

FACTORS INFLUENCING THE PROJECT COST ESTIMATING DECISION

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Abstract

This paper presents an empirical study of factors influencing cost estimating decisions of construction contractors in the UK. While a large number of factors influence the practice of cost estimating, the ten most important are complexity of the project, scale and scope of construction, market conditions, method of construction, site constraint, client financial position, buildability and location of the project. Analysis of variance, which tests the null hypothesis that the opinions of the very small, small, medium and large companies are the same, was produced. This shows that, except for the form of procurement factor, there is no difference of opinion, at 5% significance level, on the factors influencing cost estimating.

Keywords: Cost estimate, tendering, cost estimators, Analysis of variance

1 Introduction

Cost estimating can be described as the technical process or function undertaken to assess and predict the total cost of executing an item of work in a given time using all available project information and resources [1]. The Code of Estimating Practice produced by the Chartered Institute of Building [2] defines estimating as the technical process of predicting costs of construction and tendering as a separate and subsequent commercial function based upon the net cost estimate. Green [3] compared estimating and tendering using systems concepts; estimating is classified as a closed system and tendering as an open system.

According to Stewart and Stewart [4] underestimating a job may result in winning a competitive tender without allocating sufficient resources to perform the work, which may result in cost overrun or a loss of profit to the company. On the other hand, company that bids too high because of inaccurate cost estimate may not be selected, due to their high bid, to execute the work. It is reckoned that both of these results have an adverse effect on the profitability of the organisation. Smith [5] reckons that the process of cost estimating is very important as it enables construction companies to determine what their direct costs will be, and to provide a 'bottom line' cost below which it would not be economical for them to carry out the work.

Estimating practice tends to address such issues as: (1) who is going to do the work, (2) what the work content is (detailed specifications), (3) when the work is going to be done (scheduling), (4) where the work is going to be performed (on site, in factory - to be subsequently assembled on site) and (5) how the work is going to be performed. Nonetheless, an estimator is expected to consider either formally or informally factors that are relevant to the successful execution of the project. This is apart from other variable items such as production rates, material wastage and other historic cost data.

This paper, therefore, presents factors considered by construction contractors when estimating for construction work based on a survey of the UK contractors ranging from very small to large sized firms. The need to identify these factors becomes important, given that it has been argued that despite considerable literature on estimating practice, the primary focus is on estimating formats, procedures, and processes [6].



2 A review of cost estimating factors

Azzaro *et al's* [7] empirical study commissioned by the Royal Institution of Chartered Surveyors investigated cost estimating from the viewpoint of the quantity surveyor working in the contracting sector. The study, based on a semi-structured survey of 11 main contractors and 2 sub-contractors, sought to identify current estimating techniques and the type of data bases used to arrive at tender prices. Issues covered in the study included the determination of unit prices, preliminaries items, and allowances for profits and overhead, as well as the adjustment of prices to take account of such factors as market conditions, site conditions, location and the nature of the tender documentation. The study failed to investigate the factors considered by estimators as part of construction contractors' estimating practice.

Tah *et al.* [8], based on semi-structured interviews with seven contractors, investigated current practices of estimating the indirect costs (indirect costs were described as those which are not traceable to a specific work item, and consist of site overheads, general overheads, profits and allowances for risks) involved in tendering for construction work. The study, whilst recognising the limitation of the research due to low rates of response because of the sensitivity and confidential nature of the subject, concluded by indicating a high degree of subjectivity involved in indirect cost estimating. It also recognised that the percentage added to the cost estimate is based on the subjective judgement of senior management. The study reported that the subjective decision making processes involved in these tasks are characterised by qualitative data and knowledge that is often vague and difficult to structure and quantify. However, no investigation was undertaken to identify factors that are considered by estimators in arriving at decisions on cost estimate.

Skitmore and Wilcock [9] investigated estimating processes of smaller builders based on an experiment conducted with eight practising builders' estimators. The work investigated the processes of estimating rather than the practice of cost estimating, by looking at methods that estimators used to price selected items from bills of quantities items and the variability associated with the outcomes. The motivation for this investigation was that little descriptive material is available concerning the processes employed by builders in determining a tender price. The research concluded that the main factor determining the rating method (i.e., method of preparing unit rates for bills of quantities items) was the item quantity, although this varied in importance between the work sections investigated (groundwork, in situ concrete and masonry). An important conclusion emanating from the research was that not enough is known about factors involved in cost estimating in decision, although there is a wealth of prescriptive literature available on the subject.

