QUANTIFYING CONTRACTORS’ QUALIFICATIONS USING PAIRWISE COMPARISON IN BEST VALUE PROCUREMENT METHOD

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Among the critical factors of project success is the proper selection of qualified contractors. More owners are adopting Best Value (BV) procurement which combines the technical qualifications with fee proposals to rank bidders. However, the successful application of BV depends on two integral factors: ranking of contractor’s qualifications using multiple criteria and the weights assigned to each selection criterion. Many criteria are qualitative, leading to difficulties in objectively quantifying a contractor’s rank. Thus, this paper provides owners with a simplified decision-support methodology that quantifies criteria that owners might consider in their decisions, reduces the number of comparisons that owners must perform, and reduces bias in defining criteria weights. This was achieved by first collecting the criteria commonly used to assess contractors’ competence. Then, criteria were analyzed and clustered into separate, quantifiable groups. Third, pairwise comparison was employed to devise a criteria-weighting method based on the clustered groups and determine the scores of bidding contractors. The proposed methodology could help identify the areas of strengths and weaknesses of each contractor in comparison with other bidders. The method presents a scientific and practical approach and, thus, can be considered for future applications.

Keywords: Contractor assessment, Evaluation criteria, Bid evaluation, Decision-support methodology, Tendering approach, Construction management companies.

1 INTRODUCTION

With the continual growth of construction projects’ complexity, the procurement of the right contractor has become crucial. Traditionally, competitive bidding has been widely accepted where contractors sometimes reduce their bid price to win the bid and, later, try to increase their profit margin by raising claims (Hatush and Skitmore 1998). In the light of this, there have been trends towards the use of other methods such as the Best Value (BV) method. In BV, the contractor’s score is determined by summing the weighted scales of different criteria that include cost and contractor’s qualifications (Abdelrahman et al. 2008). However, there are still obstacles hindering the implementation of this method. The first obstacle is the qualitative nature of the selection criteria. To tackle such an issue, objective selection criteria that could be quantified to differentiate between bidders are needed. The second obstacle relates to deciding on the criteria weights. The weights are either fixed or tailored according to project characteristics and owner’s needs and preferences (El Wardani et al. 2006, Kashiwagi 2011). This gives a great room for subjectivity; hence, researchers have attempted to develop objective systematic evaluation methods such as...
pairwise comparison (Muralidhar et al. 1990), Multiple-layer Fuzzy Pattern Recognition approach (Yawei et al. 2005), Analytical Hierarchy Process (AHP) (Fong and Choi 2000), and Multi-Criteria Decision-Making (Cheng and Li 2004). The current application of pairwise comparison, such as AHP, has proven to be effective; however, a limitation arises when there are numerous evaluation criteria and/or alternatives as this results in numerous comparisons. In fact, paired comparison should be performed on a maximum group of seven elements considering the limitations of human performance such as memory span, attention span and others (Saaty and Ozdemir 2003). Thus, an objective decision-support method requiring a reasonable number of comparisons is needed. Therefore, this paper proposes clustered groups of criteria that allow for an easier measurement of contractors’ competence. It also provides a decision support methodology that enables owners to objectively decide on the criteria weights without having to perform numerous comparisons. Owners will be able to rank bidders and compare the scores of different contractors.

2 RESEARCH METHODOLOGY

To achieve the objective of this paper, the research team started by analyzing the literature as well as procurement documents that are available online for several public owners in Alberta to identify the criteria used to assess contractors. Then, quantifiable criteria were selected and divided into groups and subgroups based on their interdependencies to assess contractors’ competence. The number of criteria were kept to a minimum. A criteria-weighting method was then developed using pairwise comparison to define the weights of the clustered criteria and determine the final scores of contractors along with ranking the contractors in each qualification category.

3 LITERATURE REVIEW

It is integral to assess the general performance of bidders in the market. Most of the studies emphasized the importance of contractors’ experience in the selection process (Russell 1988, Doloi 2009, Puri and Tiwari 2014). The number of years of experience as well as the owner/contractor relationship are indicators of contractors’ experience (Abdelrahman et al. 2008). However, experience should not be solely related to the duration the company has been in business since only a specific project team from the company will be engaged in the project (Doloi 2009). Another important evaluation criterion is what is called Beyond Contractual Reward (BCR), as introduced by Lo and Yan (2009), that captures profit deliberately gained by contractors through submitting change orders and claims. Financial capacity is also crucial for contractors’ evaluation. The initial capital cost proposed by Abdelrahman et al. (2008) is a good measure of financial capacity. Moreover, credit rating is a measure of financial status according to Puri and Tiwari (2014) and is considered a meaningful numerical measure of contractors’ financials. Puri and Tiwari (2014) also suggested banking arrangements and bonding criterion as a measure of financial soundness.

