Standardization of Bid Evaluation for Construction Projects

Hesham A. A. Khalek[1], Remon F. Aziz[1], Dina B. Saad[2]

[1]Structural Engineering Department, Faculty of Engineering,
Alexandria University, Alexandria, Egypt.

[2] M.Eng. Candidate Engineer, Structural Engineering Department, Faculty of Engineering, Alexandria University, Alexandria, Egypt.

ABSTRACT

Selection of an appropriate bid for construction projects in Egypt is of a major concern for organizations. Without a proper and accurate method for selecting the most appropriate bid, the performance of the project will be affected. So in this paper, different methods of bid evaluation are reviewed from literature including all of their affecting parameters. As the decision making to select a bid is a very complicated process, involving the considerations of different criteria so, this paper proposes systems that can assist in the process of decision process of ranking contractors, for that the weighted criteria method and the analytic hierarchy method are studied and applied in three different case studies of construction projects. The availability of the two methods is applied and results are analyzed and the analysis led to some interesting findings that reflect on the current practice of application range for both methods and also results are compared to achieve the best bid accompanied with recommendations of different application ranges.

Keywords: Bid evaluation, Construction Projects, Weighted Criteria method, and Analytic hierarchy method.

Introduction

The technological development of the world and accelerated growth of construction projects make a great competition in their field, so all competitive construction companies always surveying about how to remain strongly in market and should be creative to be able to achieve their goals. Cost reduction and quality improvement are the main competitive assets for an organization. Therefore, when it comes to taking an action in these matters, companies tend to analyze their activities accurately in order to give priorities to the most essential ones, while, for other secondary matters they tend to assign them to a contractor. By doing this, the outsource action then becomes an independent industry which lead to the issuing of rules and criteria for selecting the best bids whose capabilities are compatible with the organizations' requirements. Consequently this research discusses outsources, bid evaluation and criteria for selecting the best bid and find the right methodologies in dealing with bidders. Decision making is a principal daily life activity that has to be done by the managers and directors of construction projects regardless of their managerial level. However, the significance of their decisions varies according to those managerial levels. There are two different inputs/principles for decision making which are the self-decisions and organizational-decisions besides the quantitative inputs of taking decisions based on specific criteria.

Research objectives

The aim of this research is to help managers make the best and most suitable decisions by using two methods which are the "weighted criteria" method and the "analytical hierarchy process" method designated as "AHP". They work by doing comparisons between the different alternatives based on previously adopted standards.

Also the objectives of this research is to determine the selection criteria of the right bid according to the organizations' activities, and come up with results that address the (advantages and disadvantages /strengths and limitations / weaknesses and strengths) of using the scientific methods.

Literature review

In this part a brief of previous work for different bid evaluation methods and criteria for selecting the best bid were reviewed as listed in table (1).

Table (1): Summary of past works:

Methodology	Researchers
Defined bid evaluation as a decision-making process	**Russel and Skibiniewski (1988)**
Identified five main elements as common factors in the contractor selection process for all types of procurement arrangements	**Hatush and Skitmore (1997)**
(The weighted criteria method) proposed a modified quantitative model for selecting contractors	**Holt et al. (1993)**
The ability of AHP to measure and synthesize the multitude of factors in a hierarchy is outstanding	**(Forman and Gass 2001)**
The AHP enables people to refine their definition of a problem and improve their judgment and understanding through repetition	**Thomas Saaty (2010)**
Computation complexity: With an increasing number of criteria in one level the number pairwise comparisons and individual calculations increases exponentially	**(Götze 2008)**
Another advantage of AHP over other methods is that a consistency check is integrated in the procedure. Only decisions and evaluations with a defined consistency are acceptable. Others decisions and evaluations might be at random.	**(Meixner and Haas 2002)**
Hierarchical structure of contractor selection	**Fong and Choi (2000)**

METHODOLOGY

Bidding and the bid evaluation Process, which involve invitation to bid and bid submission as well as the technical, contractual and financial appraisal of the submitted bids, is particularly vulnerable to a variety of schemes that result in fraud and agreement corruption.

The weighted criteria method

The weighted criteria method of bid evaluation requires that selection criteria in addition to price are included in tender documents and form part of the tender assessment process. A system of weighting the selection criteria is used to compare bids and identify the bidder with the best performance record in terms of time, cost and value for money.

