

Utilizing Analytical Hierarchy Process for Contractor Selection in Turkish Public Construction Procurements

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Abstract

The contractor selection decision plays a vital role in the successfully completion of a project. The Turkish public construction sector has a tradition of using the lowest bid as the criteria for contractor selection. However, the selection of a contractor based on bid price alone may lead to the failure of the project in terms of cost overruns, time delays and poor quality standards. Other selection criteria have to be considered in addition to the bid price. Therefore, there is a need for quantitative methods to help project owners for the selection of the best/appropriate contractor. This paper proposes a multi-criteria approach which aims to help the Turkish public construction sector to evaluate and select the best/appropriate contractor based on not only bid prices, but also on other criteria such as economic, financial, professional and technical qualifications.

Keywords

analytical hierarchy process, contractor selection, public construction procurement

1. Introduction

Construction industry is one of the leading sector in which the world's largest companies compete. Similarly, the construction industry is one of the leading one in Turkey. A total of 43 Turkish construction companies were selected for the Top 250 International Contractors List prepared by the Engineering News Record in 2015. Accordingly, in 2015 Turkish construction industry has become the world's 2nd largest, ranking behind China (ENR, 2016). Public construction procurements have also great impact on the country's economy. When the 2015 statistics is examined, it is shown that by the year 2015 a total worth of \$42.748 billion public procurements are made and, \$17.936 billion of them are construction procurements (KIK, 2016a). Thus, the successfully completion of a construction project and overall project performance is highly critical. In this regard, selecting a capable construction contractor is highly important and greatly impacts the overall performance of any project. The contractor selection is the process of selecting the most appropriate contractor to deliver the project as specified. In other words, it is the process of identifying a contractor who can undertake the owner's project and take it to satisfactory completion in terms of time, cost, and quality expectations (Holt et al. 1994; Wong, 2004; Cristóbal, 2012). As the contractor plays the vital role in the overall project performance, selecting the right contractor for the right project is the most crucial challenge for any

construction project (Singh and Tiong; 2006; Cristóbal, 2012). Furthermore, selecting the most appropriate contractor has attracted significant academic research endeavor over the last two decades (Holt, 2010).

There is a wide variety of criteria that used for selecting a contractor throughout the construction industry. In the private sector, owners develop their own procedures and methods to evaluate and select contractors. However, in the public sector, bid price generally is the main criteria for selecting contractors. In Turkish construction industry, the method used for contractor selection in awarding public construction procurements is also based on the principle of acceptance of the lowest bid price. However, the evaluation on lowest price basis is accepted as one of the major causes of project delivery problems (Hatush and Skitmore, 1998; Holt et al., 1994; Topcu, 2004). The selection of a contractor based on bid price alone is quite risky and may lead to the failure of the project in terms of cost overruns, time delays and poor quality standards. Therefore, there is a need for the consideration of other selection criteria have to be considered in addition to the bid price.

There are several methods attempting to evaluate the contractors by using various selection criteria. These methods include AHP (the analytical hierarchy process) (Fong and Choi, 2000; Al-Subhi Al-Harbi, 2001; Madhi et al., 2002; Cheng and Li, 2004; Topcu, 2004), MAUT (multiattribute utility theory) (Moselhi and Martinelli, 1990; Hatush and Skitmore, 1997; Lambropoulos, 2007), fuzzy set theory (Nguyen, 1985; Singh and Tiong, 2005; Padhi and Mohapatra, 2010; Al Humaidi, 2014), TOPSIS (the technique for order preference by similarity to ideal solution) (Yawei et al., 2007; Cristóbal, 2012), and fuzzy AHP (Jaskowski et al., 2010; Hosny et al., 2013).

In this paper, the existing practice of the contractor selection process in Turkish public construction procurements is examined. A proper method which considers several selection criteria for selecting the most best/appropriate contractor is proposed. Analytical Hierarchy Process (AHP) method is applied as a multi-criteria decision making approach. AHP helps to identify how the selection criteria are weighted and pair wise comparison matrices facilitate to prioritize the level of importance for each selection criteria.

