

INTRODUCTION TO CONSTRUCTION MANAGEMENT

1.1. INTRODUCTION

During the last few decades, there has been a phenomenal growth in various construction activities in the country. During the age of globalisation, India is giving maximum attention on infrastructural development by constructing roads, airports, shipping dockyards, railways, power plants etc. The construction industry belongs to the capital goods sector of the economy and produces assets in the form of buildings, roads, bridges, airports etc. These add to the Gross National Product (GNP) as capital assets and at the same time increase the productivity of other sectors of the economy as well.

We know that all sectors of the economy, whether it is infrastructural sector, industrial sector, housing sector, mining sector, or even the irrigation and agricultural sectors, have certain components of construction work associated with them, though in varying proportions. It may be noted that construction projects involve large variety of construction activities such as, process and utility buildings, storage sheds, structures for supporting machineries, equipment and material handling systems, tall structures like chimney, silo, over-head tanks, as also the infrastructural facilities like residential quarters, roads, drainage, hospital, sewerage system etc.

As we know that a project is composed of jobs, activities, functions or tasks (however large or small it may be), limited in scope and time and giving some benefit to the users when the project is completed. All the tasks of a project are related one to the other in some manner and all of these should be completed in order to complete the project. Each project has one specific purpose and is finished when its objectives have been fulfilled.

Therefore, a project is a specific activity on which money is spent (in the form of resources *i.e.* men, materials and machines) in the expectation of returns. Each project, having a specific geographical location, has a specific starting point, a specific end point and is intended to achieve a specific objective and would serve a group of population.

Since modern construction projects require a huge amount of capital, we have to adopt latest technology, modern equipment and modern management techniques to achieve economy, quality and quick results. Projects connected with construction of dams, canals, roads, airports, railways, mining etc involve large magnitude of earth work and construction materials like steel, concrete etc, and handling of millions of cubic metres of mineral/rock/earth. These tasks require deployment of large fleets of construction equipment which are becoming very expensive and sophisticated. Efficiency of these equipment is a crucial factor in completion of projects in time and cost reduction. The task of managing construction project requires specific managerial as well as technical skill and experience.

Implementation of a project is an investment decision for the development of the country from social and economical considerations. In an investment decision, the criteria for the selection of the project is based on efficient use of resources, and this is to be linked to the development policy of an economy. The development policy would aim at a rapid increase in national income or its distribution or both.

1.2. TYPES OF CONSTRUCTION PROJECTS

As discussed earlier, projects may be widely varying from one another in their concepts, targets and sizes. There are hundreds of different projects of diverse nature and size. Construction projects may be classified depending upon the type of construction, as under:

1. **Buildings.** Residential, office, apartment blocks, educational institutions, marketing complexes, recreation centres, hospitals, hotels, factories, utility buildings etc.
2. **Industrial structures.** Industrial structures supporting machinery, equipment, plant and material handling structures.
3. **Tall structures.** Cooling towers, high rise buildings, chimney, transmission towers, silos, overhead tanks etc.
4. **Hydraulic structures.** Dams, canals, barrages etc.
5. **Power Plants.** Structures for hydropower, thermal power, nuclear power plants.
6. **Special structures.** Structures for off-shore platforms, space research stations etc.
7. Highways, bridges, tunnels.
8. Airports and runways.
9. Railway network.
10. Sewerage and water treatment plants.
11. Land Development works.
12. Marine structures, harbours etc.
13. Oil/gas pipe lines and transmission lines.

1.3. CHARACTERISTICS OF CONSTRUCTION PROJECTS

1. Each project has a definite finish or completion *i.e.*, time bound.
2. Each project is comprised of series of intermediate activities consuming resources and time.
3. All projects are essentially cost benefit enterprises.
4. Each project is unique in itself, which means no two projects are absolutely similar with reference to their objectives, location, infrastructure and project team.
5. Each project has a fixed set of objectives. Once the objectives have been achieved, the project ceases to exist.
6. A project exists for a fixed duration of time.
7. The project work is normally entrusted to a project manager (head of the project) who coordinates the work of various persons working on the project.
8. The project team is constituted of members belonging to different disciplines.
9. A project cycle consists of project preparation, implementation and operation phases.
10. A project is dynamic in nature and is subjected to many changes during its life span.
11. Every project has many constraints in terms of availability of resources and completion of time.
12. Every project has large number of activities and they need coordination.
13. Construction projects generally employ high value and huge resources of men, materials and machines.

1.4 . IMPORTANCE OF CONSTRUCTION MANAGEMENT

A project, in general, is bounded by the limitations of a definite scope of work and a time of completion, giving certain pre-determined benefits to the user on completion of the project. Each activity of the project is allotted time required for its completion and resources like manpower, materials, know-how etc. For completing a project satisfactorily, all the activities are required

to be performed systematically in a predetermined planned way in a time bound schedule with optimised utilisation of manpower and other resources.

Most of the modern construction projects are multi-disciplinary and complex in nature, both from technical and managerial point of view. Such projects require expert knowledge in various fields and require more attention to the construction process. Introduction of computers in field of management of construction projects has brought a qualitative change right from the planning stage to the implementation, control and review. The construction manager by using his foresight and innovative skill with proper coordination effectively utilises resources for achieving result-oriented plan of implementation and control for completing the project in time.

As we know that, timely completion of the construction project is very important so as to get social-benefits in time as well as starting of return on investment, as delay in implementation of the project adds to the interest burden on the capital investment. As effective construction management results in timely completion of the project and it also contain the cost of construction within the cost estimates. Thus construction manager must have adequate control over (a) timely completion of the activities, (b) quality and (c) costs.

Here management means performing functions of planning, scheduling, implementing and controlling. These aspects are discussed in a separate chapters in the book.

