UNIVERSITY OF SALAHADDIN- ERBIL
COLLEGE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING.

METHODS OF CONSTRUCTION AND ESTIMATION

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CHAPTER ONE
INTRODUCTION

1. General Concepts of the Project

The efforts of an engineer or architect, who designs a project, and constructor, who builds the project, are directed toward the same goal, namely, the creation of something which will serve the purpose for which it is built in a satisfactory manner. Construction is the ultimate objective of a design.

The application of engineering fundamentals and analyses to construction activities may reveal methods of better controlling quality, schedule (time), and costs of a construction project. Figure (1.1) shows the triangle of these objectives.

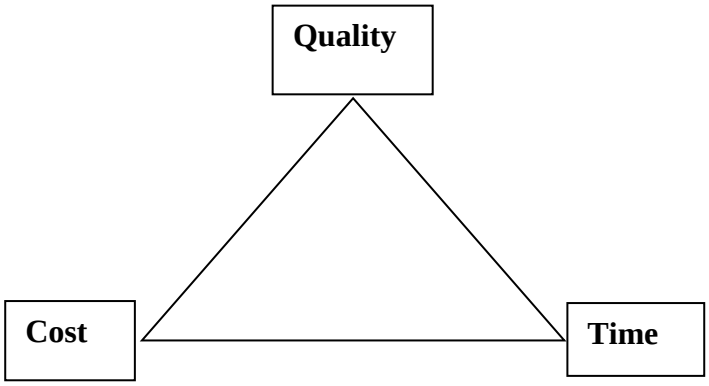

Fig. (1.1) Triangle of the major objectives of the project

To attain these objectives, total quality management role can be shown in figure. (1.2).

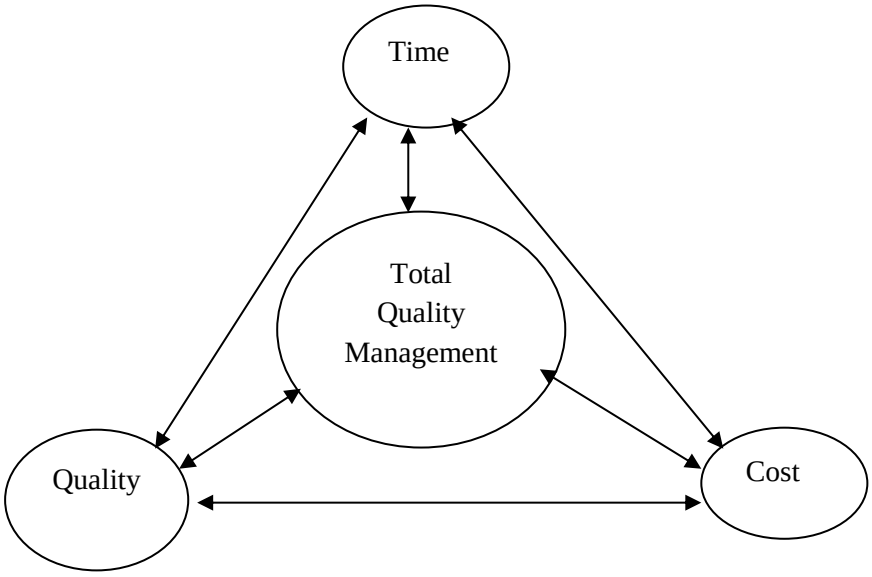

Fig. (1.2) The Interrelationships between the project objectives and the Total Quality management.

The project is a means to achieve a goals as shown in figure (1.3).