2. Contractor Selection in the Construction Industry

In the construction industry, especially the public sector has a long tradition of using the lowest bid as the only selection criterion for contractors. However, using bid prices as the sole criterion in contractor selection is often criticized by many researchers. In the Latham Report it is recommended that "choice of consultant or contractor should be made on a value for money basis, with proper weighting of criteria for skill, experience and previous performance, rather than automatically accepting the lowest in all cases" (Latham, 1994). Holt et al. (1995) indicated that "emphasis presently directed towards encouraging lowest bid should be redirected towards establishing contractor ability for achieving client satisfaction project performance, quality of completed project, etc". Kumaraswamy (1996) concluded "public sector clients are most often constrained to select the lowest (evaluated) bidder, other than in exceptional circumstances, which makes short-listing all the more important. However, it is increasingly recognized that the lowest bid is not necessarily the most economical solution in the long term". Hatush and Skitmore (1998) believe that "the acceptance of the lowest price in bid evaluation is the prime reason for project delivery problems, as contractors desperately quote low prices by reducing their quality of work, and hope to be compensated by submitting claims". Topcu (2004) stated that "contractors participating in a tender with lower bid prices to stay in business are likely to be risky from a project owner's point of view, since later on they might search for raising additional income through their claims or cutting costs to compensate thereof". Waara and Bröchner (2006) added that "although the public sector has a long tradition of using the lowest bid as the award criterion for contracts, reliance on nonprice criteria is increasing". Banaitienê and Banaitis, (2006) also added that "lowest price does not automatically mean advantage for the client as the quality and duration of a construction project may be compromised".

On the other hand, apart from bid price, other criteria that help to select contractors have been analyzed by many researchers. Russell et al. (1992) suggested seven distinctive contractor decision factors for

public owners: (1) performance, (2) type of contractor, (3) capacity for assuming new projects, (4) location, (5) percentage of work performed, (6) third-party evaluation, and (7) financial capability. Liston (1994) identified seven contractor selection criteria, as follows: (1) past performance, (2) business location, (3) capacity, (4) financial capability, (5) resources, (6) procedures, and (7) quality assurance. Hatush and Skitmore (1997) proposed an explicit set of contractor selection criteria such as (1) bid amount, (2) contractors' financial soundness, (3) technical abilities, (4) management capabilities, (5) safety performance, and (6) reputation. Fong and Choi (2000) identified and prioritized eight criteria for contractor selection as (1) tender price, (2) financial capability, (3) past performance, (4) past experience, (5) resources, (6) current workload, (7) past relationship and (8) safety performance. Plebankiewicz (2009) introduced five basic criteria for contractor prequalification, which are (1) financial standing, (2) technical ability, (3) management capability, (4) health and safety, and (5) reputation. Al Humaidi (2014) examined common characteristics during contractor selection are related to (1) technical capacity, (2) financial status, (3) past experience, and (4) management resources.

2.1 Contractor Selection Process in Turkey

In Turkey, public construction procurements are carried out under the Turkish Public Procurement Law No. 4734. The purpose of this Law is to establish the principles and procedures to be applied in any procurement held by public authorities and institutions governed by public law or under public control or using public funds (KIK, 2016b). Within the scope of Public Procurement Law, "Regulation on Implementation of Construction Works Procurements" has been used to govern the principles and procedures to be applied by the contracting entities (KIK, 2016c). Public sector owners have to follow this specific regulation during the contractor selection process. According to the Regulation, contractor selection process is summarized in Figure 1.

As shown in Figure 1, the contractor selection process starts with receiving and opening the contractor's bids. The bids are submitted to the contracting entity until the indicated deadline time of submitting bids. The tender commission reviews the bid envelopes in order of receipt; then the envelopes are opened in front of the participants together with the bidder contractors. Within the bid envelopes, the contractors are asked to submit several documents which prove that they are suitable and qualified for the procured construction work. These documents are required for evaluation of economic and financial qualification, and professional and technical qualification of the contractor. Documents concerning the economic and financial qualification are (1) documents obtained from the banks showing their unused portion of cash credit or unused portion of letter of credit, (2) balance sheets or equivalent documents, and (3) documents indicating the workload. Documents concerning professional and technical qualification are (1) documents indicating that the contractor is currently acting and is authorized to submit bids, (2) work experience certificates, (3) documents concerning the organizational structure and personnel, (4) documents concerning the machinery and other equipment, and (5) quality and environment management system documents.

