



Factors Affecting Construction Cost Estimation of Building Projects

Shabniya .V

M.Tech scholar

Department of Civil Engineering

MES College of Engineering, Kuttippuram, Malappuram, Kerala, India

Abstract:

Construction industry could be considered as a very important sector for development all over the World and the construction cost estimation is the most important element in it. Realistic estimation of construction cost is vital for both successful planning and completion of every construction project. The key factor in a project's success is the accurate cost estimation at its early stage. It is difficult to quickly and accurately estimate construction costs at the planning stage itself when project information is limited. This study was carried out to identify the factors affecting construction cost estimation. The factors were identified based on questionnaire survey. Questionnaires were given to 64 experts in the construction industry to determine the importance of construction cost estimation and to determine the score of each factor. Statistical analysis was carried out on the feedback of the respondents of the survey. RII value of the factors was found using Microsoft Excel. The mean score of each factor was determined and the p-value was calculated using the SPSS software. The significance of each factor used in the questionnaire was determined. The significant factors were identified using the mean score and their p-value.

Key Words: Construction industry, cost estimation, questionnaire survey, structured interview significant factors

I. INTRODUCTION

Realistic estimation of construction cost is vital for both successful planning and completion of every construction project. Also in the face of uncertain conditions, reliable cost forecasts become an important source of information for decision making by all construction parties. [1] Accurate cost estimation at the early stage of a construction project is key factor in a project's success. But it is difficult to quickly and accurately estimate construction costs at the planning stage, when drawings, documentation and the like are still incomplete. As such, various techniques have been applied to accurately estimate construction costs at an early stage, when project information is limited. While the various techniques have their pros and cons, there has been little effort made to determine the best technique in terms of cost estimating performance[2]. The purpose of this paper is to explore the significant factors affecting the cost estimation of construction projects

II. LITERATURE REVIEW

Cost estimating is an essential task for budgeting and bid preparation for any construction project. To adequately define the project scope and to ensure sufficient construction funds are available, cost estimates are required during the various stages of project development. As the project progresses, the estimates are refined to ensure the project is still cost effective, sufficient funds are available for construction, and the contractors bid price is reasonable. A key factor for a successful project is the preparation of an accurate estimate, which can influence by many factors that affecting this accuracy.[3] Yong and Mustafa, (2012) find that the financial capability of the clients is the major factor critical to the success of a construction project at Malaysia.

All three groups of participants in the industry opined that apart from financial capability, "project stakeholders" factors" such as competence, cooperation in solving problems, commitment and communication are significant factors ensuring the success of a construction project. External factors such as availability of resources and weather conditions also played a crucial role in contributing to the success of a construction project.[5] While Nedal Salah Jameel Al Sheikh,[2013] conducted a research on Cost Estimation Of Construction Projects At Gaza Strip Using Fuzzy Logic through literature reviews of the cost estimating process, followed by a field survey done by 21 structured interviews in order to define the building factors which is effected the parametric cost estimation. The result of the survey and literature review shows that ten factors are affecting construction cost. The main factors are the area of typical floor, number of stories and the building type. Data from 169 case studies from real executed construction project in Gaza Strip were collected for the most important ten factors to build up Fuzzy Logic Model.[4]

III. OBJECTIVES OF THE STUDY

The construction cost estimate is a prediction and foreseeing of the total cost of a construction project before it actually exists. Several estimation methods are used in construction practice and the suitability of any particular method is usually dependent on the purpose it is used for, the amount of information available at the time of estimation, and the party using it.

Despite the reliance of clients and contractors on available cost estimation and forecasting methods, the actual final costs of construction projects still considerably deviate from their original estimates.

The major objectives of the study could be listed as follows:

- To explore the existing common practices in cost estimating.
- To identify the significant factors affecting the construction cost.

IV. MATERIALS AND METHODS

There are many factors that affect cost estimation. The results have been deduced from a field survey of 64 experts in the construction industry. The data collection consist of two sections. The Section one presents the structured interview with the clients, builders and contractors. Section two was designed to attain the key parameters and main factors affecting the building cost estimating.

