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RANKING CONSTRUCTION CONTRACTORS OF MUNICIPALITY BAISED ON (FUZZY-TOPSIS) MULTI CRITERIA DECISION MAKING IN HERAT PROVINCE

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Abstract

In this research, efforts have been made to introduce comprehensive indicators for the selection of contractors of municipal construction projects with a comprehensive overview of the literature on the selection of contractors. Choosing and how to choose a subject has been a long discussion for philosophers and scientists, therefore successful or satisfactory results need a rational and logical path in the selection process. The growth and development of the business market over the last few decades, also the increasingly competitive business market, caused the organizations and large corporations have specialized, scientific approaches to the contractor selection process and implementation of projects.

What is certain is that the selection of the contractor will ensure that the project is successful and, on the contrary, the inability to identify and select the appropriate contractor will result in inefficiency and losses.

According to the municipality's policy of outsourcing activities every day more contracting companies to participate in various municipal projects and including construction projects; and this multiplicity contracting companies have led to the selection of the right contractor a crucial and decisive thing for the municipality as an employer.

Therefore, choosing the right contractors is the first step towards achieving the desired goal employers that mean executing the project within the desired timeframe at a specified cost and quality that is desired.

Keywords: Contractor, Fuzzy Logic, TOPSIS.

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1. Introduction:

This is the first step in providing a practical and effective contractor selection model. The criteria and indicators should be formulated in such a way as to cover the concepts of Cost, Quality, time, and etc. Based on these three basic concepts, a list of criteria can be created of these three indicators; quality is a more complex category, which determines how much it requires extensive research. The scope of the implementation of a project in a timetable is determined by the employer, which means that the failure of this period will usually result in heavy fines for the contractor. The cost is generally interpreted as the cost the employer pays to finalize the project, but the cost can include, but is not limited to, the failure of the contractor to complete the contract, the re-execution of parts of the project, the conduct of the tender also be made.

In this research, we specifically seek for Criteria weighting we used the Fuzzy method and for rank the contractors of the municipality we used the TOPSIS method.

In general, for evaluation and ranking of municipality contractors by fuzzy TOPSIS method, after identifying contractors and determining criteria by experts and managers, appropriate language variables for weighting and ranking should be used. Linguistic variables should be converted to fuzzy numbers using tables containing linguistic expressions (Chen and colleagues., 2005). Different scales are used to translate linguistic terms into fuzzy numbers. The purpose of introducing different scales is one of the forms in terms of numbers the language is the language that the decision makers use (Momeni, 2006).

Literature Review

: A project can be defined as a set of activities that are performed to achieve a particular purpose. Projects include activities that must be carried out on specific dates, with specified costs and qualities determined. Projects may be tasks that are required at specific intervals. For example, closing plant accounts at the end of the fiscal year, major refurbishment of a refinery every two years etc. Projects may also include tasks that will only be carried out once by the organization, such as construction, development projects, organization development, research projects etc.(Haj Shir Mohammadi 2008). According to what was said, such things as: forming a seminar, compiling or publishing a book, setting up a factory, producing a new product, running a spatial plan, making a trip plan, and doing thousands of other things done by humans by itself, is a project.

- Organization of a project:
- Time period of the project
- Theoretical stage
- Designing and Planning Stage
- Implementation stage
- Final stage (complement)

General contractors

The general contractor is a legal person with the capability and authority in engineering, resource provision, procurement, implementation, and management, in order to carry out all activities related to the design and implementation of the project.

The general contractor can assign the implementation of different parts of the project to the consultant engineers or other qualified contractors after the approval of the employer by division of the project into the projects or stages of implementation, but in any case, the contractor undertakes the responsibility, management, control and coordination of the whole project.

Overview of goals and tasks of general contracts

Independently taking responsibilities of implementing a project which start from the survey of elementary studies, scheduling, planning till the complement of a project is the contractor job. It doesn't matter the project is small, medium or a huge project, the important is that contractor could do its responsibility. As the companies specialization we should focus on these points.

- Preliminary identification and presenting major plan in special part.
- Technical and economic justification
- Basic engineering
- Consulting services
- Supply of equipment
- The right of exploit and transfer of technical knowledge
- Create, installation and sitting up services
- Operation service
- On time project implementation (Samimi Dehkordi, 1384)

Importance of contractor selection

There are many companies and organizations that may delegate part of their activities to other companies on a contractual basis. In most countries, executive projects are carried out by contractors. Failure to select an appropriate contractor can lead to a decrease in the quality of the project, an increase in time and even an abnormal increase in the cost of the project, and in some cases leads to the project's suspension and unfinished. The choice of the contractor in the traditional way (the lowest bidder price) and the failure in considering other factors may cause the contractors to be persuaded to carry out the project with the lowest price and not paying attention to the identification of other factors (Rajaee and Hazrati, 2007).

Considering that municipal projects usually have significant budgets, the selection of unsuitable contractors for these projects can cause a lot of damage.

