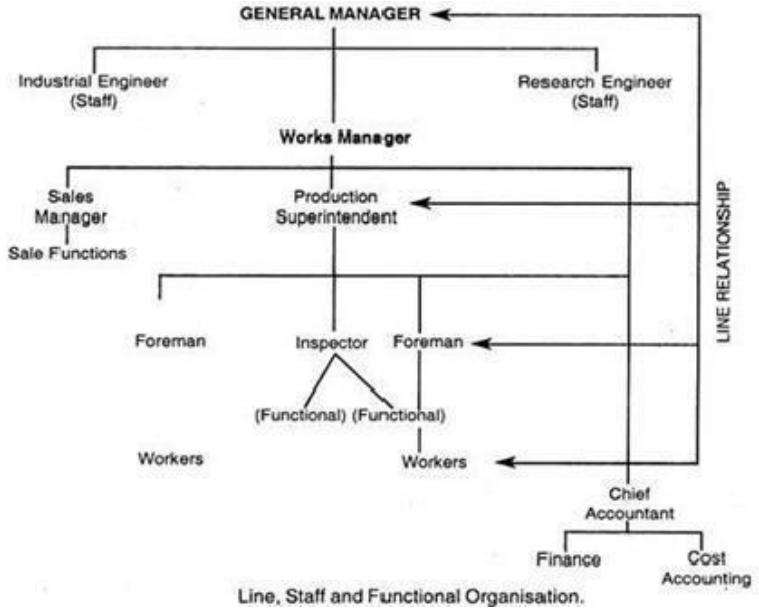
1. Sufficient expert knowledge & guidance is not available as compared with functional type.
2. Lack of responsibility among higher levels & hence the discipline as a whole will be poor.
3. The overhead cost of product may rise, because of high salaried staff.
4. The slackness of any section or department will largely affect whole working.

Application:

Now-a-days this type of organisation is preferred for medium and large scale industries, depending upon internal structure, nature of productive activities and span of business area. It is applied in automobile industries and other intermittent nature of industries.

4. LINE, STAFF AND FUNCTIONAL ORGANISATION:

Because of scientific methods, enough market competition and complications in the business, to obtain a sound system, the combination of line, staff and functional type of organisation is required.



Line, Staff and Functional Organisation.

In this system, as regards the discipline and output are concerned, the workers are kept under the direct control of foreman.

As regards quality, the inspector will have the proper authority to control the quality and he can directly order the workman as in the functional organisation.

In the staff relationship, there may be research department for the analysis of raw materials, semi-finished and finished products to withstand market competition.

In this way all the three are combined together and as this is complicated in nature, therefore, also called complicated type of organisation.

Application:

Now-a-days this pattern is followed by all government and private concerns, in which much complicated processes or operations are involved, i.e., in big chemical plants, electricity boards, steel plants and other huge undertakings.

1.2.3 MANAGEMENT FUNCTIONS IN CONSTRUCTION PROJECT

Construction and project managers play a huge role in the overall success and development of any project, leading a project from start to finish. But what steps do they take to ensure a project has been adequately completed? For those working in this field, there are six functions of construction management that need to be taken care of to ensure the success and quality of a project. Without these six functions of construction management, finishing a project would be extremely difficult.

1. Project Management Planning:

Although it is only one of the six functions of construction management, planning out the entire project is an essential task as it lays out the stepping stones for completing a project. Before a project can even be started, the project manager must plan out each step of the project. Project managers must define workers tasks and estimate the duration of each activity. This information is necessary when planning out a project thoroughly. Without a great construction plan, it is challenging to develop a budget and work schedule.

2. Cost Management:

Understanding the costs of a project is a necessary part of managing construction. The second in the six functions of construction management is creating a budget. Project managers use the budget to determine the total costs and returns expected from a particular project. They use the budget and plan to determine when steps are complete. Sometimes project managers request payment at the completion of each step. This can keep projects more affordable since subcontractors aren't saddled with the entire cost at the start.

3. Time Management:

Time is something you can never get back once you lose it, thus people make use of their time wisely. In construction, the more time spent on a project equates to higher expenses. The ability to use time wisely and efficiently is an important skill needed for someone in construction management and is the reason that it is considered one of the key functions of construction management.

A manager must have these skills: clear and effective communication, delegation, and prioritization. It is even more critical in the field of construction because any single mistake due to miscommunication or any form of time lag can build up the project expenses. Increasing expenses burden subcontractors when they lack proper scheduling and documentation.

4. Quality Management:

Project managers are also responsible for project quality, which is why it is one of the functions of construction management. In order to ensure that quality is excellent, construction management will need to analyze their work practices to see if they are up to par, determine if the material used is standard quality, and ensure that the finished product is protected from any potential harm or damage that may come to it. Without quality management it is harder to win bids from other

5. Contract Administration:

Contract administration usually begins when the other functions of construction management, such as cost and time management, have already been taken care of. Contract administration is conducted between the owner and the construction management team.

All parties exchange information and make decisions for the overall success and completion of the project. The management team completes the project to contract, and can ensure this by using the original contract documents, and analyzing and observing the overall progress of the construction project. This allows a final opportunity to correct any inaccuracies, doubts, or deviations from the initial design. This final check between the owner and management is crucial. It ensures that both parties are happy with the development of the project.

6. Safety Management:

Construction is an industry where the smallest mistake could lead to injury or even worse, death. This is why safety management is considered a huge part of the functions of construction management. In order to safely start a project, a manager must first plan ahead and determine all the potential safety hazards for each job. By implementing safety protocols such as personal protective equipment and zoning, managers can prevent injury to both workers and bystanders.

One of the most overlooked safety issues in the construction workplace is exhaustion. Exhausted workers are more likely to cut corners to finish a project faster, and often don't follow the safety protocol. In order to prevent exhaustion, management should make sure that workers are not working too many overtime shifts.