Regarding the criteria that are directly related to the project under bidding, cost and schedule are considered major project drivers (Chua et al. 1999) and, therefore, impact contractors’ scores (Puri and Tiwari 2014). Quality also remains a critical success measure for construction projects (Chua et al. 1999). The average quality performance on previous projects could be used in contractors’ evaluation as suggested by Abdelrahman et al. (2008), but this measure is hard to quantify. The literature criteria were not limited to cost, schedule, and quality; in fact, as health and safety are crucial especially in Canada due to the strict requirements pertaining to these measures as retrieved from the public documents, related measures are common. Health and safety assessment of contractors could be performed based on their performance on previous projects by measuring, for example, incident rates and fatalities (Moselhi and Martinelli 1990). Although the environmental aspects of projects are becoming of a paramount importance, only Abdelrahman et
al. (2008) proposed environmental considerations as an evaluation criterion among the analyzed studies. Finally, the investigated studies proposed criteria related to the management capabilities of contractors. However, management related criteria such as project management (PM) organization and management knowledge as proposed by Puri and Tiwari (2014) are qualitative and must be quantified. Accordingly, easily measurable criteria are presented in Section 4.

4 PROPOSED EVALUATION CRITERIA

Based on literature, the commonly used selection criteria were clustered into levels, Level zero (L0), Level one (L1), and Level two (L2) as shown in Figure 1. Granulating the criteria facilitates the comparison within each level of related criteria which are categorized as follows:

- **Contractor’s Status:** this group is divided into three elements under L1: Experience, Resources, and Financial Capacity. According to literature, the years of relevant experience, project team experience, and BCR can be used to evaluate contractor’s experience. However, since the number of completed projects affect BCR, an average BCR value per project (i.e., BCR divided by the total number of previous projects) is alternatively proposed. It is proposed to quantify the owner/contractor relationship by the number of previous projects performed with the owner. Regarding resources, their availability typically decreases as the number of current projects increases and is also a function of the company’s size. Moreover, the average number of years of experience of the resources involved in the project is also important. Finally, financial capacity has been commonly used by researchers where they suggested using credit rating, banking arrangements and bonding, and initial capital cost to quantify it (Abdelrahman et al. 2008, Puri and Tiwari 2014). The working capital is proposed as an alternative for the initial capital cost as it generally reflects financial stability. Finally, since banking arrangements heavily depend on the value of assets, the latter was chosen.

- **Project Drivers:** Schedule and cost factors remain two of the most influential selection criteria as they are globally used among other factors to measure the success of construction projects. Normally, there is a trade-off between cost and time. Hence, these two factors must be compared to each other and are added under the same level.

- **Environmental Aspects:** More owners are starting to consider sustainability as an essential selection factor. Contractors’ experience on projects that had minimal environmental impact is important. This could be quantified by the number of previous projects certified from environmental committees (e.g., LEED). The number of environmental requirements that are violated in the current bid should be also used for evaluation.

- **Quality Performance:** There were no clear quantifiable measures for any of the investigated quality-related criteria. This study suggests using the rejection rate of previously tested specimens as it reflects the quality of contractors’ work. The number of non-conformance reports also reflect quality performance. For the current project, the frequency of quality control/audits and quality assurance is correlated with the quality of the final product. As found in public projects in Alberta, there are mandatory and desirable requirements. The former must be fulfilled by all bidders and, thus, would not add value to bid evaluation. However, the latter is included as it impacts project quality. Accordingly, the ratio of the number of fulfilled desirable requirements and the total number of requirements as a criterion.

- **Health and Safety:** Health and safety requirements are mandatory and, if violated, would lead to contractor disqualification. Therefore, no related measures were included for the
current bid. However, their past performance can be used and can be quantified using incident rates and fatalities. Finally, the size of the company’s safety staff is also a good indicator.

- **Project Management (PM) Performance:** The PM experience could be evaluated based on contractors’ performance and current bid. The rate of successfully delivered projects, the rate of projects delivered on time and budget, and the average number of rejected claims per project (i.e., the cumulative number of rejected claims divided by the total number of claims) are measures of PM competence. For the current project, the number of previous projects with similar contract type and project delivery method reinforces the PM skills of the team. The number of certified managers that are assigned to the project is also suggested. Finally, the team’s familiarity with the construction methods is the only selected qualitative criterion and will be assigned 100 in case of familiarity and zero in case of unfamiliarity.

