CONTRACTOR SELECTION WITH RISK ASSESSMENT BY USING AHP FUZZY METHOD

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ABSTRACT

Contractors play an important role in any construction project. Perhaps the most important decision is the selection of contractor by the employer prior to the implementation of the project. Contractor selection process is associated with increased risk for employers. Therefore, employers always try to reduce the risk. High Impact of contractor on cost, time and quality of project, refers to the role of contractor in the project. In this study, for contractor selection unlike the conventional methods that are based on lowest value suggested for the project implementation, the selection of a contractor is based on the contractor's ability to do the project. The potential contractors using the contractor eligibility bylaw. In this paper, combination of the risk management process and fuzzy logic, have been used to identify and assess the risks of the contractors. After identifying riskthe factors and the evaluated using AHP fuzzy, Itis suggested that after obtaining weight, the fuzzy criteria and competence score for each contractor is obtained. Finally, very few qualified contractors will implement the project. This applied model can be help the employers, till the implementation of the project by the contractor would face little risk.

KEYWORDS: *Risk Assessment, Criteria, Contractor, AHP fuzzy.*

I. INTRODUCTION

Road Construction projects are part of the largest and most important sectors in the construction industry. It has full of large and small risks. They should have a special plan for them. Risk management is an important part of knowledge management and especially project management, which is responsible for improving the reliability.

One of the risks in construction projects is choosing the wrong contractors which have a significant impact on financial resources of the project. In this study, unlike conventional methods of contractor selection, based on the lowest bid tendering, contractor selection is based on the ability of each contractor to carry out the project.

This research proposes a simple multi-criterion system to assist in the decision process for risk assessment for ranking the contractors. This system uses methods that are based on the theory of fuzzy logic. This suggested model, which introduces various criteria for the evaluation of contractors, first calculates each criterion's fuzzy weight. Then, to evaluate the contractors' suitability with regard to each criterion, the model utilizes triangular fuzzy numbers. Next, it uses the fuzzy weighting (AHP) method to rank the contractors. Finally, the sensitivity of the proposed model is analyzed by implementing it in a real road construction project.

II. BACKGROUND

Owing to the important role of contractors in construction projects, selecting a contractor, whichinvolves a substantial amount of risk, is one of the most important initial decisions taken by

owners. The delay or stoppage of construction activities because of the disqualification ofcontractors has wasted a considerable amount of resources in some countries. Statistics show that a large portionof resource impairment is a consequence of choosing the wrong contractors. Usually when choosing acontractor, the focus is on the minimum price. However, this creates tremendous problems in theconstruction phases. Thus, Iranian public sector owners have concluded that it is insufficient tomerely use the lowest bid as the sole criterion for selecting a contractor. Thus, it seems to benecessary to utilize models that consider other necessary criteria. This research proposes a simple multi-criterion system to assist in the decision process for risk assessment for ranking the contractors. This system uses methods that are based on the theory of AHP Fuzzy logic.

III. RISK

Risk is indecisive phenomena and its conditions if realized have a impact positive and negative on goal of project. Risk management is a systematic process of identifying, analyzing and responding to the project risk. The process of risk assessment includes:
Identifying the risk, Qualitative and Quantitative risk assessment risk, Response planning and Seek and Control Risk.

3.1. Regulations and identifying the qualified contractor:

The provisions within these regulations are used to identify the qualified contractors. The contractors then work on the projects which are funded from the state general fund.

IV. ANALYSIS

Theory of fuzzy logic

Mr. Lotfizadh has presented the concepts of fuzzy sets and non-pungent and non-transparent boundaries. Logic based on the concept of fuzzy sets, in which membership is expressed in varying probabilities or degrees of truth that is, as a continuum of values ranging from 0 (does not occur) to 1 (definitely occurs).

4.1. Fuzzy Analytic Hierarchy Process 'FAHP

AHP is one of the most famous multipurpose decisions techniques, as presented by Thomas L. Saaty. AHP reflects the natural behavior of human thinking. This technique is based on the complex issues cross examines them and converts them in a simple way to solve.
AHP is based on three elements:

a) Principle to trace the hierarchical tree.
b) Codification of principle and priorities definition
c) Consistency principle and logical judgments.