1.2.4 MANAGEMENT STYLES

Management consists of the planning, prioritizing, and organizing work efforts to accomplish objectives within a business organization. A management style is the particular way managers

go about accomplishing these objectives. It encompasses the way they make decisions, how they plan and organize work, and how they exercise authority.

All management styles can be categorized by three major types: Autocratic, Democratic, and Laissez-Faire, with Autocratic being the most controlling and Laissez-Faire being the least controlling.

1. Autocratic

Autocratic management is the most controlling of the management styles. Variations of this style are authoritative, persuasive, and paternalistic. Autocratic managers make all of the decisions in the workplace. Communication with this type of management is one way, top-down to the employees. Employee ideas and contributions are not encouraged or necessary. Roles and tasks are clearly defined, and workers are expected to follow these directions without question while being consistently checked and supervised.

This type of style is particularly useful in organizations with hierarchical structures where management makes all of the decisions based on positioning in the hierarchy. Employees that benefit from this style of management include those who are new, unskilled, or unmotivated, as they need the supervision and clear direction. Managers can benefit greatly from using this style in times of crises or serious time constraints.

The advantages of the autocratic management style are little uncertainty, clearly defined roles and expectations for employees, and the speed of decision-making. All decisions are made by the manager and employees are expected to be compliant leaving little room for variation or confusion. Decision-making speed is ideal and is not slowed by conflicting thought or agendas.

Disadvantages include lack of staff input with ideas are not encouraged or shared. This can lead to job dissatisfaction, absenteeism, and employee turnover. Because managers make all of the decisions, the employees is not inclined to act autonomously and may become too dependent on the manager. Not all employees want or need supervision, and as a result can become resentful and unhappy. Too many dissatisfied employees and the separation of power with an autocratic management style can lead to an ‘us v/s them’ mentality.

2. Democratic

The democratic management style involves managers reaching decisions with the input of the employees but being responsible for making the final decision. There are many variations of

this style of management including consultative, participative, and collaborative styles. Employee ideas and contributions are encouraged, but not necessary. Communication is both top-down and bottom-up and makes for a cohesive team.

This type of style is versatile with the advantages being more diverse perspectives involved in decision making. As employees are being taken into account before the manager makes decisions, the employees feel valued which increases motivation and productivity.

Disadvantages of the democratic management style are the time it takes to make a decision due to the gathering of ideas and opinions. There is also the potential conflict of different viewpoints playing a role in the decision making and as a result, employees can feel less valued if their input is not taken, leading to decreased morale and productivity.

3. Laissez-faire

The laissez-faire management style involves little or no interference from management. The staff do not need supervision and are highly skilled which allows management to take the hand's off approach and leave the problem solving, and decision making to the staff. Variations of this style include the delegative style and what is referred to as boss less environments or self-managed teams.

This type of style works best in organizations with flatter decentralized management. Typically, the staff is highly skilled, more so than the management, and is trusted with setting the bar for innovation and setting the objectives.

The advantages of the Laissez faire are increased innovation and creativity through the autonomy of expert staff. Some examples of this type of employee are be teachers, creative's, and designers.

Disadvantages include the risk of low productivity by unsupervised staff, loss of direction due to the hands-off style of management.

1.3 CONSTRUCTION PLANNING AND SCHEDULING

1. **Determine the project requirements.** You may have already prepared the objectives for the project and some high-level requirements for the proposed scope during Step 1, Business Case Assessment. However, most likely they are not of sufficient detail to start the planning process. As part of the scope definition, review and revise the following requirements: data, functionality (reports and queries), and infrastructure (technical and nontechnical).

2. **Determine the condition of the source files and databases.** You can neither complete the project schedule nor commit to a delivery date without a good understanding of the condition of the source files and databases. Take some time to review the data content of these operational files and databases. Although you will perform detailed source data analysis during Step 5, Data Analysis, right now you need to glean just enough information to make an educated guess about the effort needed for data cleansing.

3. **Determine or revise the cost estimates.** Detailed cost estimates must include hardware and network costs as well as purchase prices and annual maintenance fees for tools. In addition, you must ascertain the costs for contractors, consultants, and training. A more indirect cost is associated with the learning curve for the business and IT staff members. Remember to factor that into the cost estimates as well as the time estimates.

4. **Revise the risk assessment.** Review and revise the risk assessment performed during Step 1, Business Case Assessment (or perform a risk assessment now if you skipped that step). Rank each risk on a scale of 1 to 5 according to the severity of its impact on the BI project, with 1 indicating low impact and 5 indicating high impact. Similarly, rank the likelihood of each risk materializing, with 1 being "probably won't happen" and 5 being "we can almost count on it."

5. **Identify critical success factors.** A critical success factor is a condition that must exist for the project to have a high chance for success. Some common critical success factors are a proactive and very supportive business sponsor, full-time involvement of a business representative, realistic budgets and schedules, realistic expectations, and a core team with the right skill set.

6. **Prepare the project charter.** The project charter is similar to a scope agreement, a document of understanding, or a statement of work. However, the project charter is much more detailed than the usual 3- to 4-page general overview of the project that contains only a brief description of resources, costs, and schedule.

7. **Create a high-level project plan.** Project plans are usually presented in the form of a Gantt chart that shows activities, tasks, resources, dependencies, and effort mapped out on a calendar. Some project managers also create pert charts, which show the graphic representation of the CPM on the calendar.

8. **Kick off the project.** Once you have planned the project, assigned the resources, and scheduled the training, you are ready to kick off the project. This is usually accomplished with an orientation meeting for the entire team (the core team members as well as the extended team members).

