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A Review of cost Management Techniques in Planning Phase of Construction Projects

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ABSTRACT

Cost optimization is a generalized concept it has versatile application in all phase of life cycle of construction project. In recent years the cost aspects of the project has attracted the attention of planners, designers and managers in project activity due to global competitions in infrastructure development as it has direct bearing on economy of the country. In order to know what is already known or what knowledge on cost aspect of construction already exist and after discovering the research gap what is required today, to complete the project in envisaged cost on stipulated contractual obligatory time. In this paper a thorough review of cost management techniques has been done.

KEYWORDS: Cost estimation, Cost management, Critical chain, Ceiling limit

1. Introduction

Concept of construction of any structure is invoked by the difficulty faced by any individual or public in the society to full fill this objective different alternatives are thought for example to remove congestion on any road crossing a flyover is constructed. After recognising the problem a solution is thought and project is approved by competent authority. In this whole process construction project passes through following phases:-

1. Conceptual phase
2. Definition phase
3. Planning and designing phase
4. Execution phase
5. Operational or start-up phase
6. Winding up phase.

Any laxity in any of the phase leads to cost overrun and time delays if any error in planning phase has happened it will act as a hidden drain and that will be never visible on the balance sheet of the company any ignorance on the cost aspect is fatal and disastrous for the project and for the construction agency both. So any vigilant decision maker will never ignore cost aspect of the project.

A project can fail due to following reason

1. Poor perception of the project itself
2. Due to legal hassles
3. Due to poor organisational setup,
4. Resource constraints ,
5. Ignorance of cost aspects. following techniques are applied at various stages of the planning of construction projects.

2. The cost optimisation during estimation stage

Overestimation of cost has multiplier effect and if cost and profits are not accurately adjudges then there is every likelihood that construction company may not win the project or will suffer losses so a correct estimation cost need not to be overemphasize in construction activity. So the importance of many investigators has studied on estimate with various perspectives few are being mentioned here. The whole objective of study is a knowing correct estimation of identifying minimum possible cost, most likely and maximum range of cost estimates .

Back, Boles and Fry (2000) have defined triangular probability distribution for historical cost data. The historical cost data is used to construct triangular density function to represent uncertainty in activity duration. In this paper a methodology has been developed to generate test data to compare three methods of parameter estimation, maximum likelihood, moment matching and least square curve fittings technique to produce more accurate parameters estimates. Maximum likelihood estimate yields less accurate result while optimized moment matching and least square curve fittings techniques give more accurate parameter for estimates. Least square method is better method compared to optimized moment matching technique that is the reason for its use in projects.

Determination of exact cost or exact estimates in civil engineering works before hand is a difficult task because of inherent job oriented nature of civil engineering works. Thus such estimation needs probabilistic treatment Spooner (1974). Range estimating has become an accepted tool in the cost engineering profession. In range estimating cost items are assumed to be random variables rather than known parameters which in turn will result probable distribution of cost. With the help of this distribution estimator can define cost estimate values with a prescribed level of confidence. This is a helping tool for preparing estimates and for managing resources. The standard technique employed for range cost estimate is Monte Carlo simulation.

Range estimating approach ordinarily uses historical cost data but it must be appropriately adjusted for location and time lapses. In nutshell real world data should be made as accurate as possible to minimize bias and error into the estimating procedure. The least square minimization method is best suited for the automated cost estimating system.

3. Precision in accuracy of cost forecasting

Apart from four factors of production land, labour, and capital enterprise, a time factor is also very important for construction activity as construction activity takes time in months and years in an economy. In an inflationary economy one cannot afford to fix the price without incorporating inflation factors in the cost of any activity so an accurate forecasting is important especially when the activity is coming at the fag end of the project for example painting in a housing project.

A study on human side of forecasting has been done by Lowe and Skitmore (2001). This paper is based on fully structured interview survey conducted on experienced, construction contract price forecasters. The objective of research was to investigate a relationship between the accuracy of early stage forecast and experience. Here the experience measures forecaster's length of service and the number of forecast prepared. The learning style and ways of learning of forecaster has also been considered. The study shows that no significant correlation were found between forecasting accuracy and the experience measures used except for the approaches to learning dimensions labelled risk taking traits, insecurity and self confidence. The dimension of insecurity and self-confidence suggest that balanced forecasters in other words who were neither insecure nor overconfident produce more consistent forecasts. The risk taking dimension suggest that high risk takers tend to underestimate whereas those who are more conservative tend to overestimate contract prices.