1. Data Collection Method

On the basis of literature review on factors influencing construction cost estimation 42 factors are identified. A structured interview was conducted in order to identify the need for the study. After that, a questionnaire is prepared using these factors. The questionnaire is distributed among builders and contractors of construction projects. The response is measured using a *Likert scale* system showing importance degree ranging from 1 “Not Important” to 5 “very Important” (5-Very important, 4- Important, 3- Some important, 2-Less important, 1 –Not important). This research is based entirely on the responses received from the selected construction engineering experts.

i. Structured Interviews

It is decided that the most appropriate approach was to carry out structure interviews with a number of experts, engineers, and managers in order to get a better understanding of most important factors affecting the cost estimating of construction projects. The structured interviews schedule also sought information regarding the following areas:

1. Characteristics of responding organizations in term of position of respondent, years of experience for the organization and total number of employees.

2. Factors affecting cost estimating.

The structured interview includes mainly four questions.

a. Type of Respondents

This involves the type of works in which the interviewed people are engaged.

b. Position of Respondents

This includes various positions of the interviewed experts in different firms.

c. Estimating Method

This includes the method of estimation with which the experts dealt with either manually or any special software package.

d. Construction cost estimation

This includes the opinion of experts about construction cost estimation whether it meet the estimated cost meet actual cost or not.

ii. Questionnaire Survey

After the structured interview with experts a questionnaire is distributed among them to identify the factors affecting construction cost estimation. From thorough literature study a set of 42 factors are selected for the questionnaire.

2. Data Analysis Method

To measure the importance of the factors affecting cost estimation, Relative Importance Index (RII) was measured for each factors. The relative index technique has been widely used in construction research for measuring attitudes with respect to surveyed variables. RII calculation is used to determine relative significance and for ranking the factors affecting construction cost estimation. The RII was computed using the following equation:

$$RII = (\sum W / AN) * 100 \quad (1)$$

Where W is the weighting given to each factor by the respondent, ranging from 1 to 5

$$\text{i.e. } \sum W = 5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1$$

n_1 = number of respondents for not important, n_2 = number of respondents for little importance, n_3 = number of respondents for somewhat important, n_4 = number of respondents for important, n_5 = number of respondents for very important), A is the highest weight (i.e. 5 in the study) and N is the total number of samples. The relative importance index ranges from 0 to 100. The mean score and p-value of each factor in questionnaire is determined. This was done by one way sample T - test in SPSS Software. The significant factors are determined based on the p-value and the mean score. Any factor that has a p-value less than 0.05 and has a mean score of more than 4.00 is selected as a significant factor. The p-value result is a crucial indicator to the significance of factors.

V. RESULTS AND DISCUSSIONS

1. Structured interview

From the structured interview conducted the following results are deduced.

i. Type Of Respondents

Figure 1 shows the type of respondents with whom the structured interview is conducted. Out of 64 respondents 28(44%) were builders, 20(31%) were contractors and 16 (25%) were clients.

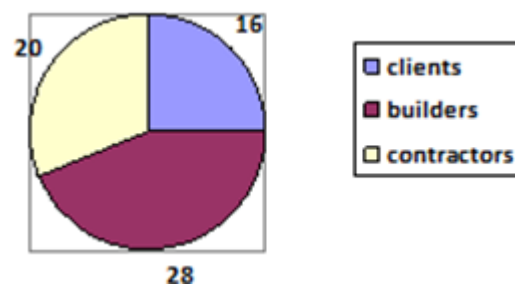


Figure 1: The Type and the Percent of the Respondents

ii. Position of Respondents

Out of 64 people interviewed, 8 were project managers, 14 were Office or site engineers, 10 were estimators and 32 were in other

positions like quality, safety etc... Table1 shows the Position of respondent in organization.