1.3.1 TYPES OF PROJECT PLANS

In broad sense, planning of entire project starts from inception to completion of the project. The following are the different types of plans prepared for typical construction project:

- Project conceptual plan
- Project preliminary plan
- Project detailed plan

Project Conceptual plan: Planning by the client begins as soon as he gets the idea about developing a facility to fulfill creative motives. His early thought process gives him the indication of the cost, time and benefit. Only when he convince about the soundness of his idea, he decides to go ahead with the feasibility studies.

Project preliminary plan: If feasibility study gives fruitful outcome then starts preliminary plan – making process. Its main is to provide direction to the client managers and staff employed during the development phase of the project. The project preliminary plan forms the basis for developing the project construction plan.

Project detailed plan:

The client entrusts the construction of project facilitates to the project management team headed by the project manager or the resident engineer. This team may be from the clients own construction agency or from a client appointed construction management consultant firm or from a suitably organized combination of these.

Schedule, cost, quality and safety can be identified as specific items on which the success of any construction project is evaluated. Although there is complex interrelationship between these, it is possible to discuss them independently – a statement such as a project being completed with very high quality but with different levels of cost and time overruns can at least be technically understood. Thus, at times it makes sense to have different plans for each of these criteria.

1) **TIME PLAN** – Time is the essence of all construction projects, and contracts often have clauses outlining awards (bonus payments) or penalties (as liquidated damages) for completing a work ahead or later than a scheduled date. The commonly used techniques for time planning activities are Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT) and Time Scale Network (TSN). The choice of the method to be used depends on the intended objective, the nature of the project, the target audience, etc.,

2) **MANPOWER PLAN** – This plan focuses on estimating the size of workforce, division in functional teams and scheduling the deployment of manpower. It may be noted that manpower planning also involves establishing labour productivity standards, providing suitable environment and financial incentives for optimum productivity, and grouping the manpower in suitable functional teams in order to get the optimum utilization.

3) **MATERIAL PLAN** – The material plan involves identification of required materials, estimation of required quantities, defining specification and forecasting material requirement, inventory control, procurement plans and monitoring the usage of materials.

4) **CONSTRUCTION EQUIPMENT PLAN** – Machines are used in construction for mass excavation, trenching, compacting, grading, hoisting, concreting, drilling, material handling, etc. This improves productivity and quality, besides reducing cost. It should also be kept in mind that heavy equipments are very costly and should be optimally utilized and their characteristics also to be considered when drawing up an equipment plan.

5) **FINANCE PLAN** – Large projects require huge investments and long time for completion and it is obvious that all the money is not required at any point in time. Contractors fund their projects from their working capital, a part of which is raised by the contractors using their own sources, whereas the rest comes from the client end in the form of mobilization advance, running bills, etc. Thus, a careful analysis needs to be carried out to determine how the requirement of funds varies with time.

1.3.2 WORK BREAKDOWN STRUCTURE

Work-breakdown structure (WBS) in project management and systems engineering, is a deliverable-oriented breakdown of a project into smaller components. A work breakdown structure is a key project deliverable that organizes the team's work into manageable sections. The Project Management Body of Knowledge defines the work-breakdown structure "A hierarchical decomposition of the total scope of work to be carried out by the project team to

accomplish the project objectives and create the required deliverables. A work-breakdown structure element may be a product, data, service, or any combination thereof. A WBS also provides the necessary framework for detailed cost estimating and control along with providing guidance for schedule development and control.

WBS is a hierarchical and incremental decomposition of the project into phases, deliverables and work packages. It is a tree structure, which shows a subdivision of effort required to achieve an objective; for example a program, project, and contract.[4] In a project or contract, the WBS is developed by starting with the end objective and successively subdividing it into manageable components in terms of size, duration, and responsibility (e.g., systems, subsystems, components, tasks, subtasks, and work packages) which include all steps necessary to achieve the objective.

The work-breakdown structure provides a common framework for the natural development of the overall planning and control of a contract and is the basis for dividing work into definable increments from which the statement of work can be developed and technical, schedule, cost, and labor hour reporting can be established. A work breakdown structure permits summing of subordinate costs for tasks, materials, etc., into their successively higher level "parent" tasks, materials, etc. For each element of the work breakdown structure, a description of the task to be performed is generated. This technique (sometimes called a system breakdown structure) is used to define and organize the total scope of a project.

The WBS is organized around the primary products of the project (or planned outcomes) instead of the work needed to produce the products (planned actions). Since the planned outcomes are the desired ends of the project, they form a relatively stable set of categories in which the costs of the planned actions needed to achieve them can be collected. A well-designed WBS makes it easy to assign each project activity to one and only one terminal element of the WBS. In addition to its function in cost accounting, the WBS also helps map requirements from one level of system specification to another, for example a requirements cross reference matrix mapping functional requirements to high level or low level design documents. The WBS may be displayed horizontally in outline form, or vertically as a tree structure (like an organization chart).

The development of the WBS normally occurs at the start of a project and precedes detailed project and task planning.

Work Breakdown Structure Guidelines:

The following guidelines should be considered when creating a work breakdown structure:

- The top level represents the final deliverable or project
- Sub-deliverables contain work packages that are assigned to a organization's department or unit
- All elements of the work breakdown structure don't need to be defined to the same level
- The work package defines the work, duration, and costs for the tasks required to produce the sub-deliverable
- Work packages should not exceed 10 days of duration
- Work packages should be independent of other work packages in the work breakdown structure
- Work packages are unique and should not be duplicated across the work breakdown structure.

