

## **Chapter 2**

### **LITERATURE REVIEW**

#### **2.1 PROJECT MANAGEMENT**

Generally, the work in engineering consultants companies are divided into three phases. They are **PRE-DESIGN PHASE**, **DESIGN PHASE** and **CONSTRUCTION PHASE**. In these three phases the project management plan and its key components should be developed. The general terms key goals, philosophies and elements of managing a project are discussed as follows:

##### **2.1.1 PRE-DESIGN PHASE**

The goal of this phase is to assemble and organize a project team of design and construction management persons. This project team should define and organize its activities to maximize its effectiveness for meeting the client's requirements.

The basic data of the project such as basic project purposes, goals and parameters of performance (particularly cost, time and quality) should be determined and documented by the owner and provided to the engineering consultant companies.

Everyone in team must know and understand the other members' responsibilities and overall project requirements. The best way of accomplishing this is by making a conclusion between Owner and Consultant company of the respective contracts and documentation of action items.

##### **2.1.1.1 Construction Management Plan**

The project manager should define and document the project requirements. This documentation must outline the plan and strategy for fulfill the Owner's requirements. It should be issued to the owner for review and approval.

The Construction Management Plan typically establishes the project scope, budget, schedule, basic system to be utilized and the methods and procedures to be followed. The team must be committed to complete the project within this Construction Management Plan.

The typical Construction Management Plan includes the following components (CMMA, 1988).

- project description.
- Milestone Schedule.
- Master Schedule.
- reference to project documents.
- project organization chart and staffing plan.
- explanation of roles, responsibilities and authority of Team members.
- project budget.
- reference to project procedure manual.
- management information system.
- bid packaging and contracting strategy.
- site mobilization and utilization phase.

#### 2.1.1.2 Project Procedure Manual

In the Project Procedure Manual, the responsibilities of each team member, levels of authority, systems, methods and procedures to be followed must be clearly defined and understood. The manual should include.

- the quality assurance.
- functional responsibilities, limits of authority.
- Master Schedule.
- check lists.
- listing of meetings (type, frequency).
- sample forms.

### 2.1.1.3 Pre-Design Project Conference

The project manager should plan, conduct and document a pre-design project meeting in order to conclude the requirements of the design phase and Construction Management Plan.

### 2.1.2 DESIGN PHASE

The goal during the design phase is to complete a set of documents defining a cost - effective project which does not exceed the Owner's budgets, performance and time requirements.

Design works have two major phases, preliminary and detailed design. The works in these two phases are usually related to architects and concerned engineers. At this stage, the owner's operation, utilization knowledge and the field constructor's experience are being more strongly focus on the requirement of the project (Hendrickson and Au, 1989).

In preliminary design stage, the physical figure, technological process, size and capacity are illustrated in term of drawings for owners's approval. For example, in a factory, the preliminary design determines the member of truss and frames, floor spaces, general functional allocation such as parking, operating space, office space, etc.

Generally, the architect has a primary responsibility for preliminary design in office building, high-rise building, houses. However, in heavy construction such as factory, structural engineers also take a primary responsibility in the preliminary design.

In detailed engineering and design, it involves the process of successively breaking down, analyzing and designing the structure and building's element to comply with recognized standards of safety and performance while rendering the design in the form of a set explicit drawing and specifications those will guide the constructors exactly how to build the structure (Donald S. Barrie, 1993).

Every items which will be built must be shown in term of drawings in this design stage. The detailed calculation sheets must be prepared to support those drawings. This design stage is comprise of design professionals including architects, landscape architects, civil engineers, structural engineers, mechanical engineers, electrical engineers, sanitary engineers, survey engineers and others as needed. The types of design professionals involved vary by type of work. The staff become much larger by people at the technician level such as draftmen etc.

The design professionals have to take all responsibilities of design decisions and execution. The role of management team during this phase should be to assist the design team by carrying out the following activities.

#### 2.1.2.1 Design Document Review

The project manager should periodically review the design documents, focusing on the need for clarity and consistency.

#### 2.1.2.2 Document Distribution

The project coordinator should coordinate and expedite the distribution of information among all team members.

#### 2.1.2.3 Meetings

The project manager should conduct periodic project meeting for the purpose of assessing progress, documenting performance, planning for completion and taking necessary action to resolve current problems. The items required for each project meeting include the following.

- review of the project budget and a current estimate of what construction costs the drawings and specification currently represent.
- review of the Master Schedule, Milestone Schedule and other sub schedule.

- discussion and resolution of any issues which have become evident through previous review of Team discussion.

#### 2.1.2.4 On-Going Consulting Activities

The project manager and project advisor should make recommendations to team members about the constructibility, cost, phasing and sequencing of construction, construction duration, impact of alternative construction methods and separation of contract categories.

At the end of Design Phase, the entire team should review all documents and consider whether they are completed, coordinated, adequately representative of the owner's needs and suitable for construction.

### 2.1.3 CONSTRUCTION PHASE

The goal of this phase is the efficiency and expending of the construction process through professional planning and execution of project activities. All focused on fulfilling the owner's scope, cost, quality, and time requirements.

#### 2.1.3.1 Coordination

The project manager and site manager are responsible for providing coordination and leadership of the designers and contractors in order to meet the project requirements.

#### 2.1.3.2 Meetings

There are three basic categories of meetings involved in the construction phase. They are pre - construction, progress and weekly or bi - weekly on - site meetings, and special meeting.

The purpose of pre – construction meetings is to orient all contractors to project procedures and site utilization requirements. The conclusion of responsibility and authority of consultant company, owner and contractors must be discussed and concluded.

The purpose of progress meeting is to monitor compliance with schedules and requirements of the contract documents. The management person should organize, conduct and record regularly scheduled progress meetings. These meetings should be held at least once a month.