Construction contract price forecasting is an important area of inquiry. So many empirical studies have been done in past notable are Skitmore et al (1990) who argue that performance of forecaster also depends on methodology of learning the profession. Most of them learn by experience Kolb (1976, 1984) which is also called experimental learning style.

This paper reports an investigation into relationship between experimental learning and early stage construction contract price forecasting accuracy.

There is no substitute of experience gained through analytical thinking in forecasting construction cost. This has been confirmed by various surveys [Ashworth and Skitmore 1983; Grieg, 1981; Ogunlana, 1989; Oteifa and Baldwin, 1991 and Fellows 1996]. It has been also found that more experienced means more accurate.

A few adhoc theories have also been proposed. Morrison in (1984) suggested that increase in forecasting accuracy is dependent upon the means through which knowledge and experience was gained on the previous project.

Investigators Brandon and Newton (1986), Brandon et al. (1988) and Brandon (1990) have explored the possibility for developing an expert system for price forecasting.

4. The cost ceiling limit

Before floating the tender it is obligatory upon owner to determine project ceiling price or cost ceiling estimates to use as a basis or reference point for evaluating the bids. A high ceiling price hits the owner's interest of cost optimization. On the other hand low ceiling price can jeopardize the project if all bids exceed the ceiling price. Therefore architect and owner have to reach an optimal ceiling price, which is acceptable to both parties. Wang (2002) has suggested a model for determining a reasonable project-ceiling price. The proposed model SIM-UTILITY is based on a utility theory and facilitated by a cost simulation approach. The utility theory is applied to reflect the owner's preferences regarding the determination criteria. Simulation approach is used to generate more objective project cost data to support execution of the utility theory. The SIM UTILITY model has been successfully applied on construction projects in Taiwan.

A higher ceiling price, allows to earn excessive profit by the successful bidder on the other hand low ceiling price creates a risk that all bids will be rejected. This will lead to withdrawal of project for redesign or reconsideration. A fresh start of tendering process is time consuming and increases owners liability for delays in the project completion time or commencement of project itself . After winning the contract at low ceiling price contractor will cut corners during construction to increase operating margins. Historical cost of projects gives some basis for determining average bidding ratio.

Most owners ordinarily make a decision based on gut feeling. Although average bidding ratio , is inferior to more systematic evaluation method. This ratio tends to be unrealistically low especially in a slow construction economy when bidder tends to propose unsustainably low bids simply to get a contract. One more drawback in this approach is lack of consideration for uniqueness of particular project. A model with strong evidence for ceiling price determination can serve as a justifiable basis for professional decisions.

Most of the researches (Carr, 1987; Ionnou, 1988; Moselhi ,,Hegazi,, and Fazio. 1993; Dozzi et al. 1996; Fayek, 1998; Crowley and Hancher 1995, Crowley 1997) have either focused on bidding models for bidders or on the evaluation of competitive bids. None has touched the ceiling price problem.

The proposed model "SIM-UTILITY" is a systematic model for determining project ceiling price and thus assisting the project tendering process.

5. key construction cost performance indicators

There is a dire need in the construction industry for identifying a set of common indicators to be used by construction executive for measuring construction performance at the project level. Cox, Issa and Ahrens (2003) have studied quantitative as well as qualitative performance indicators. The study is based on surveys. Analysis of data has shown the key performance indicator (KPIs) vary, according to management's perspective. Further analysis points towards substantial difference between construction executive and project management's perception. As per this study six indicators have been found key indicators for construction industry in general. No correlation was found between quantitative indicators and qualitative indicators. KPIs are compilation of data or measures which are used to assess the performance of a construction operation. These are the method to evaluate employee's performance on a particular job.

There are generalized models for implementing and monitoring construction activities but they are unable to identify which indicator will accurately portray changes in performance. Performance indicators can be defined either by the quantitative results of a construction process i.e. $ / unit or by /unit, qualitative measures such as worker behaviour on the job. Precise analysis of performance can be done only after identification and monitoring of key indicators.

The study identifies quality control, on time completion, cost, safety, $ per unit, and units per MHR as the six key indicators. These key indicators are widely accepted for judging overall performance of construction projects.

6. accuracy of cost estimate

The accuracy of estimate has a paramount importance. Accuracy of estimate is measured by the matching performance of the estimated cost to the installed cost. The accuracy of early estimate depends on four factors.

- Who was involved in preparing the estimate?
- How the estimate was prepared.
- What was known about the project?
- Other factors considered while preparing the estimate.

In this direction a study has been done by Oberlender and Trost (2001). This paper presents result of a research effort that developed an estimate scoring system to measure the impact of these four determinants on estimate accuracy.