Management of a construction project is a large system having several sub-systems, mainly contract management, human resource management, materials management, finance management, time management for ensuring project completion within an allocated time, and information management.

1.5. RESOURCES REQUIRED FOR CONSTRUCTION OF PROJECTS

Resources provided as input to the construction projects are human, materials, equipment and funds. Though funds are capable of procuring all these resources but men, materials and equipment are important resources. Technical and managerial skills are also sometimes considered as resources, but these are included with human resource. Managers are required to make efficient use of the resources for achieving organisation goals. Resource planning is an important activity of management.

Following resources are required for the implementation of a construction project.

1. **Human Resource.** This include skilled, semi-skilled and un-skilled workers, supervisory personnel both technical and non-technical, managerial personnel, staff engaged for operation and maintenance of equipment and machinery. Talents, skills, experience, cooperation and know-how of the human resource help in achieving higher level of productivity. Availability, quality and use of human resources is a most important factor in achieving objectives of a construction project.

From the above we see that human input as resource is both physical and intellectual. Through the use of intellectual capabilities of managers in the form of planning, organising and controlling efforts, construction managers can increase overall productivity and economy. The closer integration of human and physical resources is the major challenge of job design for increased productivity and enhanced manpower satisfaction.

Human resource planning is the strategy for the acquisition, utilisation, improvement and preservation of project's human resources.

2. **Materials Resources.** Material resources are construction materials and physical facilities like computers, electrical generators etc. In a construction project, materials planning is the scientific way of determining the requirements of construction materials, spares and other items. Materials managers should have plan their requirement considering the activity schedule of the project, and then plan for acquisition of needed resources. Construction projects require heavy investments and are financed by government, public and private enterprises.

3. Construction Equipment Resource. Machines and equipment are the important resources of an organisation. The planning of these equipment is done to have optimum use. This resource should neither be short to face problem of scarcity, nor should be more than desired to block the capital. The management of the construction project should plan the number of equipment required and time of their acquisition considering the project schedule.

The equipment resources are allocated in an optimal manner to meet the objectives of the project effectively and efficiently. Where required, help of 'linear programming' and other 'operation research' techniques is taken.

Management of the construction project must ensure that the equipment resources are made available in right quantities, at right time, in the right manner at right places. For the success of a project and for optimum utilisation, the resources must be adequate at all times and also they should not remain idle at any time.

As we know that circumstances can never remain same as predicted during planning, and some times they start deviating from the plan. Therefore, a watch by the project manager is necessary, and he has to reschedule the implementation under such unfavourable circumstances. The frequency of revision/updation depends upon the extent of unfavourable circumstances.

4. Capital Resource. Capital in the form of liquid money, assets in bank or assets as bonds should be managed very effectively. The capital assets like equipment and machinery have been discussed separately considering their importance in modern construction methods.

Funds, space etc are the resources which are generally limited in any construction project. The management of these resources is very important from economy point of view.

1.6. RESOURCE UTILISATION

The way the resources are allotted and utilised decide the success of construction projects. Management of construction project must ensure that the different resources required must be made available in right quantities, at right time, in the right manner and at right places. Inefficient and ineffective use of resources may cause slippages in schedule and cost over-runs. This can be kept under control by effective use of coordinated project resources into integrated frame work.

Resources like labour crew, finance, materials, space, equipment etc are available at the disposal of the management for the completion of the project. The completion of a project on the scheduled date depends upon the availability of resource at desired time in desired quantity.

As we have already discussed that the circumstances can never remain the same as predicted during planning and with the result the projects start deviating from the plan. Therefore, the project manager has to reschedule/update the plan and/or reallocate the resources.

Each project involves several activities and every activity requires some resources. There may be activities which are to be performed simultaneously and may require common resources. The requirement of resources to execute these simultaneous activities may exceed the available resources. However, at some other period of the execution of the same project, there may be few activities which may require very little resources. The project manager in such situations has to take decision about addition or reallocation of these resources or rearranging the time schedule of these activities without affecting much about final completion of the project.

1.7. OBJECTIVES OF CONSTRUCTION PROJECTS

Construction works are carried out for setting up a new project, addition or alteration/modification of old structures. Considering these, the objectives of construction works are as under :

1. The project should be completed in minimum duration, so as to start getting benefits at an earliest.

2. Manpower and other resources should be used judiciously in an optimum way.
3. Project should be completed with minimum capital investment for getting maximum benefits for maximum duration.
4. Build new projects in order to satisfy demand during their operation after completion.
5. Expansion of the existing project so as to meet additional demands.
6. Renovation/modification/alteration/strengthen the existing project in order to increase the life of project or accommodate new machines or to relocate existing machines to boost production.
7. Construction project should meet the constraints like quality, time, cost and environment.

1.8. PARAMETERS OF CONSTRUCTION PROJECTS

Following are the major parameters for any construction project :

1. Size. It denotes the number of tasks to be executed in a project, and each task is measured in terms of quantities of work involved.

2. Complexity. It is a measure of variety in the nature of tasks to be executed. A project is said to be simple where the tasks are repetitive *i.e.*, similar in nature.

3. Cost. It is the estimate of expenditure to be incurred for completion of the project, which the client has agreed to commit.

4. Completion time. It indicates the speed with which the project is to be executed.

5. Quality. Quality for a task is stated in terms of standard specifications.

6. Capacity. The capacity of a project indicates the demand which can be met from the project during its operation after its completion.

Productivity, efficiency and effectiveness during the execution of the project determines the actual completion time and cost of the project. Therefore, in a project with predetermined productivity standards (considered while preparing the estimates of the project), specified completion time and construction cost become the project objectives. Thus, planning and controlling of the project objectives, are the most important functions of the project management.

