Proceedings of the International Conference on Industrial Engineering and Operations Management
Dubai, UAE, March 10-12, 2020

Road Projects Estimation: A Review

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Abstract

The road infrastructure being the backbone of the transport system serves as a connection between the populace. This keeps the economy of the country flowing thereby establishing a crucial constituent of the economic, environmental and social well-being. To understand the approaches to estimating for road projects in the construction industry, this study reviewed extant literature using articles downloaded from SCOPUS database. It was established from extant literature that estimating for construction project is done to ascertain the likely required cost and also to ascertain the likely required time to execute the project. These estimates inform the project team on the financial implications of inputs made to proposed projects, thereby allowing for proper budgeting and cost control depending on the phase of construction. Reviewed literature revealed that categories of construction estimates are preliminary estimates, definitive estimates and detailed estimates while methods of estimating include subjective estimating, parametric estimating, comparative estimating, and analytical estimating. Analytical estimating was adjudged the most accurate of the four methods of estimating. It was therefore concluded that analytical estimating should be adopted for road projects to achieve the desired accuracy.

Keywords
Construction, Estimation, Project Cost, Road

1. INTRODUCTION

One of the major assets of a country is a road network as it gives both social and economic benefits to individuals, groups of people and the whole country at large. The road infrastructure being the backbone of the transport system serves as a connection between the populace. This keeps the economy of the country flowing thereby establishing a crucial constituent of the economic, environmental and social well-being. Road infrastructure is important because it is the most prevalent means of transportation of goods, people and services from the origin location to the preferred location having a single benefit of an added time and value chain. Road networks help over half of the people in the world especially in the urban areas which are the centres for business and many other socio-economic activities (Forster and Mensah, 2013; Fragkakis, Marinelli and Lambropoulos, 2015). Fragkakis, Marinelli and Lambropoulos (2015) opined that transport infrastructure is central to modern-day living by providing means of mobility for travelling to work, businesses, leisure and also for moving materials and goods. As the backbone of the transport system, road infrastructure serves as a connection between the populace while keeping the economy of the country

flowing and constituting a crucial constituent of the economic, environmental and social well-being (Swei, Gregory, and Kirchain 2017).

Estimating for construction projects is done to find out the projected costs needed to execute it in conformity with the specifications, designs and plans. With the necessary information concerning the project, the estimator can develop the total costs with fair accuracy. The process of estimating involves two distinctive tasks, namely to ascertain the likely required cost and to ascertain the likely required time to execute the project. These two tasks play a major role in enabling the consolidation of the scheduling and estimating functions of construction management (Deshpande, 1999). In project management, estimating is considered a process as it serves as the benchmark for cost control at the execution phase of the project. The estimated cost is checked from time to time as the project progresses in order to manage cost and establish corrective actions so as to improve productivity level (Lester, 2006 and Pratt, 2011).

To understand the approaches to estimating for road projects in the construction industry, this study reviewed extant literature using articles downloaded from SCOPUS database. The review is expected to shed light on the categories of construction estimates as well as the different methods of estimating for construction projects. This will assist estimators in knowing which estimation method is applicable at the different phases of the construction project.

2. ROAD INFRASTRUCTURE ESTIMATE

Bell and Kaminsky (1987) submitted that transportation agency engineers and construction contractors employ a variety of approaches in estimating a project cost ranging from formulating labour crew compositions and quoting labour productivity, equipment needed and material costs and then adding overhead/profit not forgetting to evaluate contingencies before submitting the tender as a set of line-item unit prices. In preparing subsequent cost estimates for construction projects, transportation agency engineers examine bid line-items unit prices for previous projects and the factors affecting these unit prices are analysed to arrive at a preliminary estimate. Factors affecting the unit prices taken into consideration includes project type, size and location among others which are then adjusted accordingly (Bell and Kaminsky, 1987). The major challenge encountered in preparing a preliminary estimate for road projects comes at the conceptual phase when little project information is available. The preliminary estimate is expected to include not just the construction cost but also the non-construction costs which are engineering design production cost, right-of-way and moving utilities, and contingencies for uncertainties (Asmar, Hanna and Whited, 2011).

The estimation process in the construction industry serves the following three important functions:

i. At the early phases of a construction project, an estimate of the projected cost is needed so that the financial feasibility of the project can be determined. This estimate is referred to as a preliminary estimate because it is produced from minimal details when the detailed designs are yet to be made available and the project is yet to start (Asmar, Hanna and Whited, 2011:944; Pratt, 2011:31).
ii. In cost control programmes, estimates are required to assist in controlling expenditures on the construction project. Managing cost at the design phases of a construction project entails considering substitute designs which may assist in influencing the process of making a better decision. As construction starts, the preliminary estimate serves as a benchmark for identifying deficiencies by the contractor which assists in taking corrective actions in order to keep the organisation in business by maintaining the profit margin (Pratt, 2010:427, 2011:31).
iii. The estimate is used in the process of competitive bidding. This is then used for awarding construction contracts to contractors. Winning a bid is based on the estimate prepared for the project for the purpose of openness (Pratt, 2011:31).