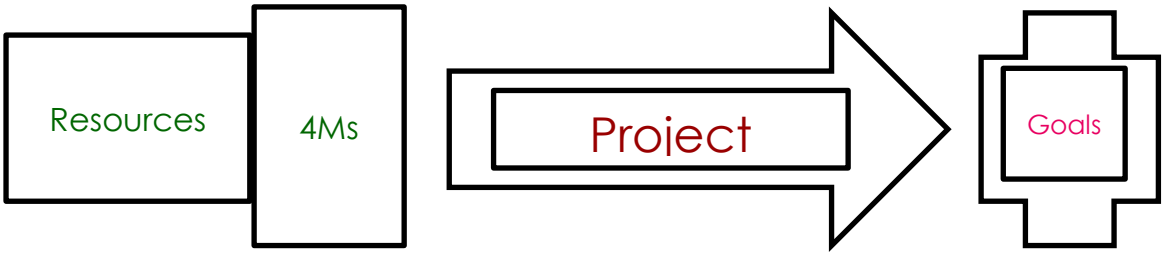

Fig. (1.3) Project is a means to achieve a goal

Project Definitions

1. A project is a temporary endeavor undertaken to create a unique product or a service.
2. A project is a finite endeavor having specific start and completion dates- undertaken to create a unique product or service which brings about beneficial change or added value.
3. A unique set of coordinated activities, with definite starting and finishing points, undertaken by an individual or organization to meet specific objectives within defined schedule (time), cost and quality parameters.
4. A project may be defined as an entire task (however large or small it may be), limited in scope and time and giving some benefit to the user when the project is completed.

The Project Life Cycle

A standard concept of a project wherein it goes through a start-up phase, building phase, a maturing phase, and a termination phase.
Engineering for construction begins long before a contractor moves onto the construction site. In fact, the total process of engineered construction may be thought of as consisting of six major elements:

1. Project definition [Needs and initial concepts]
2. Preliminary planning [Feasibility studies (economic and technical) for the project]
3. Project design [Preparation plans, specifications and cost estimates]
4. Procurement of major items [Approval by regulatory agencies, advertising for bidding and contract award]
5. Project construction [Construction and contract administration (changes & their approval) and acceptance]
6. Project startup

Figure (1.4) illustrates these six steps of project life.

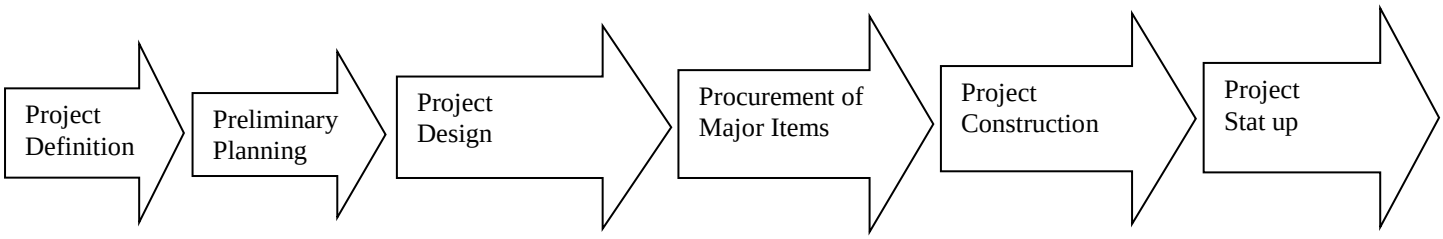

Fig. (1.4) Life Cycle of the project

Project management

Definitions:

1. May be defined as the overall control of the total process (from start to finish) to optimize the three major attributes of the process; quality, schedule, and cost.

2.The planning, monitoring and control of all aspects of a project and the motivation of all those involved in it, in order to achieve the project objectives within agreed criteria of time, cost and quality.

3.Is discipline of planning, organizing, and managing resources to bring about the successful completion of specific project goals and objectives.

The forces behind project management are:

1. the growing demand for complex,
2. customized goods and services,
3. the global production consumption environment.

Major Types of Construction

Construction facilities may be classified into four major categories, each with its own characteristics:

1. Residential Housing Construction
Includes single-family houses, multiple-family dwellings, and high-rise apartments.

2. Institutional and Commercial Building Construction
Encompasses (covered) a great variety of project types and sizes, such as schools and universities,
medical clinics and hospitals, recreational facilities and sports stadiums, retail chain stores and large shopping centers, warehouses and light manufacturing plants, and skyscrapers for offices and hotels.

3. Specialized Industrial Construction
Usually involves very large scale projects with high degree of technical complexity, such as oil refineries, steel mills, chemical processing plants and coal-fired or nuclear power plants.

4. Infrastructure and Heavy Construction
includes projects such as highways, mass transit systems, tunnels, bridges, pipelines, drainage systems and sewage treatment plants.

2.Construction Participants

2.1 Owner

The owner of a project may be a single person (like the owner of a residential building), a co-operative body, a government institution or the ownership may be shared jointly (as in a joint venture

project). A good number of big industries in the steel, petrochemical and engineering fields are now-a-days owned jointly by the government financial institutions and the private industrialists.