The Code of Estimating Practice [2] prescribes that the estimator, in the course of preparing a cost estimate, should carry out tasks such as a thorough examination of the tender documents, a site visit, preparation of method statements and the tender programme, visit to the project consultants, make enquiries and receive quotations for materials, plant and sub-contractors. These tasks are required to determine an approach to pricing the project at a level at which the costs of construction resources could be recovered. The Code of Estimating Practice also requests that the estimator should look for various factors, which may influence the approach to pricing, such as: (1) standard and completeness of the drawn information; (2) tolerances required; (3) clarity of the specification requirements and the quality required; (4) buildability; (5) whether load bearing and non-load bearing areas can be identified; (6) the extent of the use of standard details indicating previous construction experience; (7) evidence of design co-ordination of services and structural needs; (8) the amount of information concerning ground conditions and foundations; and (9) problem areas and restraints on construction in the design.

The advice provided in the Code of Estimating Practice on the factors that the estimator should look for appears inexhaustible. Akintoye and Skitmore [10], however, have produced a conceptual



model for construction contract pricing which suggests that the construction pricing process should include factors that influence cost estimating decision and data input to the cost estimate.

3 The Research Survey

At a preliminary stage of the study, a review of current literature revealed a number of factors that influence cost estimating decisions. These factors formed the basis for a pilot study with three construction contractors' senior estimating personnel. The pilot study was undertaken with a view to identifying essential issues, provide a clear definition of problem areas and clarify vocabulary. The information secured during this qualitative stage was used in the development of a questionnaire which included a range of dichotomous, multiple choice and open questions

Overall, a list of twenty four factors influencing cost estimating was identified. Likert-type importance scales ranging from 1 (not important) to 5 (very important) were used to set a quantitative measure to a qualitative feature and allowed further statistical analysis. The questionnaire, together with a covering letter, was addressed to the managing director of the firms. The letter indicated the objectives of the research and requested that the questionnaire be completed by a senior staff responsible for cost estimating activities in the firm.

The questionnaire was mailed to 200 firms, the selection was based on a combination of random and quota sampling methods. The firms were randomly selected from the lists of contractors in the Directory and Handbook of Chartered Building Companies published by the Chartered Institute of Building and UK Directory of Construction Industry published by the Building Economics Bureau Ltd., Bromley, Kent. The random sampling was complimented by a quota sampling in which 50 questionnaires each were mailed to very small, small, medium and large construction firms. Eighty-four usable responses were received from the firms, corresponding to 42% response rate.

Table 1 shows the firms' grouping and the number of firms in each group. Table 2 shows the designation of the respondents respectively. These are mainly at the senior management level.

Table 1 Turnover of Firms in the last financial Year

Grouping	Turnover (£ million)	Number	Percentage
Very Small	Less than 5	25	29.8
Small	5 –25	26	31.0
Medium	25 – 100	16	19.0
Large	Over 100	17	20.2
	Total	84	100

Mean = £69.55 million (std dev = 13.67)

Table 2 Designation of the respondents

Position	Overall	V.Small	Small	Medium	Large
Director - Managing	15	7	7	1	
Directors	34	11	7	8	8
Senior Managers	12	2	6	1	3
Managers	23	5	6	6	6
Total	84	25	26	16	17

Directors include Commercial, Estimating, Finance, Regional, Pre-contract

Senior Managers include Chief & Senior Estimators, Chief Surveyors.

Managers include Estimating Managers, Estimators, Quantity Surveyors



4 Data Analysis and Results

Statistical analyses were undertaken, using the Statistical Package for Social Sciences (SPSS). The analysis ranked the factors based on the importance index. The indexes were compared for the groups and analysis of variance (ANOVA) was produced, which tests the null hypothesis that the importance index of the dependent variable (individual factor) is equal in all the groups.

As part of the analysis, the Cronbach alpha reliability was produced. The Cronbach alpha reliability (the scale of coefficient) measures or tests the reliability of the five-point Likert-type scale used for the study. The Cronbach's coefficient alpha is 0.897 (F statistics = 18.006, $p=0.000$), indicating that the 5-point Likert scale used for measuring factors influencing cost estimating is reliable at a 5% significant level.

Table 3 shows the analysis of the sample results. From the table, the main factors influencing cost estimating decision are complexity of the project, scale and scope of construction, market conditions, method of construction, site constraint, client financial position, buildability and location of the project. Most of these factors directly affect production performance on site. Production performance for labour, plant and sub-contractors is required in the preparation of the cost estimate. Use of inappropriate production performance in the determination of a cost estimate has a direct influence on the accuracy of the cost estimate, tender price, probability of winning the tender and the profitability of the project during construction.