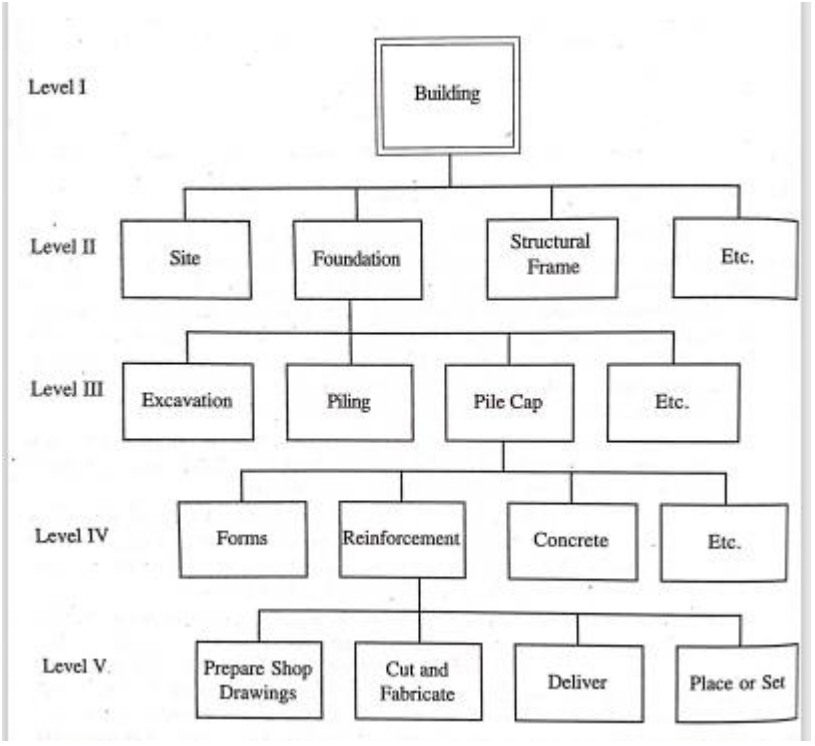


Fig. Example for Work Breakdown Structure

1.3.3 PROJECT SCHEDULING

Project scheduling is the process of putting together a time line for all the activities in the project. This involves examining the interdependencies of all of the activities, and coordinating all the tasks to ensure a smooth transition from the beginning to the end of the project. There are many different methods of scheduling, which can address the requirements of the type of project resulting in different pictorial representations of the schedules.

PREPARATION OF NETWORK DIAGRAM

NETWORK

- A network is a flow diagram consisting of activities and events connected logically andsequentially.
- In the network diagram, an activity is represented by arrows while events are representedby circles.
- Networks are of two types:
    1) PERT Network
    2) CPM Network

★ TYPES OF PROJECT SCHEDULING

1. CRITICAL PATH METHOD

The Critical path method is a pictorial representation of the project that is useful for identifying the overall length of time that a project will take. It also demonstrates which activities are necessary to complete the project and those that are not as critical. In this technique, the project is represented pictorially as a network, where the nodes represent activities and the duration of an activity is represented by lines or arcs in between nodes. The duration of each activity is estimated based on industry knowledge. Before constructing a diagram, the activities need to be identified, as does the sequencing of these events. For example, activities A and B might occur simultaneously prior to activity C, producing a diagram with the following overall shape: “ >," where the upper left end would have node labeled A, the lower a node labeled B, and the point at the right side would have a node labeled C.

Pros

1. Makes dependencies visible
2. Organizes large and complex projects
3. Organizes large and complex projects
4. Encourages the Project Manager to reduce the project duration

Cons

1. For large and complex projects, there'll be thousands of activities and dependency relationships
2. For large projects with thousands of activities, it may be difficult to print the project network diagram**.**

2. PROGRAM EVALUATION AND REVIEW TECHNIQUE (PERT)

The program evaluation and review technique (PERT) is typically applied to more complex projects. Again, a network diagram is used. The activities and their duration are represented pictorially as a network in the same manner as the critical path method. However, unlike the critical path method, PERT allows for flexibility in the period of time to complete a task. Just like the critical path method the activities and their duration are defined.

However, the duration is determined with the following formula:

Expected time = (optimistic time + 4*(most likely time) + pessimistic time)/6

Optimistic time is the shortest time that the activity can occur in and pessimistic is the longest.

3. GANTT CHARTS

Gantt charts are a pictorial representation of the phases and activities of a project, and they are typically applied to plans in a setting in which there is little variation among the projects. These charts graphically illustrate the start and end dates of a task with horizontal bars under a horizontal line representing the date. Information about the complexity or size of task is not accounted for, so a bar representing a relatively small task can have the same pictorial representation as a larger one if the timing is similar. This can cause a problem if an activity is behind schedule.

Pros:

1. Adaptable to all industries and projects

2. Easy to view progress
3. Ability to set accurate deadlines and define dependencies
4. Easily modified
5. Can be created in Microsoft Excel or in a project management system
6. Ability to assign tasks to resources

Cons:

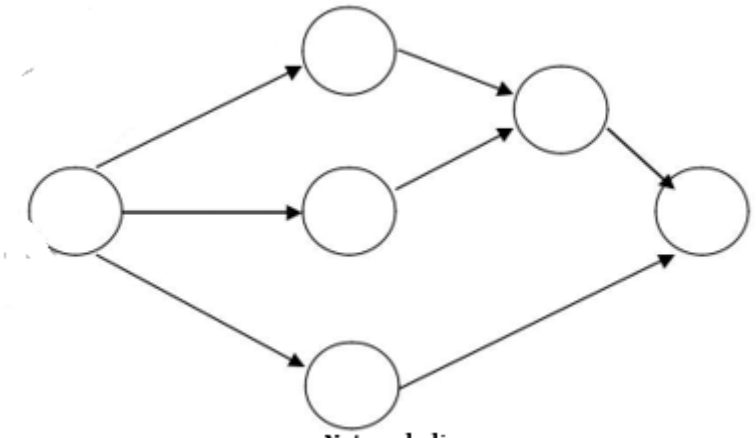
1. If the Gantt chart is not part of a project management system, it is flat
2. No versioning
3. Limited collaboration
4. No progress tracking

