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Current Practice in Cost Estimating and Cost Control in Tendering and Bidding Process in Highway Construction

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Abstract — The process of developing a comprehensive project cost estimate is critical for a project to be adjudged successful on completion. Projects' costing is one of the most critical and most widely used project management tools. The complex nature of Projects and the inherent uncertainty of the financial performance of construction projects, development funding, and the monitoring and controlling of costs and schedules make exact budget needs impossible to forecast accurately. This same characteristic also makes projects to deviate from plans. The main object of this paper is to identify the factors affecting the accuracy of project cost estimation, determine the various methods of carrying out project cost estimation in construction projects within INDIA. The study is motivated by the inability of most construction professionals to arrive at a tentative and reliable project cost estimate in project realization which has created obvious problems of project cost overrun and subsequent abandonment. The study sampled the opinion of fifty-three selected project professionals who had worked on related construction outfits in INDIA. An objective realization instrument developed using eighteen (18) factors identified in the literature as possible factors affecting the accuracy of project cost estimation were ranked based on a Likert four-point scale. The score of respondents to the factors were analyzed using descriptive and inferential statistics, mean score value and factor analytical approach as the major tool.

Keywords— Project cost estimation, factor analysis, mean score value, detailed estimate, conceptual estimate.

I. INTRODUCTION

Construction cost estimates provide the backbone for construction project budgets and bids. Owners rely on both rough and detailed estimates to determine if projects are feasible and to know the amount of financing they will need to make their project a reality. How you estimate and conduct your project management can affect the accuracy of the budget for construction costs and that budget can reveal as early as possible if the job will deliver a satisfactory result for the homeowner and turn a profit for you, the builder.

"Providing accurate and detailed construction cost estimates early in the planning and design process allows you to create a roadmap for a successful project," Marcene Taylor, president of construction estimating firm Marcene Taylor Inc., said.

There are many ways to develop a cost estimation for a project, depending on the amount of information and data you have about the project.

From preliminary estimates based on past projects, to detailed line-item estimates based on the construction bid documents, estimates can range from a ballpark figure to a well-developed proposal used to create formal bid estimates and customer contracts.

We're going to look at the types of construction estimates, how they are developed, and how software can help you better meet your customer's expectations.

II. TYPES OF CONSTRUCTION COST ESTIMATES

There are five main types of construction cost estimates: preliminary, detailed, quantity, bid, and control. Each is used for a different purpose at a different time in a project lifecycle. Preliminary cost estimation

A preliminary estimate, also called an abstract cost estimate, approximate cost, or budget estimate, is used in the early phases of a project, usually before design documents have been completed.

Project owners rely on preliminary estimates to help them have a rough estimate that helps them decide whether a project is financially feasible or not. They may use the preliminary estimate to determine how much financing they'll need or if they can afford the project with existing funds. Often a

preliminary estimate helps determine if a project will be undertaken or not before they involve too much of your time.
A preliminary estimate is usually based on the costs you've experienced on similar projects that you have recently completed. For example, a general contractor may provide a preliminary estimate for a new office building by looking at past office buildings of similar size. This kind of estimate is prepared with the understanding that a revised estimate with more specific cost detail must be completed before construction can begin.

Detailed estimate
As its name implies, a detailed estimate involves breaking down the project scope into smaller unit prices that can be priced individually. It includes costs for the materials, equipment and labor required to complete the project. Adding these gives you a total project cost.

In order to provide a detailed estimate, you need a design that is complete so you or your estimator can quantify the exact work that has to be done.

"An estimator needs to get to know the job inside and out, fully understand scope and design requirements, in order to provide a responsible estimate on any project," says Dave Shank, owner of Shank Glazing Solutions, which specializes in preparing construction estimates for glazing and bid consulting.

The detailed estimate is based on completed design documents and how much labor will cost the contractor to provide. It is often the basis of the contractor's initial building construction budget.

For example, a masonry contractor breaks out the work required for a brick wall by estimating the costs for the foundation, support structure, masonry materials and labor.

Quantity cost estimate
A quantity estimate is based on the actual number of units or amount of work that needs to be provided. The project is broken down into quantifiable pieces and all costs for each piece are added up to get the overall project estimate.

A quantity estimate is based on the count or measure of the amount of work and materials needed to complete the project. It is assumed that there is a standard cost for each unit of work and for the materials purchased. This is all typically quantified in a takeoff.