In the evaluation of the bids, documents which are submitted within the bid envelope are evaluated. Firstly the bids are analyzed and the bids that are incomplete or not in compliance with the procedure pursuant to the regulation are determined; then these bids are disqualified from the evaluation process. If necessary, the contracting entity may request the bidders to explain their bids with regard to unclear points in order to review, compare and evaluate the bids upon the demand of the tender commission. It is checked whether the bidder contractors are in compliance with the qualification criteria specified in the tender document. The bids that do not comply with the requirements are again disqualified from evaluation.

After the tender commission evaluates the submitted bids, it determines the abnormally low bids according to the other bids or the approximate cost determined by the contracting entity. As a result of this evaluation, the bids that are not deemed satisfactory are rejected. After that, the contracting entity can reject all bids and cancel the procurement upon the decision of the tender commission. Or, the tender commission determines the most cost advantageous bid. The most cost advantageous bid is determined on

the basis of the lowest price submitted. Finally, the contractor who submits the most cost advantageous bid is awarded the contract.

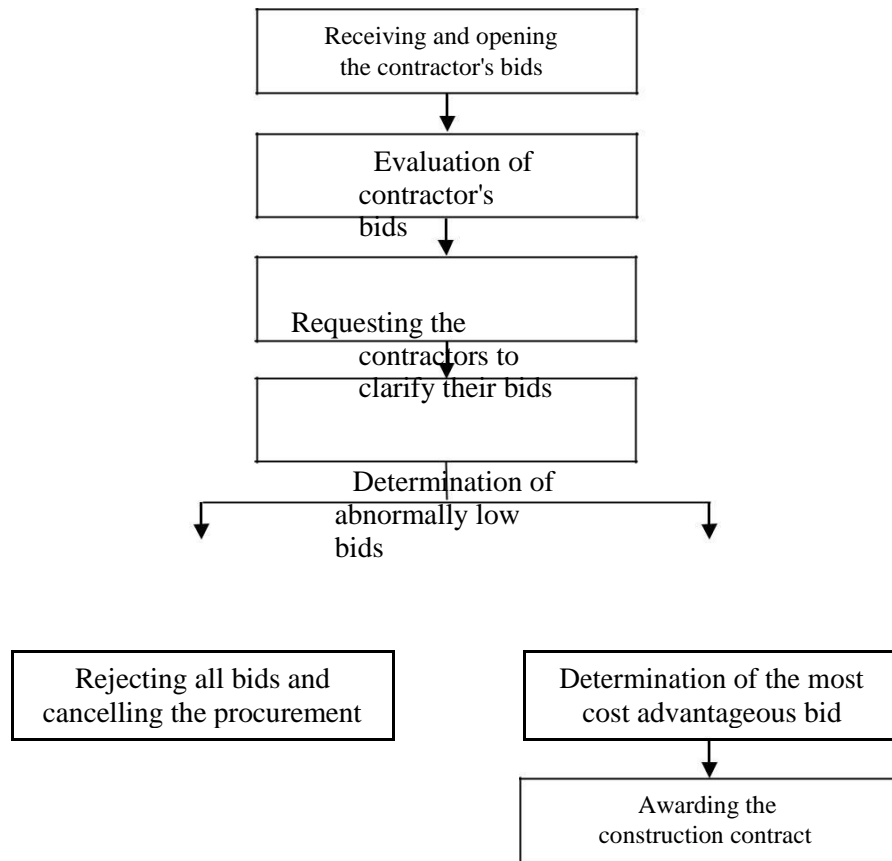


Figure 1: Contractor Selection Process in Turkey

As it is described above there is a two-step process for the selection of contractors: (1) contractor prequalification and (2) determination of lowest bidder among prequalified contractors. At first step, bidder contractors are evaluated according to their bids; and their documents are checked in order to determine whether they fulfill the qualification criteria. After the evaluation, prequalified contractors pass through the second step. At second step, only the bid prices are taken into account and the most cost advantageous bid is determined. Finally, the bidder who submits the lowest bid price is awarded the contract. In other words, the lowest bidder wins the contract. Although the public sector must necessarily be held accountable for their decisions, concentrating solely on bid price is not enough when selecting the most appropriate bidders. Contractors awarded a contract with lower prices try to compensate their profits by claiming payment of extra money or extension of time. As a result, there show up extensive delays in the planned work schedule, cost overruns, serious problems in quality and increased number of claims and disputes between the owner and the contractor. In order to solve this problem, other criteria should be considered together with the bid price at the second step. Documents, which evaluated in order to determine the prequalified contractors, should be used as other criteria at the second step. In other words, documents for prequalification should also be used for the selection of the most advantageous contractor. These documents should be quantified in order to make the selection process easier and reasonable. Then, a multi criteria decision making approach, which aims to use a set of criteria for a decision problem, should be used in order to help to select contractors. Since these criteria vary in the degree of importance, the analytic hierarchy process (AHP) technique should be employed.