❖ DIFFERENCE BETWEEN PERT & CPM

CPM	PERT
It is activity oriented	It is event oriented
Deals with projects of known magnitude	Projects which are under research work
Duration of each activities can be determined properly	Duration of each activities cannot be determined properly
It is applied to the construction	Applied to research & development activities
Cost is the direct controlling factor	Time is the direct controlling factor

NETWORK DIAGRAM

- Network diagram is a linear draft mode of an organizational system comprising of theactivities and events arranged in logical and sequential order.
- Each activity in a network diagram is represented by two numbers i.e., i and j.
- The number ‘i’ represents starting of the activity called tail event and the number ‘j’represents ending of the activity called head event.
- In the network diagram of each activity is represented in the form of arrows and each eventis represented in the form of nodes.



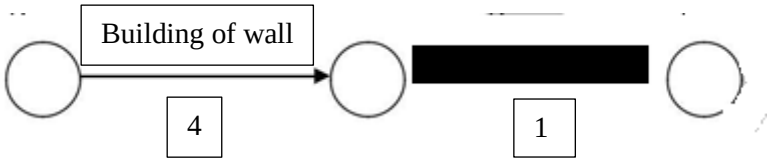
Network diagram

RULES FOR DEVELOPING NETWORKS

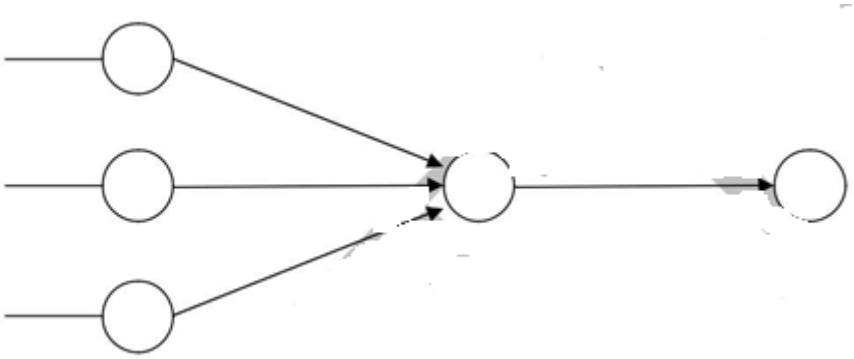
Rule 1:

No activity can commence until all preceding activities have been completed as explained below:

Ex : (i) 'Plastering of wall' can commence only after 'Building of wall' is completed.



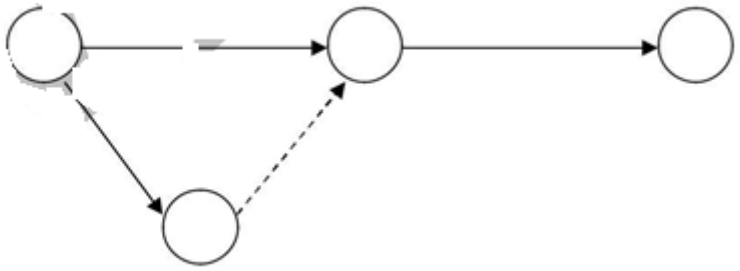
(ii) 'Concrete Foundation (D)' can commence only after 'Cement Procurement (A)', 'AggregateProcurement (B)' and 'Installation of Concrete Mixer (C)'.



Rule 2:

A 'dummy activity' is introduced in the network either to show dependency or to avoid duplicationnumbering of activities. A 'dummy activity' is an artificial activity and is shown by a dotted line. It consumes no time or resources.

Ex: 'Beam Erection (C)' can be taken up only when both 'Concrete Pier (A)' and 'Precast Beams (B)'are completed. Dummy activity 2 – 3 Shows this dependency and also avoids duplicate numbering of activities 'Concrete Pier' and 'Precast Beams'



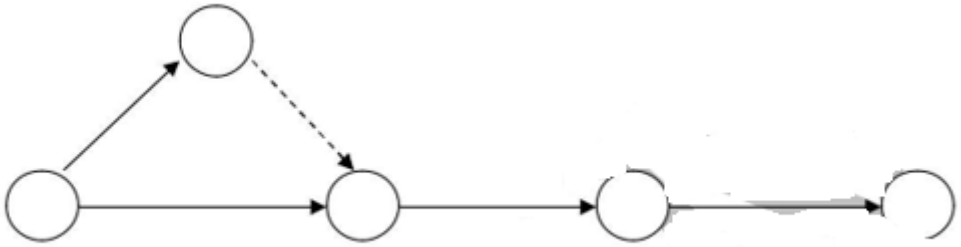
Rule 3:

The logical placement of an activity in the network is governed by the followingthree considerations:

a) Which activities must be completed before this activity can commence? (Precedence)
b) Which activities can be carried out along with this activity? (Concurrence)
c) Which activities cannot commence until this activity is completed? (Subsequence)

Ex: Consider the following activities pertaining to the construction of a mass concrete foundation:

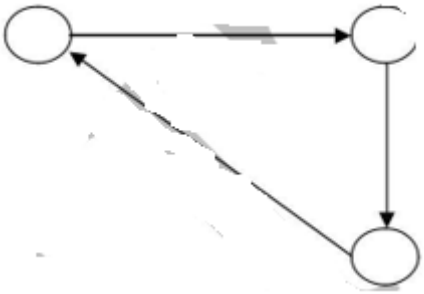
Excavate (B)	3 days
Prepare shuttering (A)	2 days
Fix shuttering (C)	1 day
Concrete foundation (D)	1 day



Rule 4:

No activity should lead back to a previous event i.e., there must not be any ‘looping’.