1.9. ORGANISATION FOR CONSTRUCTION PROJECTS

Management of construction projects is an art and science of mobilising and managing people, materials, equipment and money to complete the assigned project work on time within budgeted costs and specified technical performance standards. It aims at achieving the specified objectives efficiently and effectively by managing human energies and optimising the non-human resources placed at their disposal.

Organization set-up of a construction project depends upon project participants. The policy decision of the top management of the owner influences the organization to be adopted. A construction project generally has three parties, namely;

- (a) An owner,
- (b) A designer and/consultant, and
- (c) A builder (generally known as general contractor).

Since construction projects may be managed by a spectrum of participants in a variety of combinations, the organization for managing such projects may vary from case to case.

Traditionally, there are two contracts between these three parties as they work together to plan, design, and construct the project.

(i) The first contract is the *owner-designer contract*, which involves planning, design, and construction administration.

(ii) The second contract is the *owner-contractor contract*, which involves construction.

The following combinations of these participants are in vogue:

1. Designer Build Contracts. This system is now becoming popular. Many owner let out contracts in this system, where in the design-builders team is responsible for taking a concept developed by the owner, complete the detailed design, and proceed with construction.

2. Agency Construction Management. Agency construction management is a fee-based service in which construction manager is responsible to the owner and acts in the owner's interests.

3. Traditional Method of Designer-Constructor Sequence. Traditionally projects of moderate size and complexity, the owner often employs a designer firm which prepares the detailed plans and specifications for the constructor (a general contractor). The designer also acts on behalf of the owner to oversee the project implementation during construction. The owner may select a general constructor either through competitive bidding or through negotiation. Public agencies are required to use the competitive bidding process, while private organizations may choose any process.

4. Owner-Builder Operation. In this approach, an owner has to maintain a large work force, so as to have a steady flow of on-going project. However, the owner may choose to subcontract a substantial portion of the project to outside consultants and contractors for both design and construction. In order to integrate all efforts in project implementation, owner retains centralized decision-making.

5. Public-Private Partnership (PPP) and Turnkey Operations. Now-a-days, public-private partnerships (PPP) have become the cost effective way for Governments to fund and take up the infrastructure projects that otherwise might not be possible. In the past, many infrastructure projects have been successfully executed through P.P.P. with the central and various State Governments in India. These projects include highways and expressways, bridges, seaports, airports, industrial parks/estates etc.

Some owners delegate all responsibilities of design and construction parties in turnkey project arrangement. A contractor agrees to provide the completed facility on the basis of performance specifications set forth by the owner. If owner desire, the contractor may even take up the responsibility of operating the project.

These modes may target projects to be executed on the principles of:

- (i) Build Own Operate Transfer (BOOT),
- (ii) Build Operate Transfer (BOT),
- (iii) Build Own Lease and Transfer (BOLT),
- (iv) Build Own Operate-Share and Transfer (BOOST)

Such projects could be promoted by consortia of private and public-sector companies, financial institutions and MNCs.

1.9.1. Salient Features Related to Organisational Aspects in Construction Projects

Salient features of construction projects and their implications on organisational aspects are discussed hereunder :

1. Construction projects consist of variety of specialised activities and need a wide range of skilled tradesmen. Since construction work is of short duration, workers move from job to job, unlike manufacturing industry where workers are more or less permanent.
2. Sites of construction projects are generally in remote areas and are prone to extreme weather conditions.
3. The construction projects are carried out at places that are far off from the head offices of the organisations executing these projects.

4. Construction works in high rise buildings or other structures, involve operations at heights, making the accident rate high.
5. Project time and costs are corelated. Schedule slippages affect the project economy.
6. Construction projects operate under risk and uncertain conditions as compared to other projects which are generally well-defined.
7. Tasks of construction projects are generally non-routine and needs to employ experienced staff with proven skills.
8. Most construction projects by nature contain several inter-related sub-systems. Integration of activities of these sub-systems requires coordination.

1.9.2. Designing the Project Organisation

General principles of organisation and management shall be discussed in relevant chapters in the book, here we shall discuss special aspects related to the designing of the organisation of the construction projects.

The organisation of the construction project is temporary and ceases after completion of the construction of project. The organisation is conceived during the project conception stage and comes into existence at the start of planning stage, and grows gradually. The organisation structure undergoes changes in various stages to meet project needs. The organisation should be staffed with experienced persons to respond speedily with changing situations and speed up decision-making. Special attributes of these organisations include its innovation capacity to overcome problems as they arise.

The organisation structure for construction projects must take care of the following :

1. The groups/sections of the organisation should conform with the project work breakdown structure.
2. Each of the groups/sections should be assigned with the responsibilities and allocated resources to meet these tasks.
3. The heads of line and staff departments are generally grouped into project management team and planning chief should be assigned with the responsibility of coordination function.
4. With the change in the requirement of project tasks, the size and structure of the organisation should be changed. However, the core project team and basic structure should continue till the end.
5. The inter-relationship between various groups should be supported by the organisation structure.
6. Hierarchy of the organisation should not be too long, and efforts should be made to make it flat so as to avoid bureaucratic style of working. This helps in reducing the channels of communication and thus making decision-making process faster.
7. Efforts should be made to draw key staff from existing staff of other projects/head office, which helps in better understanding and good relationship with head office.

1.9.3. Organisation Structure

The management team of the construction project is led by a **Chief Project Manager**, who is an agent of client and acts on his behalf. The Chief Project Manager, who is chief of project or head of project also sometimes designated as General Manager or Chief General Manager or Project Manger etc. The site incharge of major contractor in major construction projects is also sometimes referred as Project Manager or General Manager Project. Head of the project coordinates and communicates with all agencies engaged in project work. He is also accountable for planning, mobilising, motivating, directing and controlling all the activities at the project.