With the exception of the client's financial situation, type of client, project team's experience of the construction type, and form of procurement, variables that are significant at the 5% level, there is no statistically significant difference in the opinion of the firms' groupings on the other variables. This suggests that construction firms, irrespective of company size, generally have similar opinions regarding the factors influencing the cost estimating decision.

The amount of specialist work, lead time for delivery of materials, and the proportion of off-site and on-site operations were surprisingly ranked low by the respondents, considering that these factors are related to sub-contract operations. In recent time, the amount of sub-contracting in construction procurement has increased. Specialist works are most likely to be undertaken by subcontractors, in addition to work that requires off-site production such as steel and concrete prefabrication. Long lead-time materials are most likely to be supplied by nominated construction suppliers. It would be expected that cost estimators would consider these elements carefully as they impact on the profitability and management of a project particularly where the work is substantially undertaken by the main contractor's domestic or approved sub-contractors.

The form of procurement was ranked 17th overall but this is a major factor for both the medium and large sized firms. In recent years, different procurement methods have been used for large projects and it is likely that both the medium and large firms have noticed some cost implications associated with this variable. Most small projects still use traditional procurement method based on either the JCT minor works or JCT 80 conditions of contract with or without quantities. Since there is nothing with which to compare the cost associated with this procurement method, it is not unexpected that very small firms (ranked 23) and small firms (ranked 22) have attached less importance to this factor.



5 Discussion of the Factors

Figure 1 indicates the six most important factors to very small, small, medium and large sized construction firms. The five most important factors influencing cost estimating decision for all categories of construction contractors are complexity, scale of construction, market condition, method of construction and site constraints. However, they differ in their choice of the sixth most important factor. The very small and small firms have ranked project team experience and availability of resources as their sixth important factors, respectively. On the other hand, the medium and large sized firms ranked form of procurement and project duration, respectively, in sixth position. These most important factors are now discussed individually.

Table 3 Factors influencing cost estimating decision

Factors	Total		Very Small		Small		Medium		Large	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Complexity of project	0.893	1	0.904	1	0.854	1	0.913	1	0.918	1
Scale/scope of construction	0.836	2	0.824	4	0.823	2	0.900	2	0.812	5
Market condition	0.807	3	0.792	9	0.777	5	0.863	5	0.824	3
Method of construction	0.812	4	0.824	5	0.746	7	0.875	3	0.835	2
Site constraint	0.793	5	0.800	7	0.785	4	0.800	9	0.788	7
Clients financial situation	0.785	6	0.864	2	0.731	10	0.850	7	0.694	14
Type of client	0.783	7	0.840	3	0.731	11	0.875	4	0.694	15
Buildability	0.764	8	0.728	13	0.746	8	0.788	10	0.824	4
Location of project	0.760	9	0.800	8	0.746	9	0.750	13	0.729	12
Availability of resource	0.755	10	0.712	14	0.762	6	0.775	11	0.694	16
Design Completion	0.752	11	0.760	11	0.677	14	0.838	8	0.776	9
Type of structure	0.752	12	0.654	19	0.800	3	0.729	17	0.435	24
Project team's experience	0.745	13	0.808	6	0.669	15	0.775	12	0.741	11
Construction team capability	0.729	14	0.792	10	0.654	18	0.750	14	0.729	13
Quality of information	0.721	15	0.744	12	0.662	17	0.750	15	0.753	10
Project duration	0.714	16	0.688	15	0.669	16	0.725	18	0.812	6
Form of procurement	0.688	17	0.632	22	0.624	21	0.863	6	0.788	8
Lead times for materials.	0.688	18	0.664	20	0.692	12	0.725	17	0.682	17
Expected project organisation	0.683	19	0.688	16	0.654	19	0.750	16	0.659	20
Amount of special work	0.670	20	0.656	17	0.685	13	0.693	22	0.647	22
Site operations sequencing	0.650	21	0.608	23	0.638	20	0.713	21	0.671	18
Anticipated variations	0.643	22	0.656	18	0.600	22	0.662	23	0.671	19
Expertise of consultants	0.640	23	0.640	21	0.577	23	0.725	20	0.659	21
Number of project team	0.571	24	0.576	24	0.531	24	0.625	24	0.576	23

5.1 Complexity of Design and Construction

This factor was ranked as the most important. Project complexity including the technical complexity of the task, the amount of overlap and interdependencies in construction stages, project organisation, site layout, and unpredictability of work and site construction; all of which can hinder performance on site. In essence, project complexity affects contract duration and consequently, the construction cost. Bennett and Fine's [11] research showed that project complexity can be viewed in terms of size of a task, speed of production, the extent of repetition, number of operations, incidence of different kinds of work, and extent of predictability of operations. The study by Bennett and Fine concluded that the size of a task (e.g., by repeating the same sequence of operations and extent of degree of interference with construction -measures of project complexity - with consequent effect on project organisational structure) affects project work breakdown unit costs and durations.