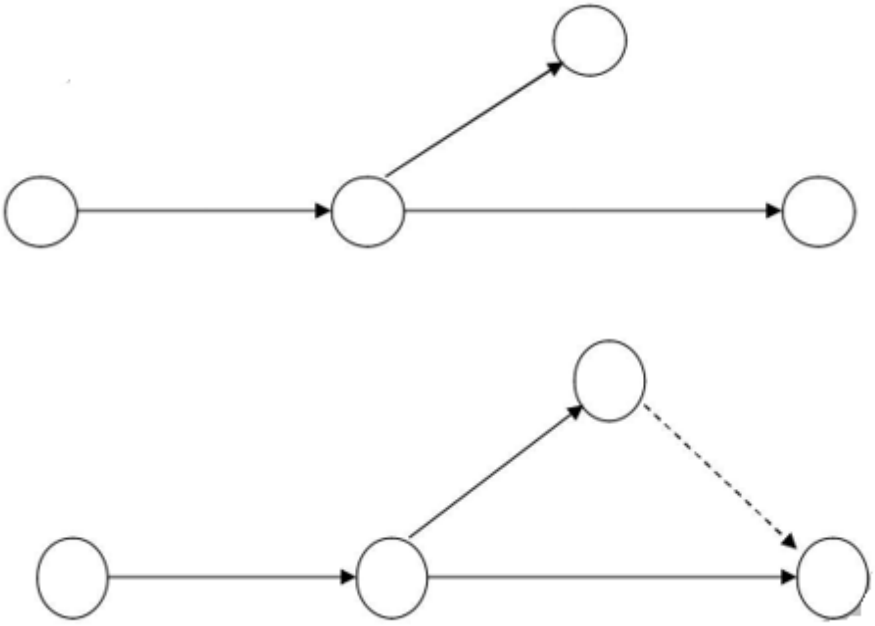
Ex:



'Concrete curing' cannot commence until 'Placing of concrete' is completed and 'Concrete testing' cannot begin until 'Concrete curing' is completed. However, 'Placing of concrete' cannot start until 'Concrete testing' is completed.

Rule 5:

In any network, there must be only one start and one finish (with any number of activities in between) i.e., no activity should be left dangling.

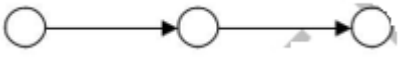


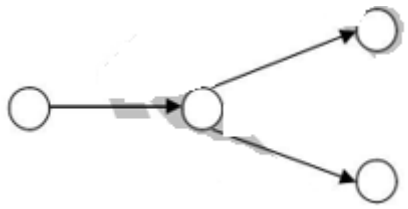
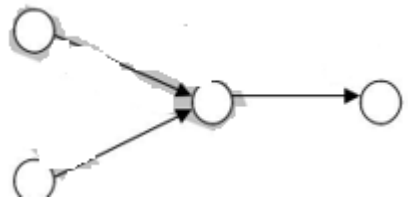
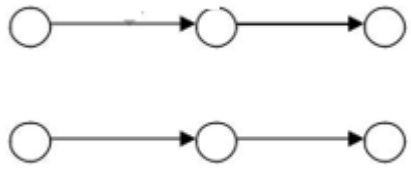
LOGIC FOR NETWORK DEVELOPMENT

The following questions must be asked for logical development of a network:

1) Which activities must immediately precede this activity?
2) Which activities should immediately follow this activity?
3) Which activities can take place concurrently with this activity?

Based on these questions and the rules for network development, each activity is connected in oneor several of the ways as below:

NETWORK ELEMENTS	INTERPRETATION
	Activity C cannot start before activity B is completed (OR) Activity C follows Activity B (OR) Activity B precedes Activity C

	Activities D and E cannot start before ActivityC is completed. However, once Activity C is completed both activities D and E can start simultaneously
	Activity C cannot start before both the activities A and B are completed.
	Activity C follows B and E follows D. However, both activitychains are independent of each other.

NETWORK TECHNIQUES

Terminology

a) Activity – Performance of a specific task, operation, job or function which consumes time and resources and has a definite beginning and end is called an activity. For example, excavate foundation, lay brickwork, backfill trench, fix shuttering, concrete wall, etc., are all activities.

b) Event –An instantaneous point in time marking the beginning or end of one or more activities is called an event. An event consumes no time or resources. For example, excavation completed, brickwork laid, shuttering fixed etc., are all events.

c) Network – A network is the diagrammatic representation of a work plan showing the activities, step-by-step, leading to the established goal. It depicts the inter-dependence between the various activities i.e., which activities can be done together and which activities must precede or succeed others.

d) Dummy activity – It is an imaginary activity of zero duration (consuming no resources) represented by dotted line (). It indicates that an activity following the dummy cannot be
started until the activity preceding it is completed.

e) Duration (D)– It is the estimated time required (in days, weeks or months) to perform anactivity.

f) Earliest Start Time (EST) – This is the earliest time that an activity can be started.

g) Earliest Finish Time (EFT) – It is the earliest time that an activity can be finished.

$$EFT = EST + D$$

h) Latest Start Time (LST) - It is the latest time that an activity can be started without delaying the completion of project.

i) Latest Finish Time (LFT) – It is the latest time that an activity can be finished without delaying the completion of the project.

$$LST = LFT - D$$

j) Total Float (TF) / Slack – It is the amount of time that an activity can be delayed without delaying the completion of the project.

$$TF = LFT - EFT \quad TF = LST - EST$$

K) **Free Float (FF)** – This is the amount of time that the finish of an activity can be delayed without delaying the earliest starting time of a following activity.

$$FF = \underset{\text{(Following activity)}}{EST} - \underset{\text{(This activity)}}{EFT}$$

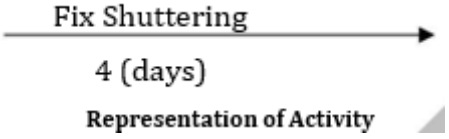
L**) Critical Path** - It is the series of inter-connected activities through the network for which each activity has zero float time. Critical path determines the minimum time required to complete a project and also represent the longest path in a network.