TABLE 1.POSITION OF RESPONDENT INORGANIZATION

Position of respondents	Clients		Builders		Contractors		Total	
	Fre	%	Fre	%	Fre	%	Fre	%
Project managers	0	0	8	28.6	0	0	8	12.5
Office or site engineers	0	0	14	50	0	0	14	21.9
Estimator-s	0	0	6	21.4	4	20	10	15.6
Others	16	100	0	0	16	80	32	50
Total	16	100	28	100	20	100	64	100

iii. Estimating Method

Out of 64, 93.75% of the experts use manual method of cost estimation like unit price method. Only 6.25% of them is using special software package for cost estimation. This clearly shows the need of special package software for cost estimation. Table 2 shows the Estimating method that the experts adopted for calculating the construction cost.

i. Construction cost estimation

When the experts are asked about the construction cost everyone said that the estimated cost does not meet the actual cost. This clearly shows that a well established technique is required for construction cost estimation which reduces the difference between the estimated cost and actual cost. Table 3 shows the respondent's opinion on the construction cost whether it meets the actual cost or not.

TABLE.2. ESTIMATING METHOD

Estimat- ing Method	Clients		Builders		Contractors		Total	
	Fre	%	Fre	%	Fre	%	Fre	%
Manually	16	100	24	89	20	100	60	93.75
Special package software	0	0	4	11	0	0	4	6.25
Total	16	100	28	100	20	100	64	100

TABLE. 3.OPINION FOR CONSTRUCTION COST

Is construc- tion cost meet Estimation cost	Clients		Builders		Contractors		Total	
	Fre	%	Fre	%	Fre	%	Fre	%
YES	0	0	0	0	0	0	0	0
NO	16	100	28	100	20	100	64	100
Total	16	100	28	100	20	100	64	100

2. RII and Ranking of investigated factors

RII was used for ranking the factors affecting construction cost estimation. RII value of all the 42 factors was calculated using equation (1) in Microsoft Excel.

In Table 4, the investigated factors with their RII scores and rankings are represented. The results of the study revealed that the 42 investigated factors are ranked from 1 to 36.

3. Identification of significant factors

Table 5 shows the result of one way sample T-test of the investigated factors. The determination of the significant factors

occurs through identifying their mean scores and p-value. This mean score can be identified as an average mean score; since a mean score less than 4.00 has no significance and more than 4.00 is significant.

Therefore, each significant factor is considered of high importance when its mean score is more than 4.00, and has a p-valueless than 0.05.

It is observed that out of 42 factors, 15 factors are identified as the significant factors. The significant factors that are affecting the construction cost estimation are represented as X1,X2,.....,X15. It is seen that the fifteen significant factors show ranking from 1 to 12.

TABLE .4. FACTORS WITH THEIR RII VALUES AND RANKINGS

No.	Factors	Score	RII	Rank
1	Accuracy of site Investigation	172	53.75	28
2	Amount of Rework during Design	188	58.75	26
3	Availability of trained resources	174	54.375	27
4	Change in Schedule	240	75	16
5	Changes in construction Methods	256	80	13
6	Changes in Design/Scope(By clients, consultants or architects)	220	68.75	19
7	Type of structural skeleton	194	60.625	23
8	Communication among project team members	88	27.5	36
9	Construction productivity (labour shortage, unskilled labourers)	152	47.5	32
10	Contractor's ability in financial management	160	50	31
11	Contractor's Experience with similar Project	204	63.75	21
12	Delivery or Procurement approach	204	63.75	21
13	Faulty execution	202	63.125	22
14	Floor Height	268	83.75	12
15	Force Majeure	168	52.5	29
16	Form of Contract	208	65	20
17	Geographic Conditions	292	91.25	3
18	Gross Floor Area	300	93.75	1
19	Ground conditions	280	87.5	8
20	Health and Safety Conditions	162	50.625	30
21	Inadequate design team resources	188	58.75	26
22	Inconsistent application of contingencies	222	69.375	17
23	Level of construction and site complexity	248	77.5	15
24	Level of Design Complexity	272	85	10
25	Location of Project	190	59.375	25
26	Management conditions	192	60	24
27	Market conditions	284	88.75	6
28	Number of Storeys	282	88.125	7
29	Cost of foundation	288	90	5
30	Ownership of Building	122	38.125	34
31	Percent of Repetitive Elements	268	83.75	12
32	Productivity of Man Power	204	63.75	21
33	Quality of work	276	86.25	9
34	Sub contractor's experience and capability	136	42.5	33
35	Tendering procedure	92	28.75	35
36	Total Duration	296	92.5	2
37	Type of Building	272	85	10
38	Type of Finishing work	254	79.375	14
39	Type of Foundation	290	90.625	4
40	Changes in materials	284	88.75	6
41	Unforeseen events/conditions	270	84.375	11
42	Volume of HVAC	221	69.0625	18