The fuzzy AHP technique can be viewed as an advanced analytical method developed from the traditional AHP. Chang (1992) introduces a new approach for handling of pair-wise comparison scale based on triangular fuzzy numbers, followed by the use of extent analysis method for synthetic extent value of the pair wise comparison (Chang, 1996).
The first step in this method is to use triangular fuzzy numbers for pair wise comparison by means of FAHP scale and the next step is to use the extent analysis method to obtain the priority weights by using synthetic extent values.

Table 1: Time convertor function

Linguistic variable	Triangular fuzzy number
Equal	(1،1،1)
Very low priority	(1،2،3)
Low higher	(2،3،4)
Good	(4،5،6)

Very good	(6‹7‹8)
Absolute priority	(8‹9‹10)

The following section outlines the Chang's extent analysis method on FAHP.
As per Chang (1992, 1996) each object is taken and analyzed for each goal. The numbers used in this procedure are fuzzy triangular numbers. Therefore M extent analysis values for each object can be obtained.

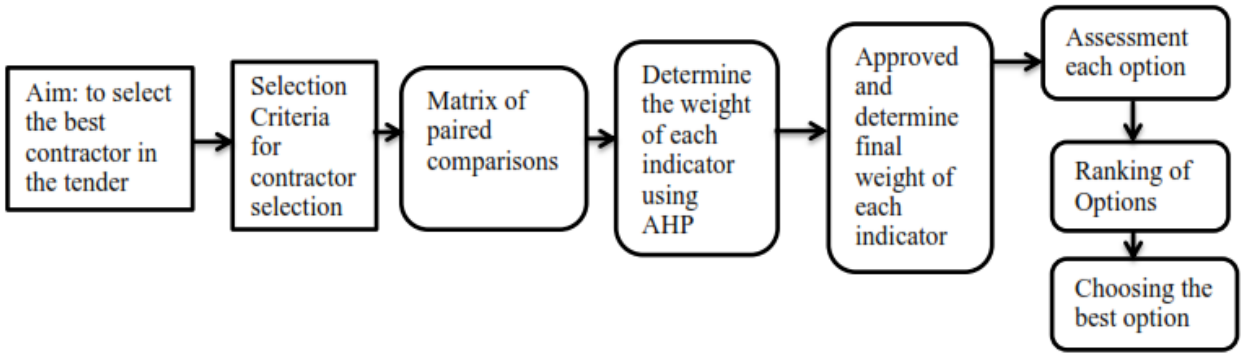

Figure 1: The Structure of the Proposed Model

V. CASE STUDY

To choose the best contractor for the construction project the steps involved shown in the figure 1 above. There are three organizations for the implementation of the project. One of these three organizations is graded as one according of the law of competence and the other two are graded as three.

Step 1: Identifying the Risk

In this step we need to identify the risks involved. once the risks are identified based on the law they from the eligibility criteria for the contractors. In this particular study we identified the following risks for chosing the contactor. As shown in fig 2.

(a) Expertise (c_1) (b)Financial ability (c_2)
(b) Managers and staff (c_3) (d)Executive Records (c_4)