The size of structure *i.e.*, management team depends upon the nature or extent/scope of the project work. The structure for large and medium projects include specialist departments like design, contract, quality assurance, materials, equipment, finance and personnel departments. A sample organisation chart for a construction project is shown in Fig. 1.1. Here only departments are being indicated and the strength of each department depends upon the quantum of work and nature of decisions involved. Similarly number of departments can also be increased or decreased depending upon the nature of works in the project.

1.9.4. Role of Head of a Construction Project

Head of the construction project, hereafter will be referred as Project Manager, is the king pin around which the whole organisation revolves. His main task is integrating the inter-disciplinary and inter-organisational efforts for successful accomplishment of the specified objectives. His main aim is to achieve the specified goals within the available resources.

Main responsibilities of a Project Manager are team building, monitoring and control of progress, scheduling and finances, resource management, coordination with various heads of departments, head office and outside agencies. His functions vary with the nature of construction project and organisational set-up.

Roles of Project Manager reflecting the behaviour pattern are given hereunder :

1. **Figure head role.** He is focal point for making-decisions.
2. **Leadership role.** He directs the inter-functional efforts by building a motivated team.
3. **Liaisoning role.** He must maintain contacts with concerned outside agencies, and Government officials.
4. **Monitoring role.** For execution of project, he must monitor the progress regularly and exercise control over time, cost, quality, scheduling etc.
5. **Disseminator's role.** He should transmit relevant informations received from external sources and internal MIS to the concerned officials.
6. **Entrepreneur's role.** He must explore and then utilise opportunities to promote the interests of the project.
7. **Spokesperson's role.** He acts as a role representative of the client for communications with external parties.
8. **Conflict handling role.** He must maintain organisational harmony by resolving conflicts.

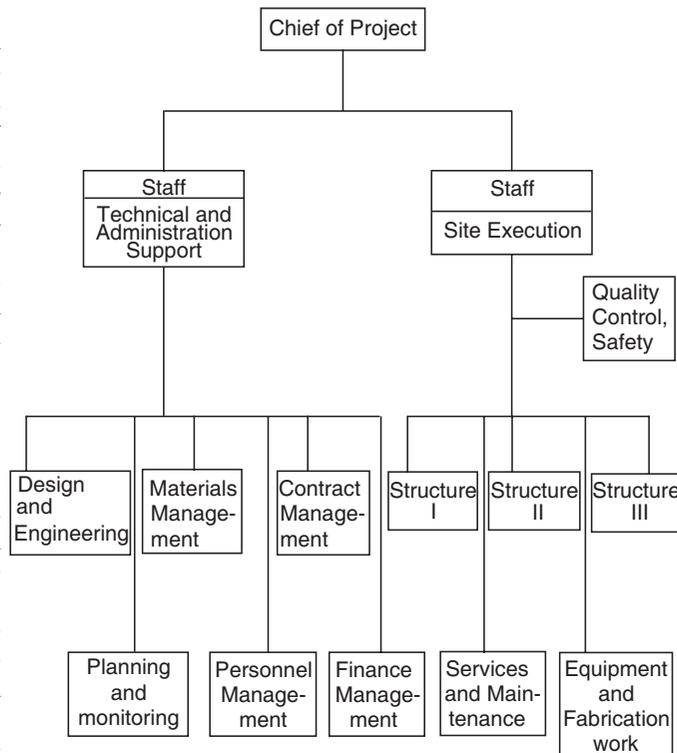


Fig. 1.1 Organisation structure for a medium or large size project.

9. **Resources allocator role.** He has a final say in allocating the project resources and making changes in allocation which are necessary so as to ensure availability of adequate resources on time and for required duration.
10. **Negotiator's role.** He must negotiate important conflicting issues and business related matters with outside agencies.

For exercising above roles effectively and efficiently, Project Manager must have good managerial skill, technical expertise, businessmen like qualities, leadership qualities, excellent communication skills and wide construction experience.

1.9.5. Functions of Project Manager

Project manager, for the success of a project, must be nominated from detailed project report stage, and is expected to exercise following functions :

- (A) To help management in :
 - Objective setting. — Planning the project.
 - Deciding project organisational structure.
 - Policies.
 - Decision-making by submitting recommendations.
 - Strategic planning.
- (B) To perform following functions :
 - Submitting effective reports. — To provide leadership.
 - Optimum utilisation of resources. — Guide his team in problem solving.
 - Create working environment.
 - Reduce conflicts and improve inter-personnel relationship.

1.10. MANAGEMENT OF CONSTRUCTION PROJECTS

As we know that many of the modern projects are very large in size, demanding mobilisation of lot of resources, involving interdisciplinary activities, necessitating execution and completion of these projects within schedule time in an efficient manner and also to achieve the desired quality in a most economical way. The present-day project management demands a systematic approach in the implementation of the project, right from planning stage to the commissioning.

The management of a construction project includes the way to plan, coordinate, control and implement all the activities of a project within the scheduled time and cost, and also to achieve the desired quality.

Major management functions for a construction project are :

- (i) Planning and scheduling.
- (ii) Implementation.
- (iii) Monitoring and control.
- (iv) Review.

1. Planning and Scheduling.

In any construction project, planning stage starts with the soil investigation and topographical survey of the land, where the project is proposed to be set-up. Next stage of planning is preparation of feasibility study and then Detailed Project Report (DPR) showing the exact location and broad specifications of the project including residential colony, office complex, road network (for colony, approaches, haul roads etc.) and other facilities. At this stage schedule is prepared showing the time-frame of the project alongwith preliminary budgetary estimate of different structures of project and various facilities.