2.2 Construction Management Consultants (Designers)

It is to hire the construction management consultants for rendering (performing) certain services on contract basis for the entire life of project. The nature of tasks assigned to this group by the client vary, but it generally includes the following:

a. Project feasibility, including cost estimates.
b. Site survey and soil investigation.
c. Security and coordination of designs and drawing work.
d. Estimating, initial planning, and budgeting costs.
e. Processing prequalification of construction agencies, tendering, and awarding contracts to the successful bidders.
f. Designing project organizations for executing works and developing standard operating procedures and systems.
g. Developing detailed construction plans, project schedules and performance measuring standards.

Supervising works, including administration of contracts and controlling of project time, cost and quality objectives

2.3 Contractors

Construction contractors form the backbone of the construction business as they execute most of the construction works. In the competitive construction business, which requires special resources for different types of construction work, the contractors generally tend to specializes in a particular area of
construction. Two types of contractors are usually perform the projects,

- general contractors and
- specialty contractors.

The function of a general contractor is to coordinate all tasks in a construction project.
Specialty contractors include mechanical, electrical, foundation, excavation, and demolition contractors. They usually serve as subcontractors to general contractor of a project.

2.4 Material and Equipment Suppliers

Major material suppliers include specialty contractors in structural steel fabrication and erection, sheet metal, ready mixed concrete delivery, reinforcing steel bar details, roofing, glazing etc.
Major equipment suppliers for industrial construction include manufactures of generators, boilers and piping and other equipment. Many suppliers handle on-site installation to insure that the requirements and contractual specifications are met.

2.5 Project Manager

The key person who is responsible for and dedicatedly managing the entire project, from the start to the end. He is responsible in realizing the project targets by optimum use of available resources through efficient co-ordination and creating motivation of all concerned.

He is responsible to the owner (unless he is the owner himself),

- he has to look after the economy, the engineering and technical part of the project,
- he has to know the local rules and environment,
- he arranges procurement of materials,
- he coordinates in the production activities and ensures quality control and proper inspection, supervision.
- he is the main coordinator amongst his subordinate staff and departments.

The project manager (PM) is expected to integrate all aspects of the project, ensure that the proper knowledge and resources are available when and where needed and above all, ensure that the expected results are produced in a timely, cost-effective manner.

2.6 Customer/Users

The most important group of people who will be using the final services or products of the project. Without this group of stakeholder, the project should not even exist.

The user of a project may be the same person/body as the owner, as in the case of residential buildings or industrial establishments.

The Engineer and Construction

When an owner of a project under construction recognizes a need for the project, he usually employs an engineer to make a study to determine the feasibility of the project. If the study indicates that it is justified, an engineer will be engaged to prepare the plans and specifications and usually to supervise the construction of the project.

It is the duty of the engineer to design that project which will most nearly satisfy the needs of the owner at the lowest practicable cost.

The engineer should study every major item to determine if it is possible to reduce the cost without reducing the desired level of quality or prolonging the time of construction.

It may be possible to change the design, modify the requirements for construction,
or revise portions of the specifications in such a manner that the cost of the project will be reduced without sacrificing quality or schedule.

The engineer should be reasonably familiar with construction materials, methods, and costs if he or she is to design a project that is to be constructed at the lowest practicable cost.

Selection of Professional Services

1. Financial Planning Consultants:

At the early stage of strategic planning for capital project, an owner often seeks the services of financial planning consultants to evaluate the economic and financial feasibility of the constructed facility.

2. Architectural and Engineering (A/E) Firms

Traditionally, the owner engages an architectural and engineering (A/E) firm or consortium as technical consultant in developing in developing a preliminary

design. After the engineering design and financing arrangements for the project are completed, the owner will enter into a construction contract with a general contractor either through competitive bidding or negotiation.

3. Design/Construct Firms

A common trend in industrial construction, particularly for large projects, is to engage the services of a design/construct firm. By integrating design and construction management in a single organization, many of the conflicts between designers and contractors might be avoided.

4. Professional Construction Managers (CM)

In recent years, a new breed of construction managers (CM) offers professional services from the inception to the completion of a construction project. These construction managers mostly come from the ranks of A/E firms or general contractors who may or may not retain dual roles in the service of the owners.

5. Operation and Maintenance

Although many owners keep a permanent staff for the operation and maintenance of constructed facilities, others may prefer to contract such tasks to professional managers. Understandably, it is common to find in-house staff for operation and maintenance in specialized industrial plants and infrastructure facilities, and the use of outside managers under contracts for the operation and maintenance of rental properties such as apartment and office buildings.

