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Appropriate Contractor Evaluation Techniques in Construction Industry Based on Multicriteria Decisions

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Abstract:
Choosing a contractor is always be a major step in a construction project. For any construction client, choosing a suitable contractor is the most important aspects in construction projects. Objectives of contractors' criterion like experience, time of completion, bid value, safety and technical capability are needed to be kept in concern."Minimum bid value" should not be the only criteria of selection. This paper suggests MCDM (Multicriteria Decision Making Methods), which not only compares the contractors but also gives a pair wise comparison weights to the criterion for which the contractors are being selected. With this goal two methods, analytical hierarchy process (AHP) and techniques for order preference similar to ideal solution (TOPSIS) are being used. AHP will help in finding the weights of criterion and the weights of contractors compared pair wise, meanwhile TOPSIS will use the weight calculated by AHP in finding the solution closest to the possible ideal solution i.e "Contractor selection". Highest rank given by TOPSIS show the contractor is the best among all. In this Paper a case study is also to evaluate the efficiency of AHP and TOPSIS.

Keywords: Multicriteria Decision Making Methods, Analytical hierarchy process, Top for order preference similar to ideal solution.

1. INTRODUCTION

Opting a Contractor through various other contractor, who is the most appropriate contractor to deliver the project as specified so that satisfaction for best investment of amount is assured. Clients are becoming more active of the fact that choosing a contractor Only over the bid price criteria can be risky and can confirm the chance of failure of projects. Evaluation of contractors based on multiple criteria is, therefore, becoming more famous. Contractor selection in a multicriteria environment is, in essence, largely dependent on the uncertainty inherent in the nature of construction projects and subjective judgment of decision makers (DMs).

This paper presents a systematic procedure based on MCDM (Multi criteria decision making methods) to evaluate the capability of a contractor to deliver the project as per the owner's requirements. Quite often construction projects behind schedule, price changes and inappropriate quality are a direct outcome of the selection of inadequate contractor. There are few often considered causes of inappropriate contractor selection. Firstly unsuitable criteria are selected .Secondly, unsuitable importance to limited criteria (e.g. to bid value).Thirdly, inappropriate techniques is used for the selection of the contractor.

Various research works have been done for the same job i.e. best selection of contractor. Contractor's qualifications (i.e. past experience in similar job, technical capability, financial status and experience of management on site etc) and project characteristics (i.e. type, duration, contract type, location, resources and variation between the contractor's bid value and the next lower bidder's price etc) are the fundamentals factor of selection [1].In construction projects, quality performance of contractors is considered as vital for client satisfaction [2]. The need for such research has emanated because of increasing construction project complexity and uncertainty, increasing client's expectations and demands, increased competition, and higher performance requirements (Wong 2004) [3].

Some methods require somewhat vague, i.e., not crisp, input and/or judgment from the decision makers. The analytical hierarchy process works well when the available data for the decision makers are difficult to quantify or when it is necessary to rely on expert opinions or preferences in some intangible aspects. However, the method has been frequently criticized for its inability to adequately accommodate the inherent uncertainty and imprecision associated with certain environments [4].

In this paper, two multicriteria decision-making methods are applied, the technique for order preference by similarity to ideal solution (TOPSIS) and the analytical hierarchy process(AHP).

The TOPSIS method is on the basis of the principle that the optimal point should have the shortest distance from the positive ideal solution and the farthest from the negative-ideal solution [5].

This method is, therefore, suitable for cautious decision makers that might like to have a decision that not only makes as much profit as possible, but also avoids as much risk as possible. The AHP method is on the basis of the particular measure of Comparisons of attributes and Comparisons of available alternatives. AHP will help to assign weight to attributes as well as to the alternatives (contractor).Therefore; these two methods

will together provide a solution to ideal solution with a effective optimum weightage.

2. OBJECTIVE OF THE RESEARCH

To use the criteria as an important parameters for the selection of Contractor along with the decision support system using multicriteria decision making system.

a) To collect the knowledge about the various approaches for the selection of contractor used by the clients.

b) To examine the criteria, and define the prior criteria which affect the selection of contractor.

c) To generate theoretical prototype that examine the criteria and explore them by opting the best alternative (contractor) based on MCDM.

3. METHODOLOGY

To determine how well each contractor scores for each qualitative criteria, AHP (Saaty 2000) will be used.