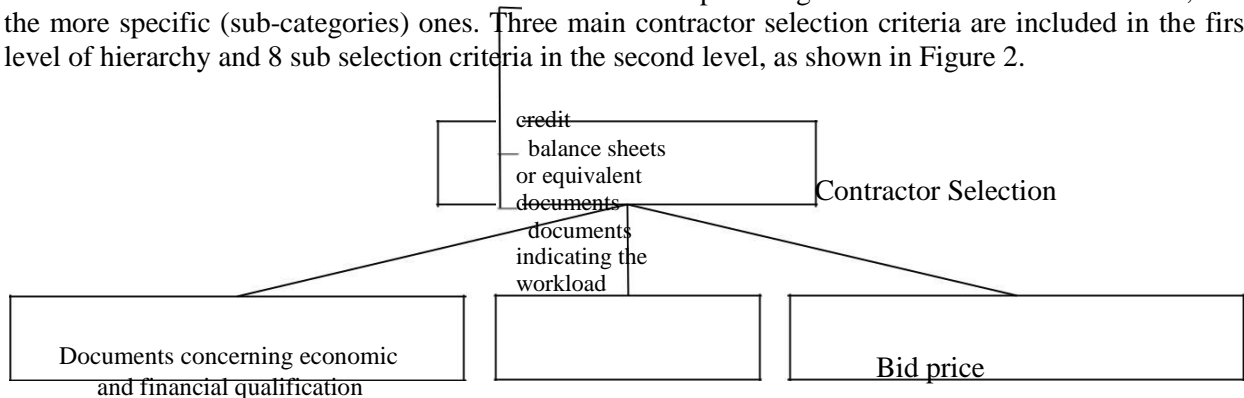
3. Analytical Hierarchy Process

The analytical hierarchy process (AHP) developed by Saaty (1980) is a strong and flexible multi-criteria decision analysis approach. In this approach, the most important steps are formulating the decision problem and constructing the hierarchy. After constructing the hierarchy, the decision maker can begin to prioritize the criteria in order to determine the relative importance of them in each level of the hierarchy. Criteria in each level are pair-wise compared with respect to their importance. Pair-wise comparison is based on a scale of 1 to 9 as per the definition of weights given in Table 1. The decision maker compares each criteria with all the remaining ones via pair-wise comparison.

Table 1: AHP pair-wise comparison matrix (Saaty, 1980)

Intensity of importance	Definition	Explanation
1	Equal importance	Two criteria are of equal importance
3	Weak importance of one over another	Experience and judgment slightly favor one criterion over another
5	Essential and strong importance	Experience and judgment strongly favor one criterion over another
7	Very strong and demonstrated importance	A criterion is strongly more important than the other
9	Absolute importance	The evidence favoring one criterion over another is of the highest possible order of affirmation
2, 4, 6, 8 Reciprocals of above nonzero	Intermediate values between adjacent scale values If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	When compromise is needed A reasonable assumption

In this paper, Super Decisions software program is used in order to identify the relative importance of contractor selection criteria. In Super Decisions, the decision-maker first structures the problem into different hierarchical levels. The model is built from the top starting with the main selection criteria, then the more specific (sub-categories) ones. Three main contractor selection criteria are included in the first level of hierarchy and 8 sub selection criteria in the second level, as shown in Figure 2.



documents obtained from the banks showing their unused portion of cash credit or unused portion of letter of