Evaluation criteria must be developed, reviewed and approved before the competitive process begins. The bid documents must fully disclose the evaluation methodology, criteria and weightings, and the process to be used in assessing submissions. The criteria and weightings to be used must be selected so that the most appropriate criteria are used to review the bids. The best value for money outcome is the one that reflects the requirements of the particular project. If the project is highly technical or difficult, emphasis should be placed on the weightings of the total of the non-price criteria and the sub-attributes of technical skills and methodology. If the project is made up of multiple separable parts and requires a number of trade skills as subcontracts, then a higher weighting should be given to management skills.

Selection criteria must be comprehensive and cover all the information required to allow the bid evaluation to take place. Only information provided by the bidder in response to the selection criteria, and other information requested in the bid documents, is permitted to be used in the bid evaluation.

Table (2): The weighting range for Selection Criteria should be within the following:

Range	Criteria	Minimum- Maximum
Non-Price		**10-40%**
	Relevant Experience	5-20%
	Past Performance	5-20%
	Technical Skills	0-20%
	Resources	0-20%
	Management Skills	0-20%
	Methodology	0-20%
Price		**60-90%**

Table (3): Average Weights Used for Bid Evaluation Classified by Project Types:

	Buildings	Utilities	Industrial	Elec.Mech.	Others
Technical (%)	31	40	43	48	50
Financial (%)	69	60	57	52	50

Table (4): Average Weights Used for Bid Evaluation Classified by Project Size:

	<1 M	1-5 M	5-10 M	10-20 M	> 20 M
Technical (%)	0	30	32	38	40
Financial (%)	100	70	68	62	60

Scoring "Non-Price" Criteria

The evaluation procedures are as follows:

1. Add the individual scores for each non-price criterion. Each criterion is given a point score from 0 (poor) to 10 (excellent) in increments of 0.5.

2. Weigh the individual scores for each non-price criteria according to the pre-determined weightings. The weighted score is calculated by multiplying the score by the weight. In the example given below, the weighted score for tender 1, criteria 1 is calculated as 9 x 20% = 1.80.

3. The sum of non-price scores for each tender is then normalized to 10. Normalizing is a transformation applied uniformly to each element in a set of data so that the set has some statistical property.

4. The following formula is applied to normalize the non-price scores

   = (Sum of non-price score for each tender x 10)/ Highest sum of non-price scores

5. This score is then adjusted for the total weighting of all the non-price criteria to obtain the overall weighted non-price score.

The highest non-price total score is given a score of 10 and the other sums are ranked accordingly in proportion.

Scoring Price

Scores for price are based on the following method: (Note that the lower the price, the higher the score.)

$$\text{Normalized price score} = \frac{\text{lowest bid price} \times 10}{\text{Bid price}}$$

Total Scores

Total score = Scoring "Non-Price" Criteria + Scoring Price

Equivalency Rule

When the difference between the first and second ranked scores is less than 3% the lowest price bid of the two is taken as the preferred bid unless there are extraordinary reasons for not doing so.

The "3% rule" is based on a statistical review of the variances in the subjectivity of the evaluation committees' individual scoring.

The Analytic Hierarchy Process (AHP) method

The Analytic Hierarchy Process (AHP) was developed in the seventies by Thomas L. Saaty. Generally defined the AHP is a procedure for structuring and dissolving multi-criteria decision problems (Meixner and Haas 2002). As the name implies, objectives and criteria are structured analytically in a hierarchical order. Analytic means that the decision problem is analyzed mathematically by means of logical conclusions (Zimmermann and Gutsche 1991). Furthermore the name stresses the procedural character of AHP (Gotze 2008). Different alternatives are compared with regard to criteria in a pairwise mode with a fundamental scale of absolute numbers which has been proven in practice and validated theoretically. This procedure converts individual preferences into ratio scale weights. Like this for each alternative a linear additive weight can be obtained which can be used to rank the alternatives and thus support the decision-making (Forman and Gass 2001). In Fig (1) the three main levels of the typical AHP hierarchy objective, criteria and alternatives are depicted.