In the next stage, planning process includes approvals of different Government authorities. In case of large projects, involving multi-disciplinary activities, a number of government departments are to be approached like district administration, state government, Pollution Control Board, concerned ministries, Land and Revenue department for land purchases, PWD

for roads, electricity supply agencies for electricity, Forest and Wild life departments, Ministry of Environment and Forest, other government agencies, RBI for issue of foreign exchange etc. After obtaining these approvals, project authorities should seek approval from Public Investment Board (PIB).

After the project is sanctioned, the planning process enters into the next stage for inviting tenders, selection of consultants/specialists for preparation of detailed working drawings and estimates, selection of contractors, suppliers etc.

A construction schedule, after carrying out above mentioned activities, is then prepared. This scheduling work is done by Mile-stone charts and Network techniques. At this stage, resources are also decided. A Master Schedule is prepared for the whole project, and this Master Schedule is broken up into sub-schedules of different departments.

Planning and scheduling is also carried out for raising the organisational set-up, manpower planning, inventory planning, equipment planning, and resource planning including phase-wise cash-flow requirements.

2. Implementation.

For achieving the objectives of a construction project, next stage is to take up the implementation of the project for its construction. For proper project implementation, emphasis should be on action as per planning for which organisation set-up and sound project management system should be established for managing the project in scientific and rational manner, following the latest management principles, tools and techniques.

For effective implementation of construction project an effective management system with regular Management Information System is needed for coordination and monitoring of activities of different participating agencies. Implementation of a construction project starts with the setting up of basic infrastructural facilities for residential and official accommodation along with facilities required for the project like approach road, electricity, communication system, security, workshop and arrangement of necessary resources including human resources.

Many of the project activities come under the purview of the contractors, who are entrusted with various construction activities. Inspection for quality control, progress and other monitoring for the purpose of carrying out control over cost, schedule etc are carried out by the client. Proper coordination is required to be maintained by the project authorities with all concerned.

3. Monitoring and Control

In order to ensure completion of the project in time and within estimated cost, the efforts of the management are so organised that the status of the project on all fronts may be known at regular intervals. Progress on all these fronts are compared with the schedules planned earlier and the status of the project is determined regularly to ensure that the project is not having an over-run either in cost or time. If there are deviations, the problem areas are identified and proper corrective measures are applied.

Thus, project monitoring is a systematic procedure to collect and analyse informations related to the implementation of the project. The basic object of monitoring is to identify the areas where corrective action is required to be taken in order to ensure proper implementation as per plan.

Controlling in a construction project is a management function and involve;

- Control over performance time.
- Control over human activities.
- Control over movement and consumption of materials.
- Control over workmanship and quality.
- Control over costs.

Effective project control is essential for realising the project objectives, mainly time, cost and quality, by (i) ensuring regular monitoring of the performance, and (ii) motivating project personnel to strive for achieving the project objectives.

From above we have seen that, primary objective of the management of construction projects is to finish the project within the scheduled time and budgeted cost while achieving the good workmanship or quality by ensuring quality control, quality assurance and inspection.

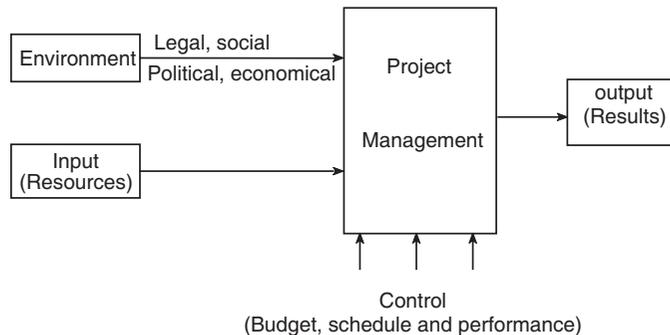


Fig. 1.2. Project management system.

The construction projects may be owned by a single person (*i.e.*, ownership firm), a cooperative body, a government institution or the ownership may be shared jointly (as a joint venture project). Who-so-ever may be the owner of the project, all the major projects are managed by qualified and experienced managers. The construction projects are generally used by the public at large, though the owners may be anybody.

1.11. PROJECT MANAGEMENT

As we have discussed earlier, a project is a collection of several activities with a definable finish essential to achieve a specific objective. Project management is a tool of management for planning and control. The objective of which has been defined as an attempt to make the most efficient and effective use of resources, viz. manpower, equipment, facilities, materials, money, technology and information, so that the organisational objectives and goals can be achieved within budget, on schedule and at the desired performance/technology level, while adhering to the ever-changing environmental input factors, like legal, social, political, economical and technological.

1.12. CONSTRUCTION INDUSTRY AND ITS PRACTICES

As we know that all sectors of the economy, whether industrial sector, the infrastructural sector, the housing sector, oil sector, or even the agricultural sector, have certain components of construction activities associated with them, though in varying proportions. In the present day world, technical advancements have revolutionised construction industry. Modern construction areas include, high-rise buildings, dams, power-houses, irrigation system, energy conversion plants, industrial plants, infrastructural facilities like, roads, bridges, railways, airports, seaports, oil terminals, refineries etc.

The construction activities contribute to the economic development of a country. It has generally been observed that gross domestic product (GDP) per capita and the investment in the construction per capita follow a straight line relationship. The construction industry belongs to the capital goods sector of the economy (other major sectors of the economy are consumer goods sector and services sector) and produces visible assets. These end products of construction add GDP as capital assets and help in increasing the productivity of other sectors of the economy as well.

Construction industry provide a vast scope for cost and time reduction by improving performance and quality through knowledge gained in planning, scheduling and controlling construction process, where men, materials, machines, money and management techniques work together and by adopting latest construction practices.

In addition, construction sector generates more employment than most of the sectors. It also generates employment in other sectors like steel, cement, brick, construction machinery, transport sectors whose materials are consumed in bulk in the construction sector.