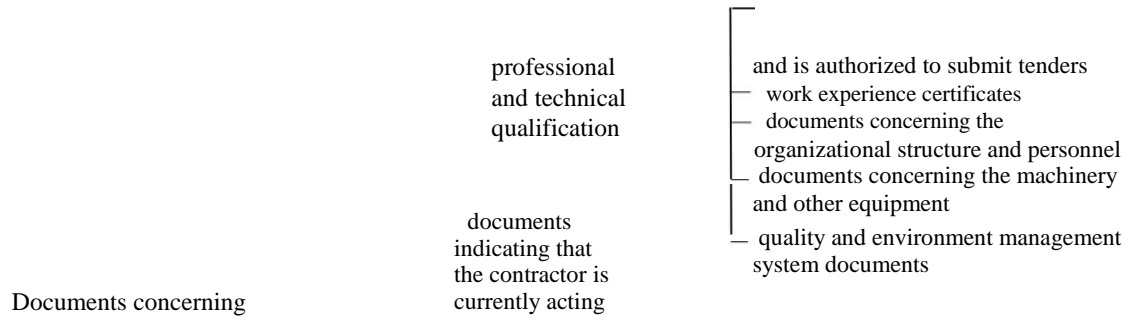


Figure 2: AHP model for contractor selection

Once the hierarchy structure is established, the decision-making process can take place. The decision-maker derives ratio-scale priorities reflecting the relative importance of selection criteria via pair-wise comparisons. The pair-wise comparisons are done with respect to overall goal of the model: contractor selection. The comparison is based on a scale of 1 to 9 as per the definition of weights given in Table 1.

Hypothetical pair-wise comparisons are applied to the main criteria in the second level of the hierarchy with respect to the goal at the first level, as it is shown in Table 2. The decision maker assigned the bid price a weight of 3 compared with the documents concerning economic and financial qualification (EFQ) and documents concerning professional and technical qualification (PTQ). Thus, the decision maker considers the bid price to be moderately more important than the EFQ and PTQ when compared to the selection of a contractor. From this matrix, the normalized priority values of the three criteria can be computed. The priority values are shown in the last column of Table 2.

Table 2: Pair-wise comparison matrix for the main criteria

	BP	EFQ	PTQ	Priorities
BP	1	1/3	1/3	0.600
EFQ	3	1	1	0.200
PTQ	3	1	1	0.200

In a similar manner, the sub-criteria in the third level of the hierarchy are pair-wise compared to their associated factors at the second level. Thus, by this evaluation procedure, every criteria receives a normalized priority ranking relative to other associated criteria at the same level. The priority values of criteria in each matrix are shown in Table 3.

Table 3: Priority values of criteria for contractor selection

Main Criteria	Priority values of main criteria	Sub-criteria	Priority values of sub-criteria
Bid price	0.600	Bid price	1.000
Documents concerning the economic and financial qualification	0.200	documents obtained from the banks showing their unused portion of cash credit or unused portion of letter of credit	0.649
		balance sheets or equivalent documents	0.279
		documents indicating the workload	0.072
Documents concerning professional and technical qualification	0.200	documents indicating that the contractor is currently acting and is authorized to submit tenders	0.092
		work experience certificates	0.559
		documents concerning the organizational structure and personnel	0.152
		documents concerning the machinery and other equipment	0.152
		quality and environment management system documents	0.045

Accordingly, each bidder contractors can be added to the last level in the hierarchy. Then, the decision maker also apply pair-wise comparisons for the contractors. Then, the contractors can be prioritized. The contractor to be selected is the one attaining the highest priority value.

4. Conclusion

Contractor selection has been a debated issue for the project owners. Especially, in public construction projects, the owner is the government and the money needs to be spent carefully. In Turkish public construction procurements, the current practice is regarded as the lowest bidder

contractor is awarded the contract. However, other criteria and characteristics of the contractors should not be underestimated for an effective selection process for successful project outcomes. Using a multi-criteria approach for evaluating contractors not only with bid prices but also with respect to their economic, financial, professional and technical aspects can help the best/appropriate contractor selection.

In this paper, an AHP model was developed to facilitate the Turkish public construction sector to evaluate and select the best/appropriate contractor. The model considers bid price, economic and financial qualifications, professional and technical qualifications as the main criteria in making the final decision. Other criteria can be added to the model according to the owner's requirements. Since each construction project is unique, AHP gives owners the flexibility to add or reduce the criteria in the hierarchy with respect to the goal of contractor selection. The hierarchy design and evaluation allow the project owner to determine the relative contribution of each of the criteria to the final decision. Thus, the decision reflects not only the bid price, but also other criteria, owner's needs and preferences. Finally, the selected contractor would be the best/appropriate bidder, but not the lowest bidder.

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