TABLE .5. IDENTIFICATION OF SIGNIFICANT FACTORS BY T-TEST

SL No.	Factors	Mean	p value	Significance
1	Accuracy of site Investigation	2.688	0	Non Significant
2	Amount of Rework during Design	2.938	0	Non Significant
3	Availability of trained resources	2.719	0	Non Significant
4	Change in Schedule	3.75	0.02	Non Significant
5	Changes in construction Methods	4	1	Non Significant
6	Changes in Design/Scope(By clients, consultants or architects)	3.438	0	Non Significant
7	Type of structural skeleton	3.031	0	Non Significant
8	Communication among project team members	1.375	0	Non Significant
9	Construction productivity (labour shortage, unskilled labourers)	2.375	0	Non Significant
10	Contractor's ability in financial management	2.531	0	Non Significant
11	Contractor's Experiance with similar Project	3.188	0	Non Significant
12	Delivery or Procurement approach	3.188	0	Non Significant
13	Faulty execution	3.156	0	Non Significant
14	Floor Height	4.188	0.006	Significant
15	Force Majeure	2.625	0	Non Significant
16	Form of Contract	3.25	0	Non Significant
17	Geographic Conditions	4.563	0	Significant
18	Gross Floor Area	4.688	0	Significant
19	Ground conditions	4.375	0	Significant
20	Health and Safety Conditions	2.531	0	Non Significant
21	Inadequate design team resources	2.938	0	Non Significant
22	Inconsistent application of contingencies	3.469	0	Non Significant
23	Level of construction and site complexity	3.875	0.132	Non Significant
24	Level of Design Complexity	4.25	0.004	Significant
25	Location of Project	2.969	0	Non Significant
26	Management conditions	3	0	Non Significant
27	Market conditions	4.438	0	Significant
28	Number of Storeys	4.406	0	Significant
29	Cost of foundation	4.5	0	Significant
30	Ownership of Building	1.906	0	Non Significant
31	Percent of Repetitive Elements	4.188	0.005	Significant
32	Productivity of Man Power	3.188	0	Non Significant
33	Quality of work	4.313	0.001	Significant
34	Sub contractor's experiance and capability	2.125	0	Non Significant
35	Tendering procedure	1.438	0	Non Significant
36	Total Duration	4.625	0	Significant
37	Type of Building	4.25	0.001	Significant
38	Type of Finishing work	3.969	0.795	Non Significant
39	Type of Foundation	4.531	0	Significant
40	Changes in materials	4.438	0	Significant
41	Unforeseen events/conditions	4.219	0.005	Significant
42	Volume of HVAC	3.453	0.013	Non Significant

Table.6. Significant Factors

ID	Factors
X1	Gross Floor Area
X2	Total Duration
X3	Geographic Conditions
X4	Type of Foundation
X5	Cost of foundation
X6	Changes in Materials
X7	Market conditions
X8	Number of Storeys
X9	Ground conditions
X10	Quality of work
X12	Level of Design Complexity
X13	Type of Building
X14	Unforeseen events/conditions
X15	Floor Height
X16	Percent of Repetitive Elements

I. CONCLUSIONS

There are only a few studies held that identify major factors affecting the construction cost estimation in developing countries such as India. A structured interview was conducted to explore the common practices of cost estimation and the need for the study. In this study forty two factors are identified as affecting the construction cost estimation from previous studies .A questionnaire survey based on these forty two factors was conducted using a likert scale. The survey was carried out which was conducted with 64 experts in the construction field to determine the importance of each factor. From the one way sample T-test, it can be concluded that gross floor area, total duration, geographic conditions, Type and cost of foundation, changes in materials, market conditions, number of stories, ground conditions, quality of work, level of design complexity, type of building, unforeseen events/conditions, floor height and percentage of repetitive elements are the fifteen significant factors which in turn have rank from 1 to 12 while calculated the relative importance index (RII).

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