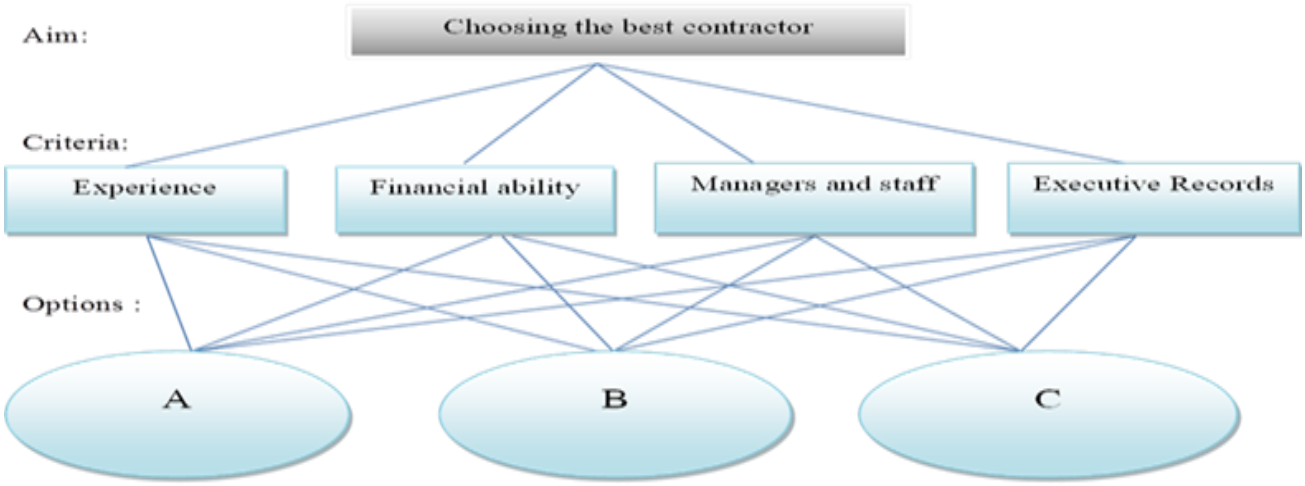

Figure.2 Hierarchical Tree structure

Step 2: Risk Analysis

In this step of analysis we need to rate the risks we have choosen to a scale. To assess the risks involved they are graded into five categories. They are very low(VL), low(L), medium(M), high (H) and very high (VH). Using this categorization we can now analyze the three organization for the risks identified earlier. Table 2 shows the risks of the various contractors and their degree of variation of the risks involved.

Table 2: Criteria of selection

Criteria	Expertise	Financial ability	Managers and staff	Executive Records
Contractor				
A	M	VH	H	H
B	L	H	H	M
C	M	H	H	M

The above criteria of the risk are now compared as AHP and are shown in Table 3. Each of the risk which are identified are compared for all the three companies and fuzzy logic numbers are assigned as shown in table 4,5,6 and 7.

Table. 3 Comparisons of AHP

Criteria	C1	C2	C3	C4
C1	(1,1,1)	(6,7,8)	(6,7,8)	(4,5,6)
C2	(1/8,1/7,1/6)	(1,1,1)	(6,7,8)	(4,5,6)
C3	(1/8,1/7,1/6)	(1/8,1/7,1/6)	(1,1,1)	(6,7,8)
C4	(1/6,1/5,1/4)	(1/6,1/5,1/4)	(1/8,1/7,1/6)	(1,1,1)

Table.4 Paired Comparisons Matrix of Alternatives for Expertise Risk

Expertise	Company A	Company B	Company C
Company A	(1,1,1)	(6,7,8)	(6,7,8)
Company B	(1/8,1/7,1/6)	(1,1,1)	(2,3,4)
Company C	(1/8,1/7,1/6)	(1/4,1/3,1/2)	(1,1,1)

Table.5 Paired Comparisons Matrix of Alternatives for Financial Ability Risk

Financial ability	Company A	Company B	Company C
Company A	(1,1,1)	(4,5,6)	(4,5,6)
Company B	(1/6,1/5,1/4)	(1,1,1)	(2,3,4)
Company C	(1/6,1/5,1/4)	(1/4,1/3,1/2)	(1,1,1)

Table.6 Paired Comparisons Matrix of Alternatives for Managers and Staff Risk

Managers and staff	Company A	Company B	Company C
Company A	(1,1,1)	(2,3,4)	(2,3,4)
Company B	(1/4,1/3,1/2)	(1,1,1)	(1,2,3)
Company C	(1/4,1/3,1/2)	(1/3,1/2,1)	(1,1,1)

Table.7 Paired Comparisons Matrix of Alternatives for Executive Records Risk

Executive Records	Company A	Company B	Company C
Company A	(1,1,1)	(4,5,6)	(4,5,6)
Company B	(1/6,1/5,1/4)	(1,1,1)	(2,3,4)
Company C	(1/6,1/5,1/4)	(1/4,1/3,1/2)	(1,1,1)