For all the phases of a construction project, there is the need for an estimator (as shown in Figure 1) who gives the appropriate estimate for each phase upon which management decisions can be based. These estimates inform the project team on the financial implications of inputs made to the proposed projects which allow for proper budgeting and cost control depending on the phase of construction (Pratt, 2011).

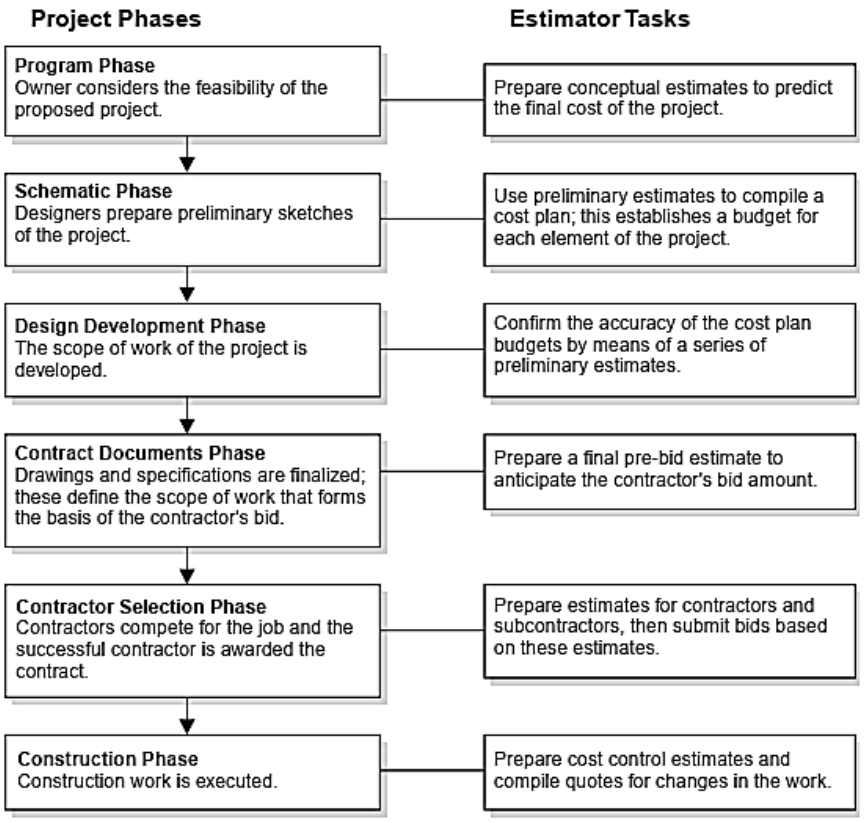

Figure 1. Tasks of an estimator at each phase of the construction project
Source: Pratt (2011)

3. CATEGORIES OF CONSTRUCTION ESTIMATES

For the purpose of identifying items and activities necessary to meets the demands of the client, it is crucial to determine the project scope. Defining the scope will give enough information that will assist in making a list of the activities to be executed. This also assists in ensuring both project budget and project schedule are not negatively affected. Various methods with accompanying accuracy levels exist for preparing the preliminary estimates. Each of these methods has its advantages and disadvantages, but the reality is that all construction project estimates are approximate values based on the estimators' professional experience and judgement (Deshpande, 1999). Three categories of estimating methods have been established by Deshpande (1999) which are explained thus.

3.1 Preliminary and conceptual estimates

Just as the name implies, this type of estimates is prepared at the conception of a project. It shows whether the proposed project is feasible economically. As the detailed design phase is entered, the preliminary estimate can be refined once a decision has been made by the project team and the client. Even though the estimating procedures vary substantially, they mostly falls into one of the following classifications, according to Pratt (2011):

i. **Time-referenced cost indices –** It reveals cost changes per time and so it is mostly employed in the construction phase of a project. It helps in speculating changes in methods, technology, and productivity and also reflects inflation trends.
ii. **Cost-capacity factors** – This category focuses on the changes in size, capacity, and scope of construction projects.
iii. **Parameter costs –** It relates the costs of the project to some physical parameters which reflect the scope and size of that construction project.
iv. **Component ratios –** As the construction and design process progresses, more detailed information is obtained concerning the specifications of the project together with its elements. This will, therefore, assist in knowing the types and size of the machinery to be employed which then gives the construction manager an idea of good price estimations (Deshpande, 1999).

3.2 Definitive estimates

Initial preliminary approximate estimates at this stage of the project are revised and revised to ensure accuracy is achieved by introducing extra necessary information as the project progresses. Construction projects, according to Deshpande (1999) are said to be classified into three categories according to the purposes of conclusive estimates as follows:

i. **Traditional project:** Guaranteed maximum-price, lump sum, and cost-plus-a-fee negotiated contracts are included in this category.
ii. **Unit-price projects:** This category involves heavy construction jobs, examples of which are tunnels, dams, airports, and highways. The uniqueness of this category is that rates are constant but quantities can change within the confines of the type of construction work.
iii. **Design-construct:** They are similar to the traditional type of projects mentioned above but the major difference is that the contractor is saddled with the responsibilities of carrying out the design and the construction (Deshpande, 1999).