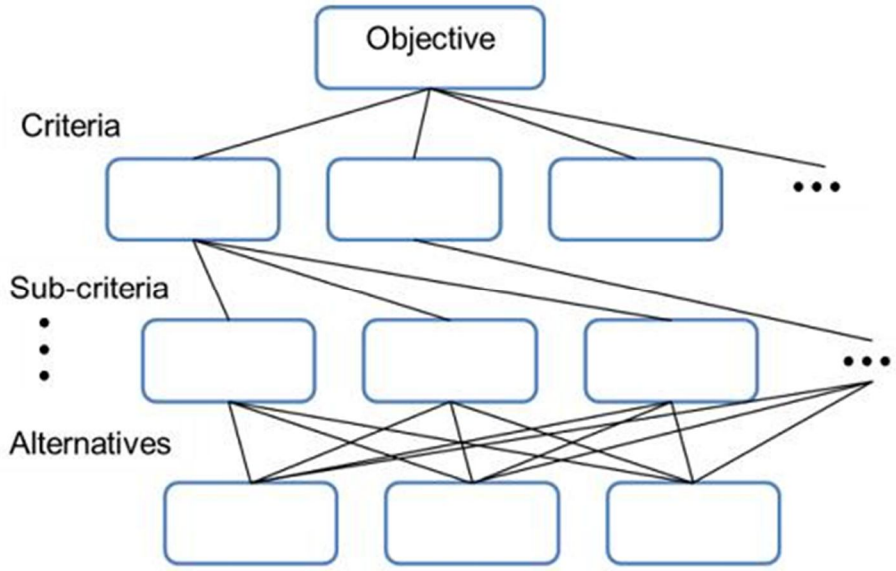

Fig. (1): Analytic Hierarchy Process typical hierarchy

The general AHP procedure is depicted in form of a flow diagram as shown in Fig (1).