Network Representation

The following two systems of network representation, namely, Activity-on-Arrow (A-O-A) system and Activity-on-Node (A-O-N) system are used for development and analysis of networks in CPM.

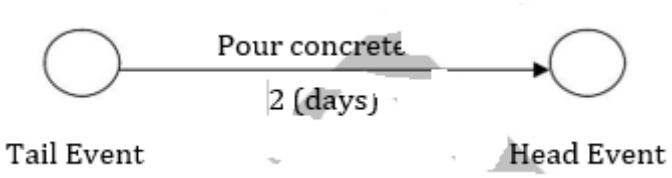
a) Activity-on-Arrow (A-O-A) System

In this system, an activity is graphically represented by an arrow drawn from left to right. The description of the activity is written above the arrow and the time taken to complete the activity iswritten below it as shown in the figure below. The length of the arrow has no relationship to the duration of the activity that it represents.



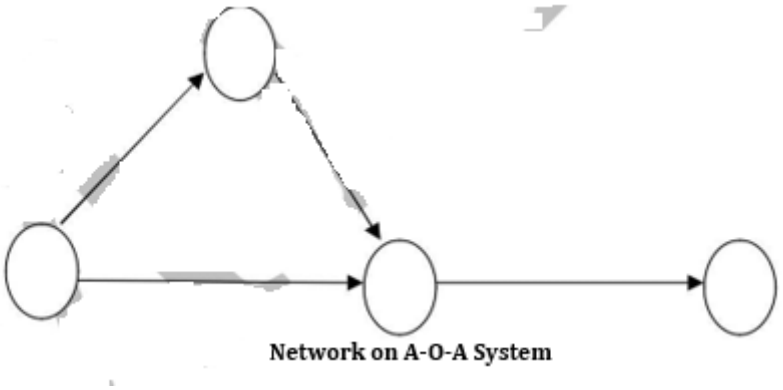
Representation of Activity

An event is graphically represented by a number enclosed in a circle. The beginning of an activity is marked by a 'tail event' or preceding event and the end by a 'head event' or succeeding event asshown below:



Representation of Events

An example of the graphical representation of a network on the A-O-A system is shown below.

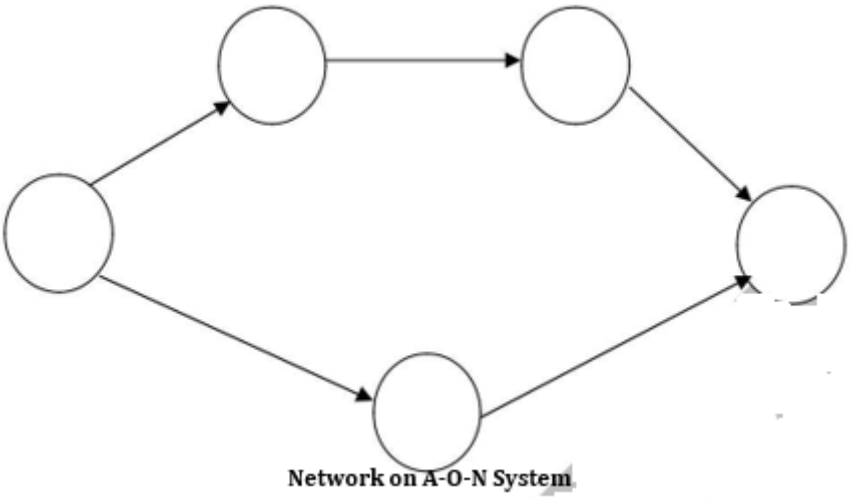


a) Activity-on-Node (A-O-N) System

In this system, activities are represented on the nodes, and arrows are used to show the dependency relationships between the activity nodes. The time required to complete an activity is also indicated in the node.

The A-O-N System is widely used in network techniques and is very popular in construction projects.

The A-O-A network shown in the figure above is depicted on the A-O-N System as shown below.



JOB LAYOUT

The job layout is the plan draw to a scale before starting project showing area available for offices, warehouse, storage of materials, equipments, workshop, fabrication yard. The areas allotted for each item should be such that the time consumed in carrying materials to project site is minimum.

Factors affecting the job layout

1) Nature and type of work

The nature and type of work determines the size of the project camp can be located at the site. Example: If the construction is of highway a number of small camps will have to be established, if the project is the construction of dam or residential building then the entire project construction unit can be established at one place.

The job layout for a Earthen dam or canal lining will be quite different from that of a multistoreyed building as the nature and extent of requirements of supporting facilities are quite different in each case.

2) Location of the projects

The job layout is determined by location such as the distance of the project from the main highway and railway and topographical features such as rainfall, snowfall,etc.

3) Method of execution of the project

It depends upon whether the project is executed departmentally or through contract agency.

4) Nature of the ground

For the movement and erection of equipment and machines strong and solid ground is essential.

5) Availability of necessary facilities

Water supply, electricity, sewage disposal unit which are necessary facilities should be available for the project.

6) Availability of resources

Plants, machineries, equipments and man power which are the resources should be locally available.

7) Availability of medicines and medical facilities

The job layout should take care to see that the medicines and other facilities are accommodated in the camp.

8) Availability of recreation facilities

The provision for recreation facilities for workers who got over work should be provided.