Rank	Contractor groupings			
	Very Small	Small	Medium	Large
1	Complexity	Complexity	Complexity	Complexity
2	Client's Financial Situation	Scale and Scope of Construction	Scale and Scope of Construction	Method of Construction
3	Type of Client	Type of Structure	Method of Construction	Market Condition
4	Scale and Scope of Construction	Site Condition	Type of Client	Buildability
5	Method of Construction	Market Condition	Market Condition	Scale and Scope of Construction
6	Project Team Experience	Availability of Resources	Form of Procurement	Project Duration

Figure 1 Most important factors influencing cost estimating decision

5.2 Scale and Scope of Construction

This is an important factor for all the contractors and was ranked in fifth position by the large contractors with an index of 0.812. Project scope is a definition of the client's requirements for space, building functions, and quality of the proposed project. This factor is important in determination of an appropriate organisational structure for a project and it has great influence on resourcing a project and the expected project duration.

5.3 Market Conditions

The cost estimator, in the estimating decision, must take into account the trends in market conditions and the implications on the costs of the resources for the project. This factor is also considered in the subsequent function of mark-up determination. It is not unexpected, therefore, that the factor was ranked third overall. However, the factor was ranked ninth by the very small contractors. A plausible argument for the low ranking of this factor by very small contractors is that they deal mainly with domestic projects, which are likely to be less affected by market conditions compared with large projects.

5.4 Method of Construction / Construction Techniques

As part of the estimating process, method statements are produced which indicates the construction methods and the resources requirement in executing the work. To a large extent, the construction method and technology of production to be employed determine the construction programme, organisational structure and successful execution of the project. This factor is ranked second and third by large and medium sized firms, respectively. These groups of firms deal with large and complex projects, which require innovative construction techniques. These firms also recognise that



innovative construction methods, if included as a tender qualification, could be used to gain a competitive advantage.

5.5 Site Constraints

Site constraints deal with multiplicity of factors and limitations pose by site position, site conditions and site access. Site conditions include topography, ground conditions, weather problems, constraints for plant and equipment. Site position is in relation to public transport, adjacent buildings etc. Overall, this factor was ranked in fifth position. The factor, apart from its influence on the physical construction of the project and consequently the production performance on site, determines the project overheads.

5.6 Clients Financial Situation and Type of Client

Information on the type of client and the financial standing is important as part of the project assessment and appraisal processes. These two factors have been identified by the respondents as being very important. These factors are usually considered very carefully by construction contractors as part of the decision whether to tender. However, if the company is satisfied with the type of client and the financial position, these may not be important factors again for the estimators. The above factors are very important in the decision to tender for very small contractors, and were ranked in second and third positions. This group of contractors, typically, has very low capital base and as a result would like to be assured that a client is able to honour the financial commitment to the project.

5.7 Buildability

Buildability indicates the extent to which the design of a building assists with construction of the project. This was ranked in tenth position by medium firms compared with a rank of four by large firms. Overall, this was ranked in eighth position. Large sized contractors, typically, have an appropriate design and construction expertise in-house to provide technical solutions to construction problem. However, a medium sized firm may not have sufficient expertise to solve construction and buildability problems. Low ranking of this factor by medium contractors tends to suggest that they need to become more aware in this respect. This factor is not considered important by small firms.

6 Conclusion

Although literature on cost estimating provides the principles involved as a technical process, a general view is that cost estimators take into account some factors that form the basis for their costing decision. The factors that interplay in the cost estimating decision, therefore, tend to nullify that estimating is purely a technical process but suggest that subjective decisions are involved in the process.

There is a general view in the industry that the accuracy of cost estimates is crucial to all parties involved with the construction project. Consequently, an analysis of factors involved in cost estimating is important. The current study shows that the main factors influencing cost estimating decisions are complexity of the project, scale and scope of construction, market conditions, methods of construction, site constraints, client's financial position, buildability and location of the project. It is believed that these factors have a direct effect on production performance on site and the performance of the construction project itself; and consequently must be taken into account in any estimating decisions. The study also shows that all the contractors agree on these factors and with the exception of the form of procurement, there is no difference of opinion, at 5% significance level, on the factors influencing the cost estimating decision on a company size basis.



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