Overview of Construction Projects

2.1 Introduction

In this chapter general description will be made to the construction projects and then the research tends to explore the main issue that is the scheduling of construction project especially those projects having repetitive nature . Because the research deals with a comparison between two scheduling methods , cost and relation between cost and time will be discussed also .

2.2 The Nature of Construction Industry

The construction industry involves generally two categories : general building construction (vertical) and engineering construction (horizontal) .General building construction includes residential, commercial, educational and industrial buildings . Engineering construction is usually being in the public infrastructure and so it is owned by the public-sector entities . It has a high degree of mechanization and uses heavy equipment and plant in the construction process [4].

Construction plays an important role in the overall economy and this is explained by the sizes of companies that carry out construction and the construction's proportion of the total value of goods and services, as well as the number of people employed in construction compared by the total workforce and the number of construction firms compared with the total businesses in industries. The construction industry's contribution to the total value of the economy in all over the world is ranged between 5.0% and 11.3%. The construction workforce comprises between 4.5% and 11.0% of the total workforce for the countries [4].

In Libya the construction industry contributes 5.2 % of the Libyan Gross Domestic Product (GDP), and it employs around 3.2 % of the total manpower [5] .

Usually , construction work is performed by organizations with small numbers of employees. An important characteristic of the construction industry is the large number of subcontractors. Such organizations limit their work to one or two kinds , such as electrical work, painting or plumbing . They typically work for general contractors and have no responsibility for the overall project [4].

2.3 Management of Construction Projects

Management of construction involves many people with different backgrounds. They can be summarized in the well-known triangle : The owner, the designer (consultant) and the contractor . However , other parties may be included , such as subcontractors, suppliers, bankers, insurance and bonding companies as well as public officials [6].

Throughout the project life cycle, from start of the project to the finish , the tasks carried out by the various parties vary in type and volume. It is essential to take in consideration the roles and responsibilities of the many parties at each phase of the construction project life cycle. The primary focus always is on the construction contractor, who carries the responsibility for the on-site work and all of the associated planning and follow-up. It is important further to understand how other people and organizations contribute to project success.

2.4 Construction Project Life Cycle

Every project in the construction industry passes through a series of phases . Although there may be some overlaps in the phases, the work generally flows from the first phase to the last such that the result of one

phase provides the basis for the phase that follows. There are six phases in the construction project life cycle each phase has its own purposes and characteristics. First, the owner must make certain pre-project decisions. Then the planning and design of the project is carried out. Next, the contractor is selected, after which the contractor mobilizes in order to carry out the field operations. The field work is that which usually considered to be the 'construction'. Finally, the project must be terminated and closed . Figure (2.1) shows the various phases of the construction projects. Focus here will be made on planning which is in relation with the issue of this research [6].

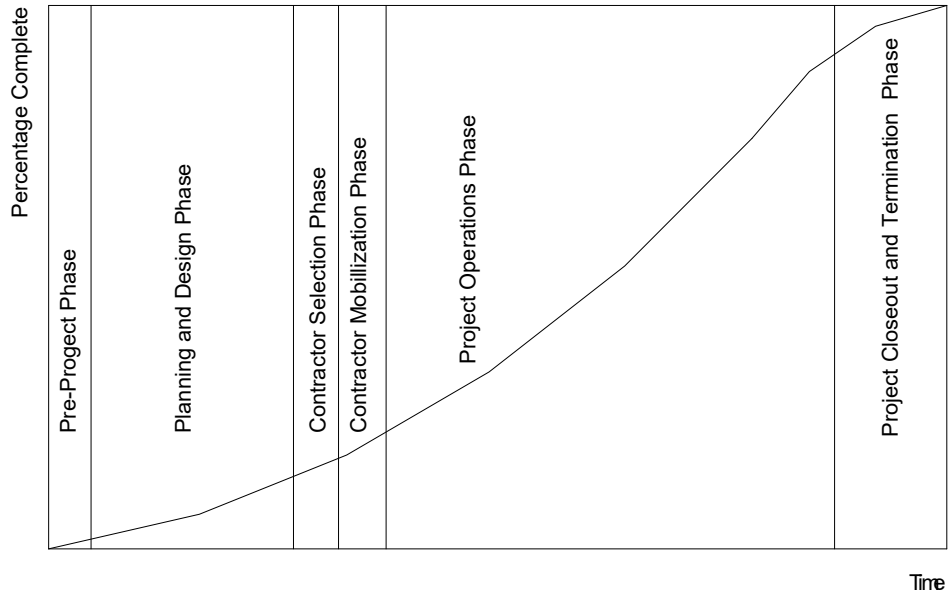

Figure (2.1) Phases of construction projects[6]

2.5 Performance of Construction Projects

A brief discussion for the outcomes of construction project performance that represent the main objectives of such projects will be given here . The factors affecting these outcomes will be explained also .

2.5.1 Performance Outcomes

There are three objectives that represent performance outcomes and have to be monitored in any construction project . They are time, cost and quality . Project control is a process of defining these outcomes and making a mechanism to achieve them . The main tools of such a control system are the time / resources schedules , the cost budget based on the cost estimate , quality assurance plan and reporting mechanism for the use of resources and other tasks [6].

2.5.2 Factors Affecting Performance Outcomes

There are many factors affecting performance outcomes of any construction project and making its period longer or its cost greater . Some of these factors belong to environmental conditions like sever climate and similar uncontrollable conditions . Other factors belong to the nature of the project itself like the complexity of design . But the most important type of the factors affecting performance outcomes is what belong to the management especially planning and control . Poor scheduling that results from using unsuitable scheduling technique is an example of such factors . Time progress control and resource productivity control are very important factors for success in any construction project and deviations in these two factors from the plans must be evaluated and corrective actions must be taken to bring the work into line with the plans [6] .