The steps are explained subsequently as follows:

1. Contractor's score is evaluated for each objective with respect to each criterion. A pair wise comparison matrix for each criterion using a scale of relative importance. The remarks are entered using the fundamental scale of the AHP.

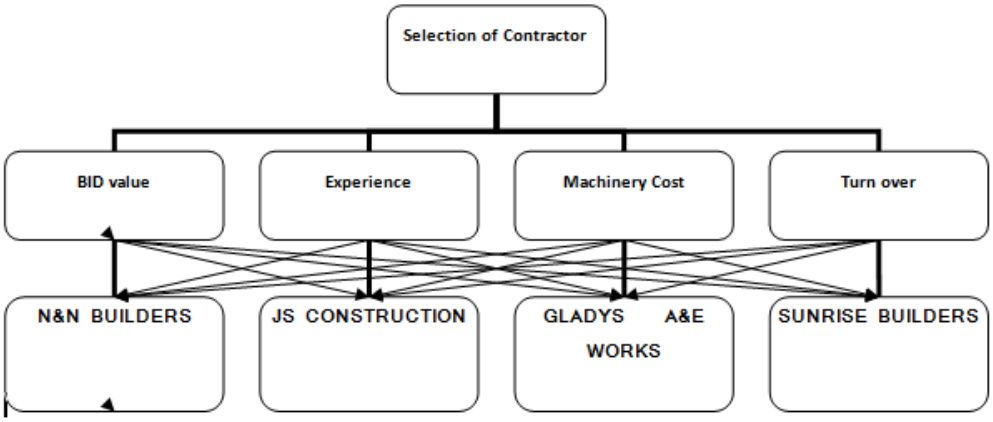
2. Pair wise Comparison Scale for AHP Preferences

cale	**Remark**
9	Extremely preferred
8	Very strongly to extremely
7	Very strongly preferred
6	Strongly to very strongly
5	Strongly preferred
4	Moderatly to strongly
3	Moderately preferred
2	Equally to moderatly
1	Equally preferred

***Case Study*:** A famous region of Kerala state of India, there is district names Kollam where a hospital was to be constructed. Hospital had to be facilitated with Cancer treatment block. Mainly four contractors came for participation. We mainly judge these four contractors over four criteria;

1. Bid value
2. Experience
3. Machinery Cost
4. Turn Over

3. Design a set of pair wise comparison matrices (size n x n). The pair-wise comparisons are done in terms of which element is prior than the other. There are n (n-1) / judgement required to develop the set of matrices in step 3. Reciprocals are automatically assigned in each pair-wise comparison.



3. Weight the eigenvectors 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 comparision.

TABLE.1. CONTRACTOR CRITERIA

	BID VALUE	**EXPERIENCE (in Years)**	**MACHINERY COST**	**TURN OVER**
N&N BUILDERS	65Cr	27	4.0Cr	350Cr
JS CONSTRUCTION	71Cr	19	4.2Cr	250Cr
GLADYS ARCHITECTS & ENGINEERING WORKS	60Cr	21	5.1Cr	550Cr
SUNRISE BUILDERS	62Cr	30	7.3Cr	600Cr

5. Compute the λmax by dividing sum of row elements by the average of all elements i.e. (weights).

6.After all pair-wise comparisons, the consistency is determined by using the Eigen value, λ max , to calculate the consistency

index, CI as follows: C.I.=(ƛmax-n) / (n-1) where n is the matrix size. consistency can be checked by taking the consistency ratio (CR) of CI with the suitable value. The CR is acceptable, if it does not exceed 0.10. If it is more, the comparision matrix is inconsistent. To gain a consistent matrix, comparision values should be redesign and improved.

7. Now using TOPSIS (Top for order preference similar to ideal solution)

8. Calculate the normalized decision matrix (Rij)

Rij= Fij/(sqrtΣFij^2) j=1,…..j i=1…..n

J= number of alternatives

i=number of criteria, Fij=value of the j alternative for the i criteria.

TABLE.2. DECISION MATRIX

	BID VALUE	**EXPERIENCE**	**MACHINERY COST**	**TURN OVER**
BID VALUE	1	2	5	6
EXPERIENCE	1/2	1	3	2
MACHINERY COST	1/5	1/3	1	1/3
TURN OVER	1/6	½	3	1

9. Calculate the weight normalized matrix. The weighted normalized value Aij is calculated as

Aij=Wi*Rij.