In the field of construction, many of the items of civil and structural work are similar and repetitive. Some of the construction practices, which are mostly used in construction industry are mentioned hereunder. A thorough knowledge of such practices and latest developments in their field, help construction engineers in achieving desired objectives. These common construction practices are discussed in Part - II of the book:

1. Excavation work. This includes dewatering and excavation by blasting.
2. Foundation work. This includes pile and well foundation.
3. Compaction.
4. Consolidation.
5. Soil stabilisation.
6. Concrete work. This includes various grades of plain and reinforced concrete, its mixing and placement; admixtures, grouting and guniting, scaffolding and form-work.
7. Bitumen mix concrete including mixing and laying.
8. Rigid and flexible pavements.
9. Tunnelling and underground works.
10. Dam and spillway.
11. Construction of canals and its lining.
12. Land development including earth filling.

Problems of Construction Industry

In many cases we have seen that projects have failed to achieve their targets of completion within the specified cost and time. Statistics have shown that about half of the major projects had more than 20% cost overruns, and similarly about 50% of the projects faced a time over-runs. Major factors contributing (problem causing) to these cost and time over-runs are listed hereunder:

- (1) **Inadequate project formulation**
 - Poor field investigation.
 - Inadequate project information/data available.
 - Lack of experience.
 - Bad cost estimates.
- (2) **Poor planning for implementation**
 - Inadequate resource planning, mobilisation and allotments.
 - Over optimistic time schedules.
 - Lack of essential resources.
 - Poor funds planning.
 - Incorrect selection of equipment.
 - Lack of knowledge about working/application of construction equipment.
- (3) **Lack of proper contract planning and management**
 - Improper pre-contract actions.
 - Improper specifications or too many changes in the specifications during implementation.
 - Non availability of working drawings in time.
 - Deployment of too many contactors and unclear division of responsibility.
 - Poor post award contract management.
 - Poor performance of sub-contractors.
 - Failure of vendors and sub-contractors to meet commitment.
 - Poor scheduling by contractors.

(4) Lack of project management during execution

- Inefficient and ineffective working, delays, frequent changes in specifications.
- Unforeseen natural calamities.
- Hindrances caused due to deliberate attempts made by manipulators/certain interests.
- Different site conditions than that available during field investigations.
- Lack of coordination between various departments of the project.
- Faulty procurement of construction machinery and materials.
- Lack of experience by construction engineers and construction equipment operators.
- Lack of construction equipment management, resulting in more down-time and poor utilisation.
- Adopting complex and complicated procedures.
- Incompetent implementation authority.

(5) Lack of management and MIS aspects**(a) Factors related to Planning :**

- Unclear objectives and targets.
- Failure to identify critical items and to take remedial measures.
- Lack of clear policies and procedures.
- Unworkable plans.
- Reluctant to take timely decisions

(b) Factors relating to Organising

- Incorrect organising structure resulting in conflicts, confusion of responsibility, inadequate delegation of authority, higher management interferences.
- Lack of coordination and cooperation amongst various levels.
- Poor communication.
- Poor human relations.
- Lack of discipline and strikes

(c) Lack of Controlling

- Inadequate information flow.
- Lack of adopting appropriate monitoring techniques.
- Absence of timely corrective measures.

(d) Problems related to Management Information System (MIS)

- Managers do not know their information needs.
- Right information could not be retrieved from available data or managers are confused due to too much data.
- Information can get misinterpreted/misunderstood.
- Information delays.

1.13. SIGNIFICANCE OF TIME IN PROJECT IMPLEMENTATION

All construction projects are time bound. Project time and cost objectives are correlated; and it is the time factor which determines the project cost. Time is essence in implementation of construction projects. Timely completion of projects is therefore of paramount importance. In other words we, can say that for a construction project time is money.

The project management is not only to establish an integrated management system for the entire project, but also define and pinpoint all the responsibility centers and interfaces by establishing common time schedule for all project activities. These warrant, therefore, a comprehensive integrated plan of action.

All activities of construction projects are directed towards the achievement of project time objectives. In complex projects, where a large number of activities are performed by different agencies, with each having its own scheduled targets, a small delay in a critical activity can affect very adversely. The delays can change the planned level resources and their availability to those activities. In spite of best efforts to complete a project on time, changes from original estimated project time-plan do occur sometimes.

There may be many reasons, both foreseen and unforeseen, controllable or uncontrollable, for non-completion of a project on time. However, a plan prepared before the commencement of construction in a project, can help in directing, coordinating, setting targets, forecasting resources, budgeting costs, controlling performance and motivating people. Therefore, the project planning starts with time planning as the first step. Project time control aims at the timely execution of work according to the planned schedule and applies corrective measures in case of time deviations.

Time control monitoring is carried out by measuring of time status of completed, in-progress and non-starter balance activities. It uses the network techniques.

1.14. SUCCESSFUL COMPLETION OF A PROJECT

A project is successful when it is completed in time and in budgeted costs. For the success of a project, following qualities/driving forces are necessary :

(i) **Drive and motivation factors :**

- Common objectives. — Strong desire for work accomplishment.
- Group acceptance.
- Good working environment under the leadership of the project manager.
- Good interpersonal relations.

(ii) **Management support :**

- Providing sufficient resources. — Priority to the project.
- Sufficient authority and delegation. — Strong organisational structure.

(iii) **Technical and experience factors :**

- Sufficient technical knowledge to the personnel.
- Right communication system.
- Well designed Management Information System.
- Proper control and monitoring system.