![Proposed evaluation criteria](image)

**Figure 1.** Proposed evaluation criteria.

## 5 WEIGHTING METHODOLOGY

The framework proposed in this study for contractor selection in BV has five phases as follows:

1. Deciding on the relevant criteria: In the first phase, a decision group, including experts from the owner’s company and consultants, is formed to choose the applicable criteria from the proposed criteria. Following that, another group is formed to determine and evaluate the values of the selected criteria for each contractor based on their submitted bids.

2. Performing pairwise comparison to obtain the weights: Pairwise comparison matrices should be formed. The main difference between this method and AHP is that AHP requires a comparison of all alternatives for each sub-criterion. This is not needed in this method.
as all the criteria are quantifiable. Pairwise comparisons are only performed for criteria that belong to the same group or subgroup. For example, credit rating, working capital, and value of assets are compared to each other at L2 while experience, resources, and financial capacity are compared to each other at L1. Upon performing the comparisons, weights of different criteria are calculated using the arithmetic mean.

3. Normalizing the criteria’s values: Contractors’ data, as described in Step 1, should be normalized considering the negative or positive nature of the attribute. For example, cost has a negative nature meaning that the higher the cost, the lower its normalized value. Eq. (1) and Eq. (2) are used, where \( X_i \) is the value of criterion \( i \) to be normalized, and \( \text{Min}(X_i) \) and \( \text{Max}(X_i) \) are the minimum and maximum values of criterion \( i \) respectively.

\[
\text{Positive nature criterion value} = \frac{X_i - \text{Min}(X_i)}{\text{Max}(X_i) - \text{Min}(X_i)} \tag{1}
\]

\[
\text{Negative nature criterion value} = \frac{\text{Max}(X_i) - X_i}{\text{Max}(X_i) - \text{Min}(X_i)} \tag{2}
\]

4. Evaluating weights: After normalizing the data, the obtained weights from the pairwise comparison can be used to calculate the score of each contractor. To do that, the calculated weight for each item in L2 of the hierarchy is multiplied by the weight of the corresponding item in L1. The calculated value is then multiplied by the weight of the corresponding item in L0. This value is the total impact of this item in L2 on the contractor ranking. For instance, the weight of “Credit Rating” is multiplied by the weight of “Financial Capacity”, and the obtained value is then multiplied by the weight of “Contractor’s Status”.

5. Obtaining the total bid score: The normalized value of each criterion in L2, as obtained in Step 3, is multiplied by the total impact of the same criterion as described in Step 4. This step is repeated for each of the criterion in L2. Then, resulting values are summed to obtain the contractor’s score. The contractor with the highest score is selected.

The described method could be also used to evaluate contractors at each level to identify their areas of strengths and weaknesses. For example, the contractors’ scores on Experience criterion (L1) or Contractor’s Status (L0) could be assessed. Figure 2 illustrates how contractors could be compared at L0 of the proposed hierarchy. Contractor A ranks third when it comes to quality and second in environmental aspects.

![Figure 2. Comparison of contractors’ qualifications at L0.](image)

Eq. (3) and Eq. (4) are used to calculate contractors’ scores for different categories at L0 and L1.

\[
\text{Score at L0} = \sum (\text{L2 Weight} \times \text{L1 Weight} \times \text{Normalized Value at L2}) \tag{3}
\]

\[
\text{Score at L1} = \sum (\text{L2 Weight} \times \text{Normalized Value at L2}) \tag{4}
\]
6 VALIDATION AND FUTURE RESEARCH

The proposed methodology was validated using the Face Validity method, as suggested by Sargent (2007), which consists of consulting with knowledgeable individuals on its logic. An expert with 25 years of experience in project management confirmed the soundness of the proposed model and the value it brings to the procurement process in terms of simplicity. However, the proposed method requires further validation using case studies which will be performed in a future study.

7 CONCLUSION

Owners might find it hard to defend their choices and scoring for contractors’ qualifications due to subjectivity. This paper proposes a simplified and objective method for quantifying and scoring contractors’ competence during the bidding stage by determining relevant selection criteria and their respective weights in BV. It captures quantifiable criteria that help assess contractors’ competence in terms of contractor’s status, quality performance, health and safety, etc. Each of these categories is divided into subcategories including criteria that can be more easily compared to each other. The methodology also allows comparing contractors at each of the proposed levels. This method simplifies the selection process as it provides a one-stage procurement process.

References


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