2.6 Cost – Time Optimization

Any delay in a project usually leads to an increasing in the cost . If the contractor is responsible of the delay , the contractor will be liable

to pay the extra cost resulting from the delay . Therefore , in general , the contractor tries to avoid delays in the activities of the project . Another reasoning for avoiding delays is to transfer resources from the current project to a new one, which may be scheduled to start before the completion date of the current project. A third reason is to earn a financial bonus from the client for completing the project ahead of schedule. However some delays are likely to occur and it is necessary to adopt a process for effective management of delays . This process is referred to as compression or acceleration . It is a trial to shorten the project duration by injecting more resources at the minimum possible cost. Principle of compression or acceleration is to find an optimum cost–time solution [6].

2.7 Cost – Time relationship

The relationship between the cost of performing and time for any activity is indirect. This is because the time for performing the activity decreases as the cost related to the resource input increases. Figure (2.2) illustrates the relationship between cost and time for an activity . Although the relation between cost and time is non-linear it is possible , without much error , to assume that this relationship is linear. Under this assumption it is possible to express the value of the cost slope between the points of the cost A and the time B as:

$$\text{Cost slope} = \Delta C / \Delta T$$

where: ΔC = Change in cost , ΔT = Change in time

This assumption enables to determine for a particular time the equivalent cost . If the rate of shortening a project to be increased then there would be greater need for additional resources and greater increase in cost [8].

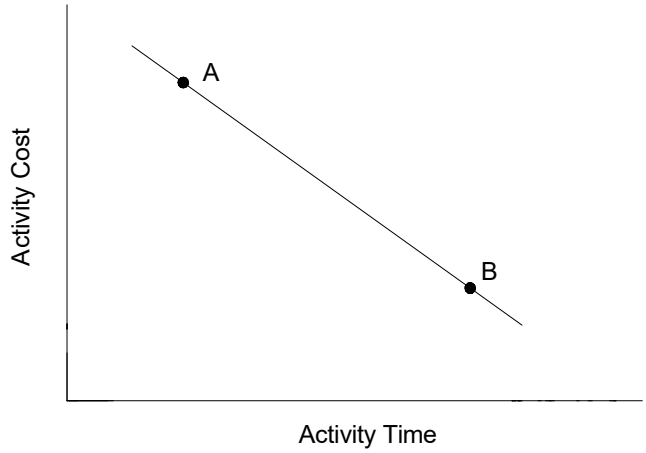

Figure (2.2) Activity Time-Cost Relationship

2.8 Cost components

There are several components of the cost of the project . However , it is convenient to group them into two categories .They are direct costs and indirect or overhead costs. Direct costs are related to the cost of labor , materials and plant/equipment. Important characteristic of the direct cost is that its magnitude increases with the decrease in the project period. Indirect costs are those related to general overheads. They may be fixed or variable over time. The total project cost is the sum of the direct and indirect costs. It is more realistic usually to express the total cost of the project as a linear function to the time elapsed . An expression that used for such purpose consists of two terms one is representing fixed costs and the other is for the variable costs . Variable costs are related to the time of the project . It is important to note that any delay in project will result in extra costs and these costs should be included in the expression of the total cost [6] .

2.9 Activity duration

Establishing the duration of activities is a very important task in scheduling . Many things must be known for that purpose among them the quantity of the work , the resources needed , the productivity rates of the required resources , the specific contractual requirements imposed on the project and the presence of risk. The quantity of the work can be computed from the bill of quantities which is usually prepared in a former stage . The planner may find productivity rate for each activity from experience or extract it from available databases. The planner may vary the activity duration by varying the labor crew size if it is possible. The planner may then optimize alternative activity durations in terms of cost and time to determine the optimum outcome. The equation used to determine activity duration in days is [4] :

$$\text{A activity duration in days} = \frac{\text{Quantity of Work}}{\text{Resource output rate per day}}$$

2.10 Deterministic vs. probabilistic estimates of activity duration

The productivity and output rates of resources from which activity durations are calculated are usually expressed as single-value estimates . They are estimated or extracted from databases in the form of average rates. An average estimate of the output rate is a mean of a distribution of individual output rates. The range of this distribution is defined by its standard deviation [4] .

Scheduling a project on the basis of average time estimates is obviously risky because in most cases actual durations are greater than the expected ones . Scheduling that relies on using average productivity and output rates of resources is referred to as single-value (deterministic)

scheduling. An alternative approach known as probability (stochastic) scheduling expresses estimates of productivity and output rates in the form of probability distributions. By using an appropriate probability analysis method such as the Monte Carlo simulation, the combined effect of individual probability distributions on the schedule can be assessed statistically [8].

2.11 Risk contingency

Delay in large construction projects is common for many reasons . Uncertain parameters usually affect the performance of the project in different ways resulting finally in an accumulated delay time . Examples for these are [10]:

- Waiting for information from the client
- Variation orders
- Ground problems
- Bad weather
- Design complexity
- Obstructions (This is common in housing construction projects)
- Materials procurement
- Industrial relations
- Civil subcontractors
- Claims

The methodology by which schedule is prepared for a construction project must involve information about the uncertain parameters and provide an understanding of the schedule reliability in presence of uncertainty [11]. The schedules generated with classical deterministic methods adopt average estimates of activity durations and don't reflect the risk of delays in the execution of the work .The risk therefore is assessed separately . Sometimes the contractor is able to gain time

extension under the contract, example of this is the situation of delay caused by variations orders or unexpected site conditions. Here there is no time contingency need to be added to the schedule. Risks for which the contractor is responsible must be assessed and added to the schedule as a time contingency. This may be achieved either by adding time contingencies to the risky activities only , to the whole project as an allowance to the end date of the schedule or in regular intervals, for example each month [12].