1.15. PROJECT CYCLE AND PROJECT PHASES

Different phases vary depending on the type, nature, size, ownership and sources of financing of the project, government policies and procedure, management systems and techniques used, but there are three basic phases through which each project passes, which are planning, implementation and operation. Sometimes these phases are divided as pre-construction phase and construction phase, which includes sub-phases as indicated under :

(A) **Pre-construction (Project planning) phase :**

- Project identification — Preliminary project formulation
- Project feasibility study — Project appraisal and approval.
- Detailed project report — Project implementation planning.

(B) **Construction (Project implementation) phase:**

- Project tendering and ordering
- Project construction, and equipment installation/erection
- Project monitoring and control — Project evaluation
- Project replanning.

Each of the phases of the project require several steps and tasks to be performed, and the planning and implementation phases involve several agencies like owners, financiers, contractors, consultants, and government agencies. The project cycle with phases and stages is shown in the sketch below :

Some authors have broadly divided the construction projects into following stages :

(1) **Formulation stage.** This includes :

- Project idea conception.
- Feasibility studies.
- Investment appraisal.

(2) **Mobilization stage.** This stage covers the preparation of :

- Project preliminary plan.
- Design drawings and specifications.
- Contract finalisation.
- Resource mobilization including funds planning.

(3) **Construction stage.** This includes:

- Construction planning.
- Induction of resources.
- Monitoring and control of construction.
- Commissioning.
- Final handing over of the project for operation.

In actual practice some work of one stage overlaps the other for some duration.

1.16. PROJECT PLANNING

Planning is determining what needs to be done, by whom and when in order to fulfill one's assigned responsibilities *i.e.*, determining what jobs are involved in a given project, their logical sequence, their inter-relationships.

There are following four **basic objects** of project planning :

- To eliminate or reduce uncertainty.
- To improve efficiency of the operation.
- To obtain a better understanding of the objectives.
- To provide a basis for monitoring and controlling the works.

Following eight **major elements** must be formulated during the planning phase :

- (i) **Objective.** A goal to be achieved within a certain time.
- (ii) **Programme.** The strategy to be followed and major actions to be taken in order to achieve or exceed objectives.
- (iii) **Budget.** Planned expenditure required to achieve or exceed desired objectives.
- (iv) **Organisation.** Design of the number and kinds of positions along with corresponding duties required to achieve or exceed objectives.
- (v) **Forecast**
- (vi) **Policies**
- (vii) **Procedure**
- (viii) **Standard**

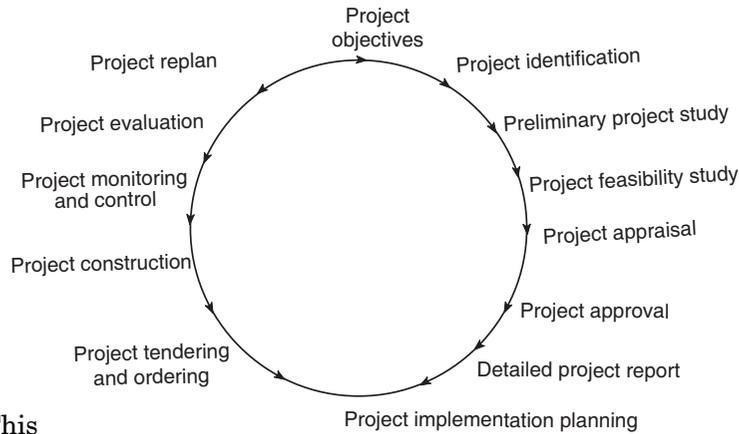


Fig. 1.3. Project cycle.

Essential Steps in Project Planning :

- (a) Define the goal.
- (b) Identify activities and tasks that must be completed to achieve the goal.
- (c) Identify dependencies between activities and tasks.

Project management relies heavily on two tools created during project planning :

(i) The work of project be break-down into elements.

(ii) To prepare a PERT chart, as this is a management tool for defining and integrating events which must be accomplished on a timely basis to assure completion of project objectives on a schedule.

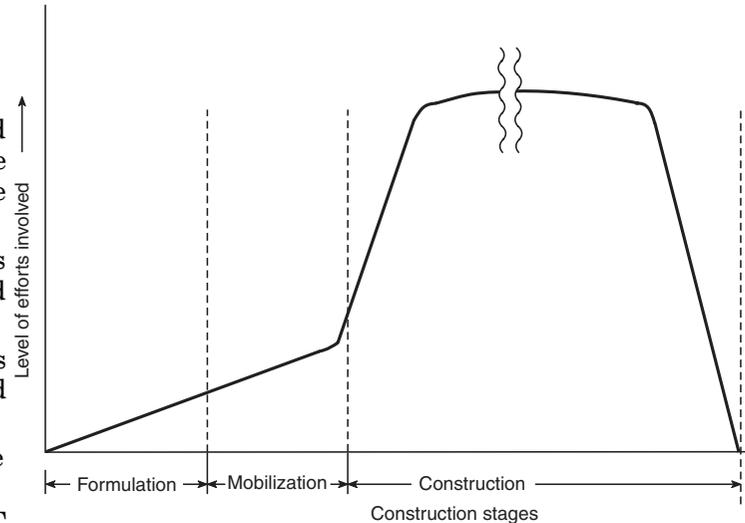


Fig. 1.4. Efforts involved v/s Time taken by various construction stages.

Tracking and Reporting

Tracking determines the real progress of the project against expectations *i.e.*, evaluating performance against schedules.

Documentation and reporting consist of preparing and summarising the projected data at the planning stage as one executes the project, and also when analysing a completed project/current progress so as to provide information for planning future projects/activities of current project.

1.17. SITE-EXPLORATION

In the initial stage of planning, it is necessary to carry out a detailed site-exploration work of the area where the project is to be located. It also gives technical guidelines and recommendations regarding the type and nature of the foundation system needed for different structures of the project.