AHP fuzzy method is used to select the best contractor with respect to the above paired comparison matrices.
First, the coefficient of each of the paired comparisons matrix is calculated. As follows:
From Table 1
$Si=\sum^{n}_{J=1}M\kappa i \; X \; [\sum^{m}_{i=1}\sum^{n}_{J=1}Mij]^{-1}$
S_1= (0.34, 0.46, 0.621), S_2= (0.222, 0.302, 0.409)
S_3= (0.145, 0.189, 0.251), S_4= (0.029, 0.035, 0.045)
To calculate the degree si we use the relation:
$V (S_1 \geq S_2, S_3, S_4) = V[(M \geq M1) \text{ and } (M \geq M2) \text{ and } \ldots (M \geq Mk)] = \min V (M \geq Mi), (i = 1, 2, 3 ,., k)$
These numbers reflect the non-normalized weighted indexes C1, C2, C3, C4 are of table 9.
$W' = (1.65, 0.303, 0.484, 1)^T$
Thus, based on the relation $w_i=w_i' / \sum w_i'$, the normalized weights indicatorC1, C2, C3 and C4 are achieved:$W = (0.48, 0.088, 0.14, 0.29)^T$
The above steps are to be implemented for all the table to achieve the normal weights for all the risks.

Table .8 Normal Weights

Criteria / **Options**	**C_1** **0.48**	**C_2** **0.088**	**C_3** **0.14**	**C_4** **0.29**	**Coefficient of relative importance Options**
A	0.412	0.644	0.62	0.507	0.727
B	0.112	0.035	0.16	0.242	0.183
C	0.474	0.038	0.218	0.246	0.325

From the table 9 the contractor A has the coefficient of relative importance equal to 0.727, which is nearer to 1. This means contractor A has low risk and is the best among the three for the risks identified. The ranking for these tree contractors is **A>C>B**

VI. ANALYSIS OF RISK

The AHP fuzzy method is used to analyze all the three companies in terms of the four risks. The strength and weaken of each company for each risk identified is presented in the figure 3, 4, 5 and 6.