Details studied for preparing a Job layout

For preparing good job layout, the following details should be studied by using Site plan and Working drawings:

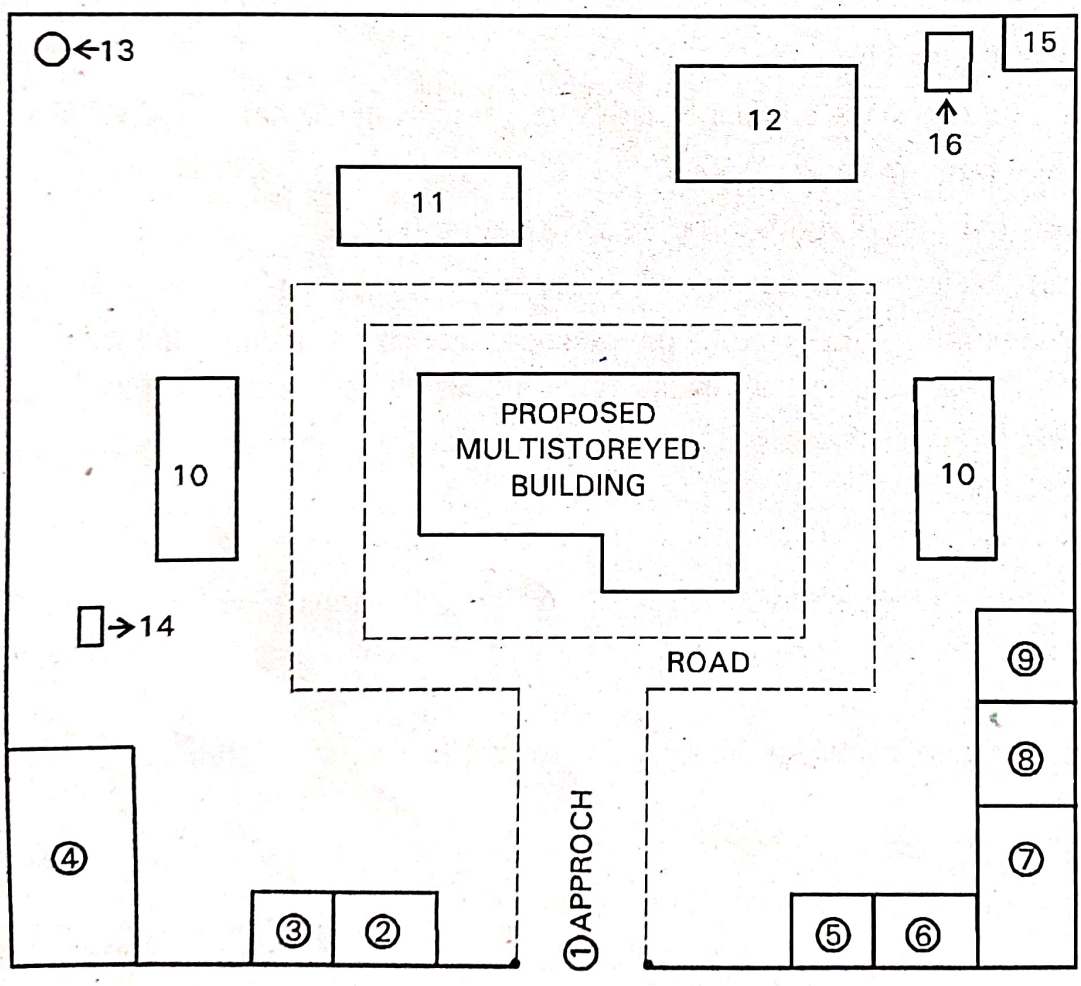
1. The boundaries of the construction site.
2. The position of the site in relation to the adjacent roads,etc., indicating the name and widths.
3. The location and size of any built up work at site.
4. The location and size of any existing building proposed to be demolished.
5. The location of any existing water mains, sewers, electric lines, etc.
6. The location of all proposed building works indicating their distance from the roads adjacent to buildings, and boundaries within 12 metres of the site and number of stories in each building.
7. The location and width of all approach roads or passages from the existing roads or passages to all buildings to be constructed.
8. The north direction.
9. Floor plans of buildings and other works showing the position and dimensions of walls, structural members, openings such as doors and windows, size of the rooms, stair-cases, lifts if any, and other essential services.
10. Elevations of all works from all open sides indicating the ground level, the heights and depths of all salient points.
11. Sections passing through walls, stair cases/lifts wells, etc. showing the details of structural members, such as foundations, walls, columns, floors, roofs, parapet, etc.
12. Terrace plan showing the slope of the roof and drainage, etc.
13. Service plan showing the plans of water supply, sewage disposal, air-conditioning or any other special services that have been planned to be provided.
14. Any other information considered necessary.

Advantages of job layout or purpose of preparing job layout

Job lay out generally is prepared for the following objectives :

1. To store the constructional materials as near the place of their utilisation as possible.
2. To save time in delivering the constructional material at the construction site.
3. To safeguard constructional material from damage and deterioration.
4. To keep the lead of cartage minimum, so that cartage expenses may remain minimum.
5. To adopt the best mode of working.
6. To finish the work with the help of minimum equipment and machinery.
7. To take maximum out put from labour and machines.
8. To provide safety to workers.
9. To avoid damage to the near by properties due to the construction.
10. To store common use materials near to each other as fine-aggregate and coarse aggregates should be stored near to each other.

Typical job layout for a multistoried RCC building



1. Main Entrance Gate
2. Watch man cabin
3. Transformer Plinth
4. Steel yard and Bar bending
5. Material Godown
6. Store room
7. Site office
8. Cement Godown
9. Equipments/Tools store room
10. Bricks/Blocks stacking yard
11. Sand/Aggregates Stacking yard
12. Form work and scaffo -lding yand
13. Bore well
14. Temporary water tank
15. Toilet
16. Septic Tank

Fig. 1.12 : Typical Job Layout