As a preliminary to the design of project structures, it is necessary to determine the topography of the site, and nature and variability of the soil strata at the project site. This site exploration includes a study of local topography, ravines, quarries, hillock, evidence of erosion or land slides, behaviours of the existing structures at or near the site, water level in the streams, water courses, flood marks, springs, drainage pattern etc. In addition, geotechnical informations should also be collected. All the above informations help in deciding the scope and methods of future field investigations.

Many informations can be gathered from the local people regarding the type of soil, seasonal variation of ground water table, highest flood level etc.

After carrying out topographical survey, soil must be investigated. Soil investigation is carried out to obtain data and information regarding soil characteristics, ground water conditions, seasonal variation in ground water level and engineering properties of soil. On the basis of these informations an assessment is done by the soil experts regarding the safe bearing capacity of soil, type of foundation suitable for the proposed structures at site and necessity of dewatering in excavation work, soil stabilisation etc.

Soil investigation programme for any construction project depends upon :

- (i) type of project,
- (ii) importance of the project, and
- (iii) nature of sub-soils involved.

A large dam project would usually require a more thorough sub-soil investigation than would a highway project. Sub-soil exploration can be held in two steps :

- (a) Investigation of the general geological character of site.
- (b) To make exploratory drill holes to provide more specific information regarding the general character and the thickness of individual strata.

The required depth of exploration depends on :

- (i) Size and type of proposed structure, (ii) Design considerations,
- (iii) The character and sequence of the sub-surface strata.

Various methods of soil-exploration are :

- | | |
|----------------------|-----------------------|
| 1. Open test pit. | 2. Auger boring. |
| 3. Wash boring. | 4. Percussion boring. |
| 5. Diamond drilling. | 6. Rotary drills. |

All the above mentioned methods shall be discussed in relevant chapters in the book.

1.18. INFRASTRUCTURE DEVELOPMENT

The development of infrastructure in a construction project involves the building of facilities necessary to support the main construction activities and later on, the operation. The infrastructure work includes mainly land development, approach road(s), boundary wall, drainage system, internal roads, water and electricity system, communication network, transport. Infrastructure also includes buildings for site offices and storage, labour and staff quarters.

In large construction projects, infrastructural development work consumes lot of time and financial resources, therefore, should be planned properly and should be started well before the commencement of the main construction work. Most of these facilities are taken up immediately after the site is selected and the decision for investment is taken after preparation of detailed project report and budgetary estimate. It should be remembered that infrastructural works are generally taken up at a time, when the site does not have basic amenities and conditions are not favourable, therefore, sufficient lead time is allowed in starting the infrastructural work.

Non-availability of adequate infrastructure facilities at the right time has been among others the main cause of time and cost over-runs *e.g.*, delays in land acquisition, non-availability of water and power for construction, approach roads to the site of work etc. As such careful planning, realistic scheduling, integrated and coordinated implementation and scientific monitoring and control of infrastructural works are essential for successful construction of project within planned time and cost.

1.19. SOCIAL COST-BENEFIT ANALYSIS

During carrying out feasibility study of a construction project, besides demand study, technical study, profitability study etc. it is necessary to conduct social cost-benefit analysis. The project may be beneficial for the local public or for regional or national level, which may help in boosting the production or services or to satisfy social needs. Sometimes although the project is uneconomical, but if it is beneficial to the society or to the country, the clearance to the project is given.

Social cost-benefit analysis is a methodology adopted for evaluating investment projects from the social point of view. Mainly public sector projects are evaluated from socio-economic considerations. The contribution of public sector projects towards social objectives such as

related to employment, health, transport, education facilities, defence, self-reliance and foreign exchange saving are evaluated.

The aspect related to social cost-benefit analysis is examined by the Project Appraisal Division (PAD) of Planning Commission. Public Investment Board (PIB) is an organ of the central government to appraise and recommends all major projects coming under the purview of the central government.

Examples of social costs are depreciation of roads and other facilities used for the project. In the construction of a hydro-electric project, a number of people have to be displaced and resettled. The actual cost of doing so and the collective hardships suffered by these people together must also figure in the social costs. Air pollution and noise are also examples of social costs.

Examples of social benefits are the provision of good housing facilities to the employees would improve their living and health, which would help in improving productivity and would bring down absenteeism and therefore would help in increasing the production for the society. The provision of drinking water supply, accessible roads or public parks in the city also generates social benefit.

Effect of construction and operation of projects on environment also need to be considered. All major projects now require environmental clearance which considers the ecological angle. Such major projects includes dams, power-houses, highways, railways, mines, refineries etc.

Questions

1. What is construction management ? Describe its importance.
2. List out different types of construction projects.
3. Write down important characteristics of construction projects.
4. Discuss major resources required for construction projects.
5. Discuss following in brief :
 - (a) Resource utilisation.
 - (b) Objectives of construction projects.
 - (c) Parameters for a construction projects.
 - (d) Salient features of construction projects.
6. Discuss organisation for construction projects, in detail. How would you design an organisation structure for a construction project ?
7. Write short notes on:
 - (a) Organisation structure for a major construction project.
 - (b) Role of head of a construction project.
 - (c) Management functions of a construction project.
8. Discuss important problems of construction projects.
9. Elaborate significance of time in implementation of projects.
10. (a) Identify main reasons for delay and cost over-runs.
(b) Write down major factors which help in successful completion of project.
11. Discuss project cycle for construction projects.
12. Discuss the importance of topographical survey and soil investigation.
13. Discuss following, in brief :
 - (a) Functions of a project manager.
 - (b) Project planning.
 - (c) Infrastructural development for a major construction project.
14. Discuss social cost-benefit analysis for a construction project.
15. Draw an organisation structure for a major hydro-power project and discuss?
16. Discuss 'construction industry and its practices' in detail.