Special meetings may be conducted, as necessary, to resolve issues of an immediate items which cannot wait until the regularly scheduled progress meetings.

#### 2.1.3.3 Time Management

The construction management team should establish procedures for monitoring compliance with the Master and detailed construction schedules. The construction management team must generate cooperation and obtain commitment from each contractor to complete the project within the owner's time requirements.

#### 2.1.3.4 Budget & Cost Monitoring

The goal is to manage the incurred costs, estimated costs and costs to complete in order to stay within the budget. The construction management team should maintain the process of tracking, projecting and monitoring costs through the construction phase.

#### 2.1.3.5 Quality Management

The construction management team should monitor contractor compliance with the quality level expected for the project. They should develop procedures for monitoring the quality of work being performed.

## **2.2 COST ESTIMATING METHODS**

The methods which are used for determining the total design and supervision cost for each company are different. There are many methods. The most suitable method for each company is depending on data and system of that company. If the company has efficiency in recording data, clear responsibility of each employee, manifest in line of command and communication, and good knowledge in design team, can predict more accurate design cost by using the sophisticated estimating methods.

### **2.2.1 METHODS FOR CALCULATING THE COST OF DESIGN AND SUPERVISION**

The estimating method used to estimate the design and supervision cost can be classified into two categories as follows:

#### **2.2.1.1 Conceptual Estimating Method**

Conceptual estimate is often used to provide the client with a budgeting cost figure for the total design effort. Conceptual estimates can be calculated by three different situations during estimating such as limited in time for making design cost estimate. (Humphreys , 1999 ; Miller , 1984 ; Ogunlana and Thrope , 1991 ; Ostward , 1984)

a) The “conference” or “expert opinion” approach simply polls a knowledgeable person or persons and arrives at a consensus of the estimated resource requirement and cost.

b) A “level of effort” is based on an estimate of the number of required engineering personnel multiplied by an agreed – upon time span to generate total work – hour estimate.

c) The “analogy” or “benchmark” approaches are often combined in determining a final cost figure. Most often such methods are used only in the first phase of design an project to seeks client approval before any further work is done.

### 2.2.1.2 Parametric Estimating Method

In this method, the work – hours or costs is estimated from some overall physical measure of the design project. For example, total construction cost, process equipment cost, floor space, etc.

Rose (1982) described parametric estimating as a technique for predicting one characteristic of a system, usually its cost, from other physical or performance characteristics of a system.

C.H. Chilton (1949) defined a model in which “engineering and construction supervision costs” could be estimated as 0.2 to 0.35 for a “simple process plant” and 0.35 to 0.5 of the process equipment cost for a “complex process plant”.

Humphreys (1991) described parametric estimate as “exponential scaling”. This estimate method determine cost by establishing a ratio of some physical measurement of size or capacity, such as square feet, of a historical project raised to an appropriate exponential power to adjust for scale. The frequent value for this exponent is equal to 0.6.

Bauman (1964) parametric estimating technique are usually used in form of determining the design cost based on the total construction cost. In real estimating, engineering design is frequently quoted as “10 percent of construction cost”.

## 2.3 PARAMETERS AFFECTING THE COST OF DESIGN AND SUPERVISION

In estimating design cost, whatever sophisticate or simple estimating methods are used, there are some limitations which are known as factors affecting design cost. It obstructs the ways to identify precisely how much total design cost for each project. In theory, it is easy to identify those factors. However, in real estimating, it is very difficult to identify what factors can affect to the total design cost and how much they can distort the total design cost. These factors can be classified into two categories as follow.



### 2.3.1 FORESEEABLE FACTORS

Foreseeable factors are the factors which can be perceived and controlled by the design company. If they have good plans and historical data records, they can both forecasting more accurate design cost estimating and reducing the actual design cost needed to design the project. The foreseeable factors are.

2.3.1.1 **Design Team** : including designers from many departments such as architect, structure, electrical, mechanical, sanitary and others. These designers are generally classified by the experience in work. The basic salary for each level of experience is different. Besides engineers and architects, design team is also included CAD operators, secretary staff, and other persons as needed. Architects and engineers are the most important factors in design team which can affect to total design cost, especially when engineers are included in forecasting the total work – hours for the design work. Therefore, the total design cost can be heavily tolerated upon the engineers and architects' experience, judgement and personnel recollection of data from past similar projects.

2.3.1.2 **Tax and Social Charges** : This factor is based on the regulation for each country and characteristic of each project.

2.3.1.3 **Overhead and Administrative Cost** : This cost is the most important part of the cost components after the design team cost. Overhead and administrative costs are difficult to measure. Thus, design companies usually represent these cost as a percentage of the total design cost. Overhead and administrative cost can be classified as follow:

- a) travel and accomodation cost.
- b) electricity and telephone cost.
- c) computer cost.
- d) meeting cost.
- e) tool and apparatus for drawings.
- f) photocopy of drawings.
- g) fax and telecommunication cost.

2.3.1.4 **Profit** : rate and profit charged to the client depends on the situations such as type of project, economic status, financial status, etc. For example, in high competitive situation, the profit rate charged by the design companies is usually at low rate, especially when design companies need to win the bidding. But in the situation that the client has preliminary qualification for some design companies to issue the bidding, high profit rate will be charged to the client.

### 2.3.2 UNFORESEEABLE FACTORS

Design companies cannot predict or aware of the problems that can affect to the total design cost in advance until they occur. Unforeseeable factors are

- a) Additional requirements and necessary changes or client change orders.
- b) Works which were not estimated in details earlier because of unavailability of the necessary data.
- c) Variations of the data used in design because of productivity changes or market fluctuation.