"Different trades have different techniques for estimating a job. For example, roofing is determined by the square foot, plumbing by the fixture count, and electrical by the opening," according to Bill Samuel, an Illinois real estate developer at Blue Ladder Development and general contractor.

For example, a concrete contractor bids the foundation for a project based on the square footage of the slab. He has determined how much it costs for each square foot of foundation, including forms, materials and labor. Because of these differences, it's best to use a digital takeoff tool that can adapt to your specific needs.

Bid cost estimate
A bid estimate is the cost estimate that is submitted to a potential client in hopes of winning the job. It will include all the contractor's costs for the project, plus allocated overhead costs and profit margin.

It's important to factor those two items in a bid cost estimate because the bid estimate is often the definitive estimate used as the basis for the construction contract. The bid estimate is based on the contractor's breakout of the building costs, plus markups for profit, overhead expenses and contingencies. Digital takeoff software typically allows for adding line items for markups and other expenses.

Control cost estimate
A control estimate is used for monitoring the project during construction and is comprised of three separate estimates: the budget estimate for financing, the budgeted cost after contracting but prior to construction, and the estimated cost to complete during the project. These budgets are revised on a regular basis to reflect approved customer change orders and actual costs incurred.

III. THE DIFFERENT COMPONENTS OF CONSTRUCTION ESTIMATES

So now that you have reviewed the different types of estimates. Let's look a little closer at how they are put together. When preparing an estimate, contractors look at three components: estimating technique, degree of accuracy and data source.

Estimating technique
There are two techniques used to create the project estimate: top-down and bottom-up. A top-down estimate is created by determining the estimated cost for the whole project and distributing costs to each task based on that estimate.

A bottom-up estimate prices each specific task individually to roll up to an actual cost for the overall project. A bottom-up

estimate is the most detailed and accurate and can be completed using takeoff software.

Accuracy of cost estimates

The accuracy of a construction estimate is based on the amount of information provided in the design documents. As we've discussed, contractors often provide estimates at various levels of document completion.

As the project development progresses, the estimates become more accurate. There are several types of estimates that are distinguished by the level of accuracy required, including magnitude estimate, feasibility estimate, preliminary estimate and definitive estimate.

Data sources for estimated cost estimates

- There are three potential sources for cost estimate data. The first is a parametric estimate, which starts with unit costs provided by third party or a contractor's in-house data.
- The unit cost is used to provide an overall estimate for the project based on the direct construction cost, which includes materials and quantity of work required.
- The second is expert judgment, when a building expert provides their opinion on the cost for the project.

IV. LITERATURE REVIEW

Yu Qiao et al. [1] Highway transportation project bundling can significantly reduce project delivery cost but could cause undesirable consequences such as reduced market competition. As such, bundling policy needs to be guided by a careful assessment of the potential impacts of bundling on bidding competition. This paper analyses the effect of project bundling policies on market competition using random-effects mixed ordinal logistic modelling, a probabilistic approach. The paper also investigates the variations of such effects across the different project types. The bundling policy factors that were found to be significantly impact bidding competition were the bundle size, bundling combination, and spatial proximity. The results suggest that bundled projects are generally associated with lower bidding competition compared to standalone projects, for all work categories except traffic projects. Further, where the bundled projects have proximal location, the bidding competition is generally higher. It was also determined that the different highway project types exhibit significant differences regarding the effect of bundling on competition: bundling policy (vis-à-vis standalone policy) generally leads to less intense competition for bridge, road, small-structures, miscellaneous, and utility projects, and more intense competition for traffic projects. In addition, it was found that there is a significant improvement on the model performance by including a random effects specification which diagnosed and addressed the unobserved heterogeneity that exists across the contract-letting years, for all the project types. The paper's models can help highway agencies not only estimate the expected number of bidders for a given project under different bundling policies but also assess the effects of the bundling policy-related factors on bidding competition.

José L. et al. [2] Bonifaz This paper confirms a positive relationship between the aggressiveness of bids and the probability of renegotiating concession contracts. We use a database of 113 concessions awarded in Peru, finding that a 1% increase in bidding aggressiveness increases the probability of contract renegotiation by 2.4%–3%. This impact is higher for the transportation sector. Our results are robust to several econometric specifications. These results confirm the hypothesis that bidders will submit aggressive bids to renegotiate contract terms once the government and concessionaire are tied, and competition is no longer possible.