6. Facilities Management

As a logical extension for obtaining the best services throughout the project life cycle of a constructed facility, some owners and developers are receptive to adding strategic planning at the beginning and facility maintenance as a follow-up to reduce space-related costs in their real estate holdings.

Construction Economy and Design Engineer

The budget for a project may be divided into six or more items:
Materials, labor, equipment, subcontractors, overhead, and profit. The design engineer has a strong influence over the costs of the first five of these items,

For example. If the engineer (designer)
-specifies materials which must be transported over distances, or
-specifies excessive testing, …….. the costs will be higher than necessary.
Other costly engineering practices include:

- Requiring many one-of-a-kind items which cannot be mass produced
- The use of nonstandard materials, or techniques when not required, or
- Establishing standards of quality that are higher than necessary

The following list indicates methods which an engineer may use to reduce the costs of construction:

- Design concrete structures with as many duplicate members as practical in order to permit the reuse of forms without rebuilding.
- Simplify the design of the structure where possible.
- Design for the use of cost-saving equipment and methods.
- Eliminate unnecessary special construction requirements.
- Design to reduce the required labor to a minimum.
- Specify a quality of workmanship that is consistent with the quality of the project.
- Furnish adequate foundation information where possible.
- Refrain (do not allow) from requiring the contractor to assume the responsibility for information that should be furnished by the engineer for adequacy of design.
- Use local materials when they are satisfactory.
- Write simple, straightforward specifications which clearly state what is expected. Define the results expected, but within reason permit the contractor to select the methods of accomplishing the results.
- When possible, use standardized specifications, ones with which the contractors are familiar.
- Hold prebidding conferences with contractors in order to eliminate uncertainties and to reduce change orders to a minimum.
- Use inspectors who have sufficient judgment and experience to understand the project and have authority to make decisions.

Construction Economy and the Contractor

Suggestions for possible reductions in construction costs by the contractor include, but are not limited to, the following:

1. Pre-bidding studies of the project and site to determine the effect of:
   a. Topography
   b .Geology
   c. Climate
   d. Sources of materials
   e. Access to the project
   f. Housing facilities if required
   g. Storage facilities if required
   h. Labor supply
   i. Local services

2.The use of alternate construction equipment, having higher capacities, higher efficiencies, higher speeds, more maneuverability, and lower operating costs.

3.The payment of a bonus to the key personnel for production in excess of specified rate.

4.The use of radios (mobiles) as a means of communication between the headquarters office and key personnel on projects covering large areas.

5.The practice of holding periodic conferences with key personnel to discuss plans, procedures, and results. Such conferences should produce better morale among the staff members and should result in better coordination among the various operations.

6.The adoption of realistic safety practices on a project as a means of reducing accidents.

7. Consideration of the desirability of subcontracting specialized operations to other contractors who can do the work more economically than the general contractor.

8. Consideration of the desirability of improving shop and services facilities or better maintenance of construction equipment.

Reducing Construction Costs

Some of the best opportunities for construction cost savings occur in the design process even before construction begins. Some design factors that can reduce construction costs include the use of modular dimensions, grouping plumbing and other equipment to minimize piping and conduit runs, incorporating prefabricated components and assemblies, utilizing economical materials (eliminating "gold plating"), and employing new technology. Injecting constructability considerations into the design process is one of the advantages claimed for the use of the construction management contract arrangement.

Some ways in which productivity can be increased and costs minimized during construction include:

- Good work planning.
- Carefully selecting and training workers and managers.
- Efficiently scheduling labor, materials, and equipment.
- Properly organizing work.
- Using laborsaving techniques, such as prefabrication and preassembly.
- Minimizing rework through timely quality control.
- Preventing accidents through good safety procedures.

Questions

1. What are the main parameters to be considered in accomplishing of any project?
2. What are the main phases of the project?
3. Define the project.
4. Define the project management.
5. List the main construction participants.
6. What are the main duties of each of? (i) Designer; (ii) Project manager.
7. Explain the role of engineer in reducing the cost of construction.
8. What are the causes of cost increasing during design phase?
9. Define some methods that engineer can use them in reducing the costs of construction.
10. Define some suggestions for contractor to reduce the costs of construction.

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