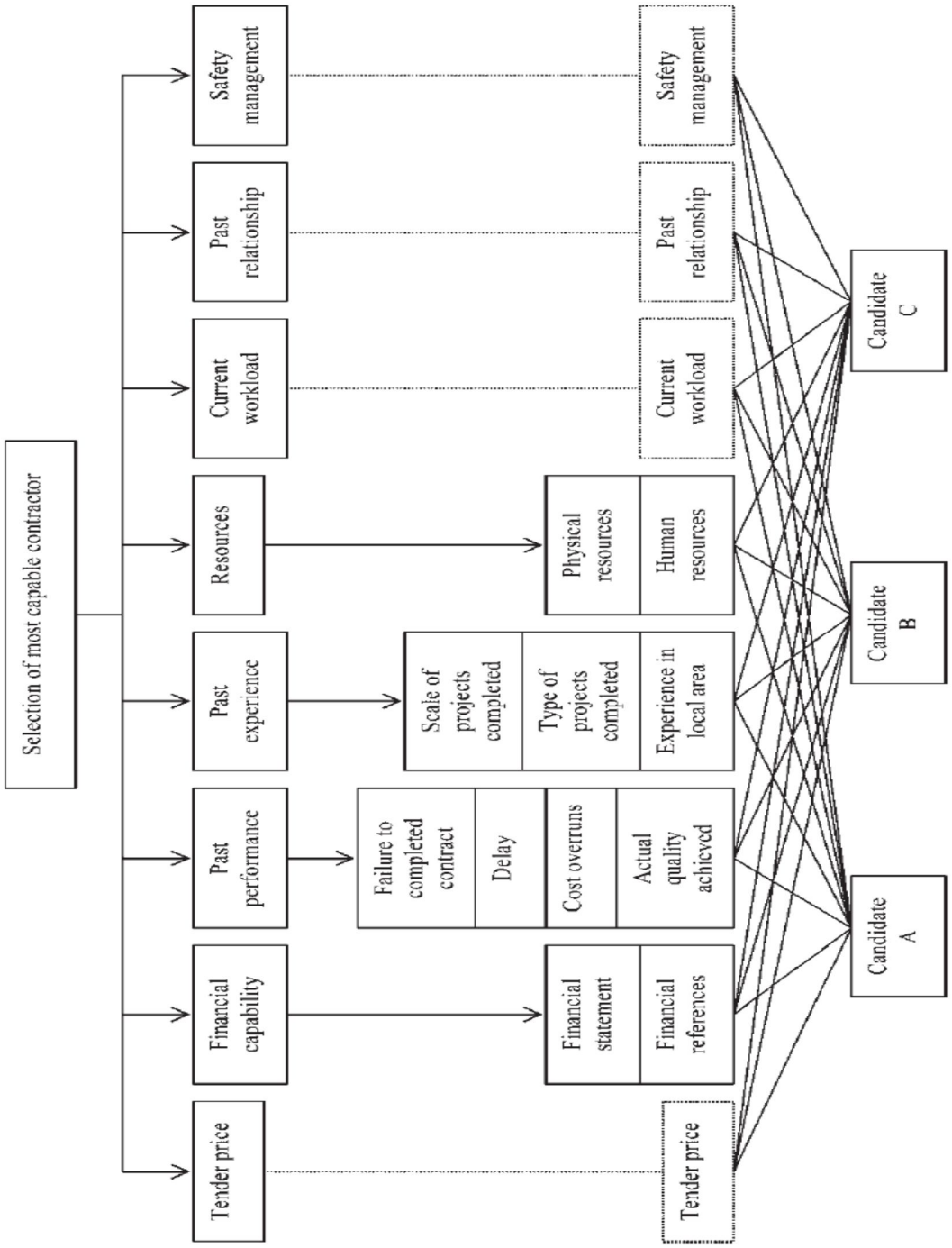

Fig (2): Hierarchical structure of contractor selection (source: Fong and Choi, 2000)

Saaty developed the following steps for applying the AHP:

1. Define the problem and determine its goal.
2. Structure the hierarchy from the top (the objectives from a decision-maker's viewpoint) through the intermediate levels (criteria on which subsequent levels depend) to the lowest level which usually contains the list of alternatives.
3. Construct a set of pair-wise comparison matrices(size n _ n) for each of the lower levels with one matrix for each element in the level immediately above by using the relative scale measurement shown in Table(5). The pair-wise comparisons are done in terms of which element dominates the other.

Table (5): Pair-wise comparison scale for AHP preferences, AL-Harbi (2001)

Numerical rating	Verbal judgments of preferences
9	Extremely preferred
8	Very strongly to extremely
7	Very strongly preferred
6	Strongly to very strongly
5	Strongly preferred
4	Moderately to strongly
3	Moderately preferred
2	Equally to moderately
1	Equally preferred

4. There are n (n-1)/judgments required to develop the set of matrices in step 3. Reciprocals are automatically assigned in each pair-wise comparison.
5. Hierarchical synthesis is now used to weight the Eigen vectors by the weights of the criteria and the sum is taken over all weighted eigenvector entries corresponding to those in the next lower level of the hierarchy.
6. Having made all the pair-wise comparisons, the consistency is determined by using the Eigen value, 1max, to calculate the consistency index, CI as follows: CI=(λmax-n)/(n-1)., where n is the matrix size. Judgment consistency can be checked by taking the consistency ratio (CR) of CI with the appropriate value in Table (6). The CR is acceptable, if it does not exceed 0.10. If it is more, the judgment matrix is inconsistent. To obtain a consistent matrix, judgments should be reviewed and improved.

Table (6): Average random consistency (RI), AL-Harbi (2001)

Size of matrix	1	2	3	4	5	6	7	8	9	10
Random consistency	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

7. Steps 3±6 are performed for all levels in the hierarchy.

CASE STUDY

Case study (1)

The execution of project for curtain wall facades and Alucobond sheets for hospital building in Egypt with the following items:

1. Supplying and erection of outside facades of semi structure glazing mechanical surface glass consists of aluminum sectors (as in approved sample) and secoreet glass gray reflection (6mm thickness) produced by Gliver bell or similar company with total flats of 720 m^2
2. Supplying and erection for covers of building facades and students services building in hospital made of Alucobond sheets (4 mm thickness) imported (vertical and horizontal).
    i. Golden color with total flats 140 m^2
    ii. Silver color with total flats 20 m^2
3. Supplying and erection for cylindrical covers (circular covers) of building facades and students services building in hospital made of Alucobond sheets (4 mm thickness) imported with total flats 20 m^2.
4. Supplying and erection of prominent horizontal breakers for international education building facades and students services building with total length 275 m

The factors that will be used in the project in hospital and the breakers made of Alucobond sheets (4 mm thickness) imported. Examples for prequalification are experience, financial position, past performance, samples and types, special conditions and payment conditions.