The estimate scoring system consists of 45 elements and is organized into 4 divisions. Data were collected from 67 projects representing $ 5-6 billion in total installed cost and these data have been used to correlate the estimate scores with estimated versus actual cost. A computer software Estimate Score Program (ESP) has been developed to automate the scoring procedure, assess estimate accuracy and predict contingency based on historical cost data. Estimator can enter the base estimate into ESP and then rate the estimate relative to each of the 45 elements. ESP on its own calculates the estimate score as the user rates each element. Using historical database can also make a comparison of similar projects. ESP can also generate a cumulative S curve. The user can also predict cost range i.e. upper and lower limits of a desired confidence level. ESP can be used to "check" the amount of contingency determined by other methods as well as a method of predicting its own contingency. The data obtained through questionnaire has been analyzed by multivariate regression to determine the relative weight of each element in the estimate score procedure. On the analysis of data it has been found that, there are 11 factor groups that affects estimate accuracy. In these element factors, five are most critical factors.

1. Basic process design.
2. Team experience and cost information.
3. Time allowed to prepare the estimate.
4. Bidding
5. Labour climate.

These five factors jointly represent 23 of the 45 elements and account for almost 76% of the estimate score.

The basic lacuna in this study is it cannot be generalized for all sorts of projects only philosophy supported by mathematical analysis can be used for other projects with a judicious approach full of wisdom.

7. the variance calculation

The variance calculation is an indicative of financial or economic aspect of any construction activity this tells accuracy of data taken in preparation of estimates and in turn quoting the price if variance exceeds the prescribed limits then corrective measures become necessary to avoid the derailment

Ordinarily variance is calculated on the basis of work break down structure rather than cost break down structure. Wang and Huang (2000) have taken time and cost as random and correlative (Elmaghraby, 1977; Jaafar, 1996) and then constructed a computation approach to integrate the time and cost. The suggested approach calculates project cost variance and activity cost variance. It also measures the logical dependence on the cost variance of each activity. Therefore it helps in better financial planning.

Since execution of construction project happens at site. Therefore, a number of common uncertainties exist. Such uncertainties have been discussed by Hemphill (1968), Spooner (1974) and Diekmann (1983).

In this work authors suggest project cost can be expressed in terms of a function of expected value (m), coefficient of correlation (r) and coefficient of variance (n) should be allocated to each individual activ-

ity. Now the effect of logical dependence on the cost variance of each activity can be determined.

The theory of constraints (TOC) [Goldratt,1999(a), Goldratt,1999(b)] approach can be directly used in straight forward manner in PERT / CPM networks. Rand (2000) has studied relevance of application of TOC in managing the project on the basis of book; "Critical Chain" by Eli Goldratt. TOC emphasizes creation of a resource buffer for activities on the critical path. The time of completion of ongoing activities are estimated and appropriate resource required for subsequent activities are told for availability. There is no scope for multitasking at the start of critical activity.

It is frequently observed that limited resources are required to work on several activities. Now question arises which activity should be performed on any specific time. The solution is in identifying critical chain. The critical chain can be defined as the longest chain of dependent steps in other words constraints. Now activities of critical chain should be done sequentially rather than in parallel, as they require same resource.

TOC and critical chain are the new concepts in project management. It incorporate human factor, lead time rather than milestone only. It is a clear departure from PERT / CPM network approach which mostly concentrates on technical aspect of project only. TOC and critical chain are being applied since 1998.

In the existing literature on construction cost only direct material, direct labour and overhead cost are usually mentioned. Nothing is said about specific costs related with construction like sunk cost.

Whereas clear notion of cost is necessary to optimize the cost or in turn to increase the profit, at the same time a proper accounting is also necessary for reporting the performance of company.

8. conclusion

I Estimate is the first activity taken after completion of planning and designing in construction project this is the estimation part in which money comes into the picture in terms of cost or in terms of goods and services needed to complete any activity. Every project has some constraints and uniqueness for example any project related to rural housing in a developing country like India has economic constraints in form of ceiling limits so estimation should be done with utmost care and the person involved in monitoring the estimation activity should well versed with the nuances of construction, notion of cost and time constraints. The man should be of full wisdom and knowledge reinforced with varied experience. In today's world the company professional should not feel complacent by enjoying a margin profit but they should also critically analyze and refine the historical cost data by sifter of experience. now it is needless to emphasize the decision makers of construction company should be well versed with the computer application simulation, optimization and operational research techniques for the success of the company.

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