Yinglin Wang et al. [3] Various stages of highway project construction process involve text, image, audio, video and other related data sources involving many participants, forming a huge amount of data. Accurately tracing the source of responsibility, refining and applying the unbalanced data in the highway project archives is of great significance for realizing the intelligent transformation of highway construction project management. This paper firstly sorts out the construction process of highway projects and the main data sources, constructs a data association network between construction entities and construction process, as well as a knowledge map of highway construction data. Then, according to the highway construction stage, an index system based on 12 key data is constructed by using the entropy weight cloud model method, and the importance of the data is evaluated. Thirdly, based on the unbalanced characteristics of highway project data, a method of mining big data in highway project archives using classification evaluation indexes is proposed, and the accuracy of this method is verified by case calculation. Finally, taking the Shizong Qiubei Expressway in China as an example, the intelligent management and control suggestions for key data of transportation projects are proposed. It is found that the key data with special importance rate in highway construction include construction data, supervision data and completion data. Boosting algorithm is more accurate than the traditional SMOTE algorithm for unbalanced data mining, which helps to save the project construction cost and improve the quality of data extraction in the project archives. This study provides a theoretical reference for key data traceability of highway

project intelligent management and control platform and the improvement of intelligent management efficiency.

Yoshinobu Nakanishi et al. [4] In open competitive tendering in Japan, one-party bid events where only one contractor submits a bid frequently occur. This situation has been criticized as hindering economic efficiency and fairness. This study uses bidding records to statistically analyze the factors that influence the number of bidders and cause one-party bids, which subsequently influence the win-reserve ratio. We found that fewer bidders participate in bidding for deals that require relationship-specific investments, resulting in a higher win-reserve ratio. In biddings with ambiguous specifications and incomplete contracts, more bidders participate, leading to a lower win-reserve ratio. Aside from these indirect effects mediated by the number of bidders, some factors directly influence the win-reserve ratio. Interestingly, indirect and direct effects conflict for follow-up deals and deal size. Thus, by highlighting deal-specific factors and differentiating between indirect and direct effects, this study brings new insights into the discussion on bidder behavior and its outcomes.

José Manuel Vassallo et al. [5] Flexible-term highway concessions are becoming quite popular around the world as a means of mitigating the traffic risk ultimately allocated to the concessionaire. The most sophisticated mechanism within flexible-term concession approaches is the least present value of the revenues (LPVR). This mechanism consists of awarding the concession to the bidder who offers the least present value of the revenues discounted at a discount rate fixed by the government in the contract. Consequently, the concession will come to an end when the present value of the revenues initially requested has been eventually reached. The aim of this paper is to evaluate the effect that the discount rate established by the government in the bidding terms has on the traffic-risk profile ultimately allocated to the concessionaire. To analyze this effect, a mathematical model is developed in order to obtain the results. I found that the lower the discount rate the larger will be the traffic risk allocated to the concessionaire. Moreover, I found that, if a maximum term is established in the contract, the lower the discount rate, the less skewed towards the downside will be the traffic-risk profile allocated to the concessionaire.

Ivan Ridderstedt et al. [6] Although most public procurements involve decisions concerning bundling, only a limited body of empirical research guides policy on this matter. In this paper, we examine the cost effects of bundling in the competitive tendering of highway pavement replacement with hot-mix asphalt. For this we use linear regression on data from a comprehensive sample of such contracts procured by the Swedish infrastructure manager (IM) during the 2012–2015 period. We find that bundling affects the procurer's cost in multiple and partly counteracting ways. Our results show that economies of scale are strong but diminishing and counteracted by the costs of bundling and bundling-related factors. Overall, the findings support the Swedish IM's current bundle design but also suggest that most of the contracts are still inefficiently small. While not perfectly generalizable to other markets, the findings provide some support for the increased promotion and use of the bundling of small-scale road rehabilitation projects in the USA. Two main implications of the results are that bundling policy should emphasize proximity and similarity rather than whether the work is small in scale and that the scope for efficient bundling should be accounted for when optimizing the timing of pavement replacement.

Victor Barros et al. [7] This study explores how the stock market reacts to the award of highway concessions using the case of Portugal, a country which awarded 19 highway concessions over the period of 1998 to 2009. We focus on the abnormal returns of both the winning and losing publicly-listed companies that participated in all the tender processes, either individually or in a consortium. The results indicate a positive market reaction, although only for firms that have previously won a highway concession. Based on their experience in winning and operating highway concessions in Portugal, these firms can bid more effectively and present proposals which generate a better value proposition for their shareholders. Accordingly, investors immediately gain from the benefits of the forecast experience and the synergetic gains from operating more than one highway concession. On the opposite, markets react sceptically when the firm starts to operate a highway concession in Portugal. This paper also suggests that markets reward more lengthy contracts positively, as well as if the biding company is not headquartered in the country.