3.3 Detailed estimates

A detailed estimate is prepared with the availability of the approved conceptual design and the completed design works. It includes tabulated quantities for the construction project called a quantity take-off'. The built-up unit cost is used to multiply the tabulated quantities to calculate the direct costs for the construction project (Pratt, 2011). The contractor's bid estimate and the fair cost estimates are the two different types of detailed estimates considering the level of detail of each estimate. Evaluation of the results of weather conditions, local practice, competitiveness in the market and the wholeness of design specifications and plans is vital for ensuring the accuracy of a detailed estimate (Deshpande, 1999).

4. METHODS OF ESTIMATING CONSTRUCTION PROJECT COST

Cost estimates used for evaluating projects, determining project feasibility, evaluating concepts and approving preliminary budgets are generally derived through four methods and the level of accuracy of these methods varies based on the project status and available information. These methods are subjective estimating (±20% to 40%); parametric estimating (±10% to 20%); comparative estimating (±10%); and analytical estimating (±5%) (Christensen et al., 2005 and Lester, 2006).

4.1 Subjective cost-estimating

This type of estimating gives a 'ballpark figure' which is generated from the past experience of the estimator on a similar project. This is because there is little or no project design information available at this phase. This is derived by a subjective 'feel' or 'hunch' of the estimator which can only be useful at the proposal phase to assist the client or sponsor to have an idea of what the proposed investment will cost. Being an approximate estimate method, it is sometimes referred to as 'guesstimating' (Christensen et al., 2005 and Lester, 2006).

4.2 Parametric cost-estimating

This method relies on the historical data of formerly executed projects to come up with a relationship that deduces the total cost (dependent variable) from the cost-influencing factors (independent variable). For most construction projects, material quantities form the cost-influencing factors. There are different types of approaches to carrying out parametric cost-estimating and the level of accuracy of each approach varies; however, they depend on the available data used for developing the mathematical function or model. During early project phases, regression analysis among other parametric cost estimation techniques is used globally. However, other techniques, such as structural equation modelling and neural networks are being used for estimating construction cost (Fragkakis, Marinelli and Lambropoulos, 2015). Even though parametric cost-estimating has been widely determined to have drawbacks such as "requirement of a defined mathematical form to fit the available historical data and the difficulty in accounting for a large number of a construction project's variables" (Hegazy and Ayed, 1998; Kim, An and Kang, 2004; Sonmez, 2004), it still gives enough accuracy for project conception phases as well as being simple to use (El Asmar, Hanna and Whited, 2011; Azman, Abdul-Samad and Ismail, 2013). Owing to these reasons, parametric cost-estimating has gained wide application in estimating cost for construction projects (Liu et al., 2013).

4.3 Comparative cost-estimating

This method serves as an alternative to the parametric cost-estimating method which is used for budget preparation. This method compares the total construction cost of a previously executed project with similar features and a cost is

arrived at for the proposed infrastructure. However, allowance must be made to cater for some inevitable differences such as the time factor of money, geographical location, availability and the proximity to necessary materials for the project, among others. In carrying out estimation using this method, the estimator compares salient features of the executed project to determine the cost of the proposed project (Lester, 2006; Ogungbile, Oke and Rasak, 2018).

4.4 Analytical cost-estimating

This method is applicable when the project has been approved for execution on site. Necessary details and information concerning the project must be made available for analytical cost-estimating to be carried out which is why it is the most accurate of all the estimating methods (Lester, 2006). The infrastructure is reduced to small divisions, subdivisions and individual component with each of the components being apportioned the appropriate cost. These are then added up to make the total construction cost (Ogungbile, Oke and Rasak, 2018).

5. LESSONS LEARNT AND CONCLUSION

It has been indicated that estimating for construction project is done to ascertain the likely required cost and also to ascertain the likely required time to execute the project. In project management, estimating is considered an essential part as it serves as the benchmark for cost control during the project execution phase. These estimates inform the project team on the financial implications of inputs made to proposed projects, thereby allowing for proper budgeting and cost control depending on the phase of construction. Also, estimates serve three purposes in the construction industry. Firstly, at the early phases of a construction project when an estimate of the projected cost is needed so that the financial feasibility of the project can be determined. Secondly, once the construction starts, the preliminary estimate serves as a benchmark for identifying deficiencies and the contractor taking corrective actions in order to sustain profit margins. Thirdly, winning a bid is based on the estimate prepared for the project for the purpose of openness. Categories of construction estimates were identified to be preliminary estimates, definitive estimates and detailed estimates while methods of estimating include subjective, comparative, parametric, and analytical estimating. Analytical estimating was adjudged the most accurate of the four methods of estimating.

From the reviewed literature, it is concluded that estimation in the construction industry is essential as it serves as the benchmark for cost control while executing the project. It informs the project team on the financial implications of inputs made to proposed projects which allow for proper budgeting and cost control depending on the phase of construction.

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Biographies

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