TABLE.3.NORMALIZED MATRIX

.54	.52	.42	.64
.27	.26	.25	.21
.11	.09	.08	.04
.09	.13	.25	.11

TABLE.4. WEIGHT CRITERIA

Criteria	**BID VALUE**	**EXPERIENCE**	**MACHINERY COST**	**TURN OVER**
weight	.53	.25	.08	.14

10. Determine the Ideal(B*) and the negative ideal(B-) solutions

B*={A1*……,An*} {(max value of Ai)}

B-={A1-……An-} {(min value of Ai)}

TABLE.5. WEIGHT NORMALIZED MATRIX

Bid value

1	3	1/2	1/2
1/3	1	1/3	1/3
2	3	1	1
2	3	1	1

Experience

1	1/3	1/2	1/2
3	1	1/2	1/2
2	1	1	1
2	2	1	1

Machinery Cost

1	1	1/2	1/4
1	1	1/2	1/4
2	2	1	1/2
4	4	2	1

Turn over

1	½	1/3	1/4
2	1	1/4	1/5
3	4	1	½
4	5	2	1

TABLE.6. WEIGHTS FOR EACH QUALITATIVE CRITERION

	Bid value	**Experience**	**Machinery cost**	**Turn Over**
Contractor 1	.21	.14	.13	.09
Contractor 2	.10	.26	.13	.13
Contractor 3	.35	.27	.24	.30
Contractor 4	.34	.33	.50	.48

TABLE.7. WEIGHT NORMALIZED MATRIC FOR EACH CONTRACTOR CRITERION

0.111	0.035	0.010	0.013
0.053	0.065	0.010	0.018
0.186	0.068	0.019	0.042
0.180	0.083	0.040	0.067

TABLE.8. IDEAL (A*) AND NEGATIVE IDEAL (A-) SOLUTIONS

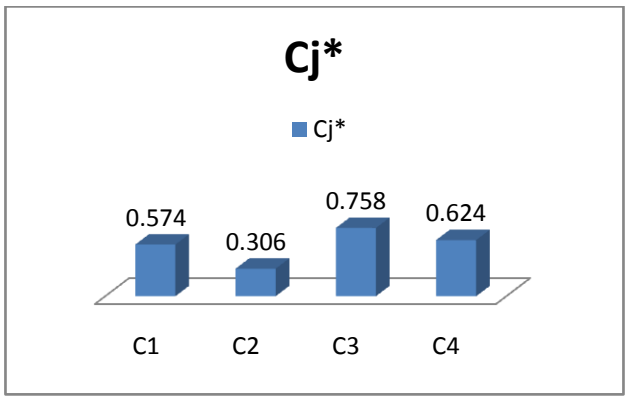
	Bid value	Experience	Machiney cost	Turn over
	min	max	max	max
Vi*	.053	.083	.04	.067
Vi-	.186	.035	.01	.013

11. Calculate the separation measures, and the relative closeness to the ideal solution (Cj*). The separation of each alternative from the ideal solution, from the negative ideal solution, and the relative closeness of the alternative aj wrt A*
Are given by
Dj*=sqrt(Σsq(Aij-Ai*) i=1 to i=n.
Dj-= sqrt(Σsq(Aij-Ai-) i=1 to i=n
Cj*=Dj-/(Dj-+Dj*).
12. Rank the preference order. Rank the alternatives by value of Cj* in decreasing order. With the maximum value of Cj* will be marked as best solution.

4. RESULT

TABLE.9. SEPRATION MEASURES (Dj*,Dj-) AND RELATIVE CLOSENESS TO IDEAL SOLUTION (Cj*) AND RANK

	Contractor 1	Contractor 2	Contractor 3	Contractor 4
Dj*	.10	.06	.14	.13
Dj-	.07	.14	.04	.08
Cj*	.574	.306	.758	.624
RANK	3	4	1	2



***Contractor 3 will be selected**

5. CONCLUSION

Inappropriate decision during selection of contractor will lead to the failure of construction projects. Suitable criteria with perfectly matched techniques of finding the best solution for the selection of contractor should be adopted. MCDM (Multicriteria decision making methods) will help in choosing the best alternative. This theoretical model will provide an idea about how an important criteria plays a vital role in selection of best solution.

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