Renata Schneiderova Heralova et al. [8] Highways and roads are an important part of public assets in all countries, allowing movement between communities. As well as other types of infrastructure, the roads infrastructure requires a proper procurement process. The research shows that prices presented in public bids are lower than those expected by contracting authorities. Public owners are restricted to the public bidding procedures, especially the provision to use low bid price in the Public Procurement Act. Often a public owner has concerns about the contractor bidding with the lowest sum. Contractors are repeatedly requested to explain the reasons for their low price. This leads to time extension of the bid process. The lack of contracts for construction work and an additional competitive concern to win out in the bid process may be the reason for low prices. An incorrect calculation of the estimated

contract price by the contracting authority itself could be another reason.

Sherzod Yarmukhamedov et al. [9] This paper uses econometric methods to study the cost efficiency of road maintenance provision in Sweden for the first time. The novelty lies in the application of econometric techniques to a new and rich panel dataset (73 contracts; 11 years, 2004–2014) with a wide range of variables and approaches to controlling for heterogeneity (including weather variation). The analysis is applied in the context of a sector where all road maintenance contracts are subject to competitive tendering, but with a state-run provider competing against private firms. The key focus is whether, even after competitive tendering, efficiency differences remain between the state provider and private entrants. We find that the state-run provider has significantly higher costs (between 8 and 20%) than private firms despite holding 60% of the market. The results suggest that substantial savings are possible through opening up road maintenance to the private sector through competition for the market; but that in Sweden, the tendering process is still not working optimally. Further research is needed to understand why the current cost gap persists between public and private providers, despite competitive tendering having been present across the whole market for several years.

Ali Akbari Ahmadabadi et al. [10] Public-Private Partnership (PPP) has been promoted as an alternative procurement method to provide public services. In recent years, several studies have been carried out in order to identify and assess the critical success factors (CSFs) of PPP projects. However, the interrelation between success criteria (SC) and CSFs in PPP projects has not received attention from researchers. To fill this gap, this paper intended to evaluate the effects of CSFs on the success of PPP projects using PLS-SEM. To this end, SC were monitored throughout construction, operation, and final transfer stages, whereas CSFs were taken into account during the procurement stage of the PPP project. Then, based on an opinion survey in Iran, the effects of CSFs on the success of PPP projects were evaluated based on the developed PLS-SEM model. Moreover, in order to validate the proposed model, two national highway projects in Iran were studied in detail. The results confirmed the effect of CSF on project success and showed that private sector capability has a direct effect on project success during the construction period and government capability is very effective during the project operation stage. In addition, investigating the case studies with respect to the introduced model indicated that a transparent bidding process, risk allocation, and good partnering are among the CSFs in PPP projects in developing countries.

V. CONCLUSION

Construction agencies require a budget estimate in the early stages of a project to manage costs that consist of two main components, a base estimate, and a contingency cost, which together represent the estimated final cost of the project. The contingency reserve usually includes risks and uncertainties associated with construction projects to contain uncertainties-induced monetary impact and avoid project cost overruns. Therefore, the contingency cost is included within the budget estimates to represent the project agency's total financial commitment. Thus, accurate estimation of the contingency cost is of critical importance to the project.

Construction contingency is the key component of the project budget for a construction contract to meet contract variation requirements that could arise during the project implementation phase. The cost performance of a construction project is a critical success criterion intimately dependent upon accurate estimations of cost contingency. Therefore, to keep the project within budget, an accurate contingency calculation is essential. Hence, it is essential for any agency to be aware of different contingency calculation techniques and select the most appropriate one based on the project characteristics.

In this study, most of the cost contingency calculation methods were collected and classified. Overall, 34 different methods and techniques were identified and discussed under these categories.

The study provided several guidelines for cost contingency methods in the construction industry in terms of;

- Selecting the model that matches the project type and objectives.
- Creating a data set priority and checking its adequacy and efficiency.
- Using the proposed model at the preliminary stages of the project to achieve the best results.

The study proposed a practical guidance approach for construction agancies to choose their appropriate cost contingency method. This work is expected to form a good resource for agencies in the budget development stage and those who want to allocate a contingency budget for their construction projects.

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