Table (7): Presents a project example for which bids A, B and C wish to prequalify. (Case study 1)

Bids	Bid A	Bid B	Bid C
Total price	2951500 L.E	1775500 L.E	1702625 L.E
Experience	11 years	35 years	9 years
Financial position	20000000 L.E	20000000 L.E	20000000 L.E
Past performance	90%	60%	88%

Samples and types	Accepted Aluminum: Hartman Facades: HE600 Doors: HE400 Glass:6mm gilnerbel Accessories: European Cobond: star bond Rubber :HPDM	Accepted Aluminum: PS Facades; semi structure Glass: sphinx Local production Accessories: European Cobond: well bond	Accepted
Special condition	No scaffolding, Electricity source and safe Store	No scaffolding, Electricity source and safe Store	No scaffolding,
Payment condition	50%prauider contract 75% Aluminum Supplying without glass 85%glass supplying 95% Installation in site 100%primary receipt	30%prauider contract 75% Aluminum Supplying without glass 85% Installation Aluminum without glass in site 100% Installation glass in site.	35%prauider contract

Table (8): Comparison between weighted criteria and AHP method for case study (1)

Bids	**The weighted criteria method**	**AHP Method**
Bid (A)	7.00	0.508
Bid (B)	9.54	0.239
Bid (C)	10.00	0.253
	Bid (C)	Bid (A)
———————————		CR=CI/RI =0.104 > 0.1 no satisfactory
Bid (C)	The weighted criteria method	

Case study (2)

The execution of structure project for school building in Egypt with the following items:

Total area of school is 522 m^2including 324m^2 for buildings and the school building consisting of ground floor and 4 upper floors contains 12 classes and security room of 5 m^2 and the remaining space is for school yard. The executed work is as follows:

General site work, repair work, structure of guard room, stadiums work, earthy work, concrete work, interior finishing work (painting and flooring), building work, insulation work, covering work, marble work, sidewalk work, wooden work, iron and Creteil work, aluminum work, sewage work and electrical work.

The factors that will be used in the project example for prequalification are experience, financial position and past performance.

Table (9): Presents a project example for which bidders' I and Π wish to prequalify. (Case study 2)

Bids	Bid I	Bid Π
Total price	3606704.85 L.E	3786120 L.E
Experience	7 years	13 years
Financial position	1000000 L.E	1300000 L.E
Past performance	70%	90%

Table (10): Comparison between weighted criteria and AHP method for case study (2)

Bids	The weighted criteria method	AHP Method
Bid I	10.00	0.794
Bid II	8.82	0.206
	Bid (I)	Bid (I)
———————————		CI=0.080 CR=CI/RI =0.089< 0.1satisfactory
Bid (I)	The weighted criteria method AHP Method	

Case study (3)

The execution of project to structure for government building on about 1000 m^2 and 15 m height and includes ground and 4 upper floors, ground floor contains parking area of 50 cars. Curtain wall facades are required with cornices around windows of G.P.C material, the building includes elevators, air conditions and upper water tanks made of polyethylene in Egypt with the following items: Execution of construction, concrete, spacers and building work, interior finishes (painting, flooring and marble), wooden work, aluminum work, fabricated iron, exterior finishes work, general site work, sewage work, fire alarm work, acoustics work, electrical work and network activities.

The factors that will be used in the project example for prequalification are experience, financial position and past performance.

Table (11): Presents a project example for which bidders' X and Y wish to prequalify. (Case study 3)

Bids	**Bid X**	**Bid Y**
Total price	9 791 928.25L.E	11 851 815 .58L.E
Experience	26 years	26 years
Financial position	30 000 000L.E	20 000 000L.E
Past performance	70%	90%
Payment condition	25%prauider contract	25%prauider contract

Table (12): Comparison between weighted criteria and AHP method for Case study (3)

Bids	**The weighted criteria method**	**AHP Method**
Bid X	9.82	.444
Bid Y	8.78	0.556
	Bid (X)	Bid (Y)
———————————		CI=0.098 CR=CI/RI =0.088<0.1 satisfactory
Bid (Y)	AHP Method	

Conclusion:

In this research, three case studies were applied using the weighted criteria method and the Analytic Hierarchy Process (AHP) method. Both methods were applied to replace the old methods of bid evaluation and selection which relied only on the lowest price of bidder regardless of other important parameters.

1. In case studies of smaller values, the weighted criteria method was possible and more accurate as this method identifies the tender with the best performance record in terms of cost and value for money and also these types of projects need single stage tendering and simple method to be used as weighted criteria method so, AHP was not applicable in this type of projects as AHP dealing with complex issues.

2. For case studies of bigger values, the Analytic Hierarchy Process (AHP) method was applied as decision problems were analyzed mathematically with best quality and as AHP was chosen for its simplicity and transparency in multi criteria choice situations and also the AHP is a valuable tool for dealing with complex issues because it allows decision makers to decompose hierarchically the decision problem to its constituent parts so it is possible to large projects of complex parameters.

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