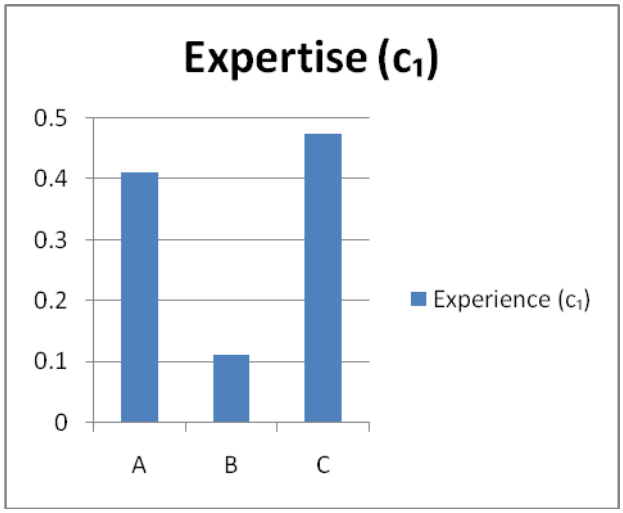

Figure.3 Expertise criteria

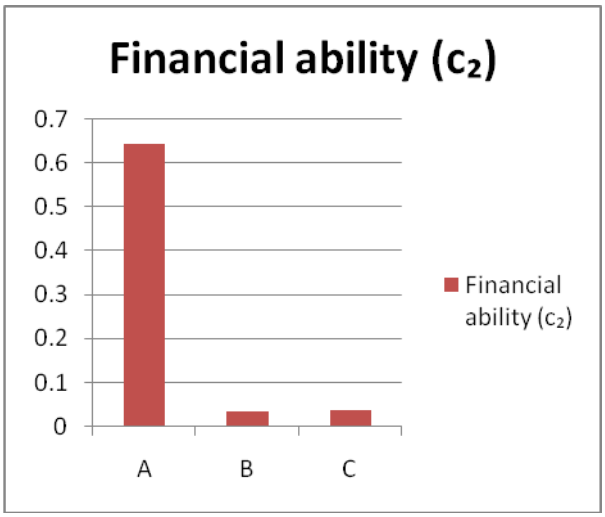

Figure.4 Financial ability criteria

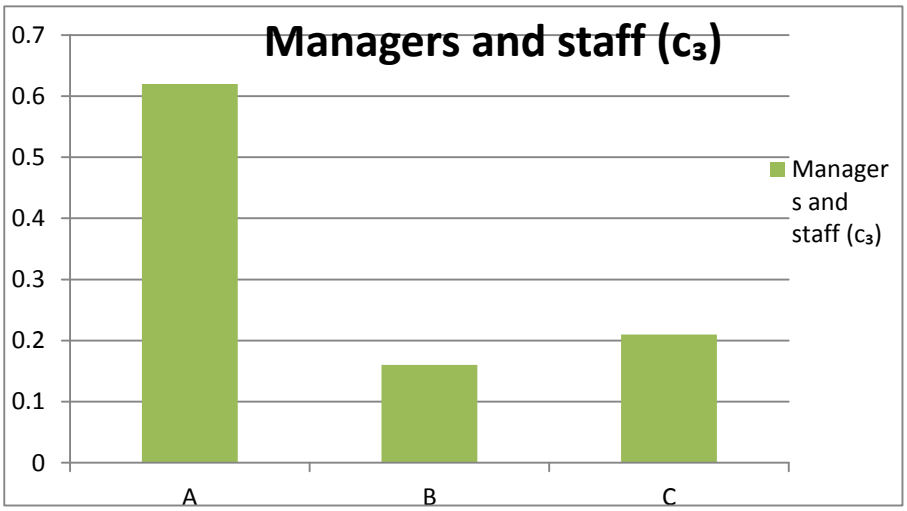

Figure.5 Managers and staff criteria

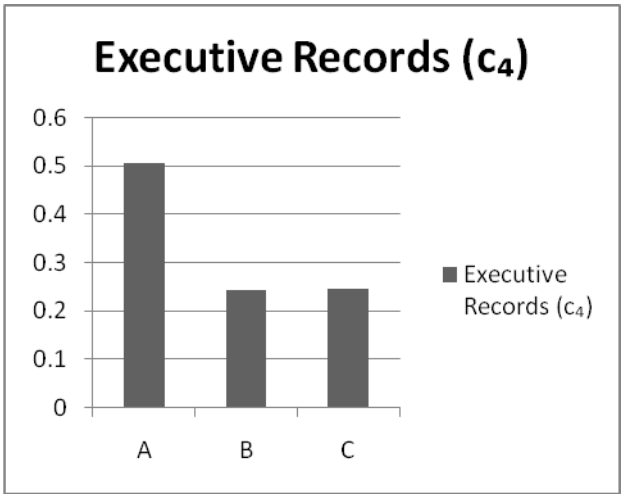

Figure.6 Executive records criteria

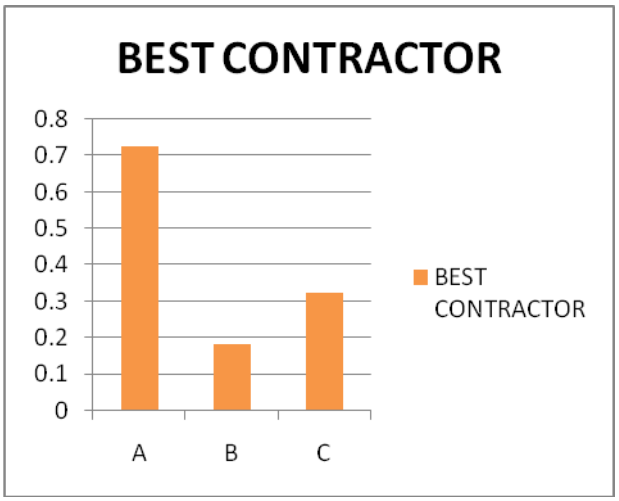

Figure.7 The best contractor based on the total weight criteria

From figure 3 it can be concluded that the company C has better expertise compared to the other two companies. For carrying out this particular project. The financial ability of the company A is better than the other two companies as shown in figure 4. The financial strength of the other two companies is very poor. The company A is better in terms of managers, staff and executive records compared with the other two companies as show in figure 5 and 6. These four criteria give us an idea of the strength of each company in terms of the identified risks.

By taking all the criteria together it is found that the contractor A is better placed with respect to the identified criteria. The coefficient of relative importance for criteria is 0.727 which indicator company A is better equipped in terms of the availability of expertise, staff, maintaining the records and the financial ability.

This method of choosing the contractor based on the important criteria which define the strength and ability of the contractor to do a particular work rather than only on the least bid offered will help us having better contractor for efficient execution of the project.

VII. CONCLUSIONS

1- AHP Fuzzy method is used to identify all the risks involved in choosing the contractor, rather than choosing the contractor only on least bid. This will help in finding out the weakness of the contractor.

2- The contractor is evaluated in terms of all the important parameters which form crucial part in the execution of the project, there is less chance that the contractor will fail in executing the project.

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