Process of selection of contractors

When outsourcing is performed, the outsourcing organization should have a deep understanding of what a contractor wants to do. After that, the project team should examine the contractors. A step-by-step approach is needed to investigate contractors and select an appropriate contractor.

Greer and Minard outlined the contractor selection process as follows: (Greer, 1999)

- Identification of potential contractors
- Identifying of the necessary capabilities
- Determining of Evaluation Criteria
- Deciding about one or more contractors
- Preparing and setting up an RFP (Request for proposal)
- Comparison and Evaluation of Proposals
- Competency appraisal
- Ensuring of job accuracy and Seriousness
- Contractor selection
- And at the end, there are negotiation and conclusion of the contract

Contractor Selection Criteria

Choosing criteria in the process of choosing a contractor is an important step, so that organizations must pay particular attention to this in order to succeed in their projects. For example, an organization that provides services to five large contractors may find a particular activity, but is size in this example an important factor? If that activity is important to the organization, financial stability and high investment power are required for the contracting company; otherwise, the contractor's services and responsiveness are sufficient, and a small, high-quality contracting in a nearby location can be the right choice; It may seem like a simple research task, but information is often not readily available or complete. Indeed, the outsourcing market is very large and varied, and everything from outsourcing simple activities up to now has covered all the support activities of large companies. Organizations have been challenged in choosing a contractor whose capabilities are tailored to their needs. Therefore, selecting criteria in the contractor selection process is an important step.

Contractor Selection Models

In most studies, the importance and difficulties associated with the scoring of various specifications and criteria related to the selection of contractors are specified. According to David and colleagues (2006), Gallien and Wein (2005), Dobler and Burt (1996), Patil (2006), Beil and Wein (2003), and Arsalan partner (2006) considering several features in bidding is important, but it's hard to implement these priorities in evaluating the bidding process and choosing a contractor (Padeh and Mahapatra, 2009).

One of the most commonly used methods for choosing contractors is the use of competitive bidding, the method in which the bidder accepts the lowest price, has a deep root in the US. The main idea behind this approach was the bidding system with the lowest bidder that protects the public section from extremism, corruption, and other inappropriate behaviors that might have occurred (Thomas and Skitemor, 2001).

In Afghanistan, the National Procurement Law is based on the same biding model, which is currently used in all governmental contracts and volunteering construction bids.

In France, this method is used after the bidder has been removed with the lowest bidder list. In the countries of Italy, Portugal, Peru and Korea, after the elimination of the bidder with the highest bidder and the lowest bidder, among the remaining bidders, the contractor whose offer price is closer to the average offered price is accepted. The same method is used in Denmark, with the difference that first two bidders with the highest bidder and two bidders with the lowest price suggestion are removed and then the remained contractor that whose offer price is closer to the average of the suggested prices is accepted. (Tapco, 2004). Paul and Guthy Yerz studied the project contract at auctions. They have used a common probability model that can be used to compare the expected price (Paul and Gothy Yorzes, 2005). Many researchers such as JS Russell, Skitemour, Wang, Kim Molner, Jason, Tachko, and others have used common methods for identifying, evaluating, and evaluating pricing. Halt and Advar have also introduced qualitative analyzes, in which identification methods, such as, the time of evaluation, and the selection of contractors participated are discussed (Bentattis, 2006).

Cheng and Lee in a model, after identifying the indicators and checking them based on the paired matrix, compared all the indices and sub-indicators simultaneously and then performed the ranking of the contractors (Cheng and Li, 2004).

Deng (1999) and Padhi and Mohapatra (2009) used Fuzzy AHP and Fuzzy AHP-SMART and Al-Harbi (2001) and Topcu (2004) techniques and AHP technique to award contractors. These techniques can also evaluate the scores that were assessed by the group. Contractors are mentally evaluated by decision making using the hourly scale which then converts these points into numbers, in this there is the possibility of comparing two to two in terms of specifications and also to contractors (Hour, 1980). However, this technique cannot be safely used as a tool for evaluating the superiority of contractors. The fuzzy that is used in AHP fuzzy scale has overcome this problem by placing the range on this scale that are determined by experts. Anyway, AHP, Fuzzy AHP, Fuzzy AHP-SMART have the problem of no rating existence. Such a problem occurs when the relevant categories of contractors are changed whenever one or more contractors are removed or added (Vang, 2008).

Hatush and Skitmore (1998) and Lambropoulos (2007) used the multi-index utility theory technique to scorecard contractors. In essence, they combined the main advantages of simple scoring methods with optimization models. In addition, in situations where satisfaction is doubtful, the utility functions of this property have the advantage that expected utility can be used as a guide for rational decision making. All decisions include choosing one among several options. For instance, each option is evaluated for determining the degree of utility in relation to a number of scoring criteria. What measures the values of the criteria with the degree of utility is the utility function. In this technique, the contractor's score is determined by the comparison of the optimal value of each characteristic (determined by the government) with the actual values of the contractor's performance. In this technique, the contractor's score is determined by the comparison of the optimal value of each characteristic (determined by the government) with the actual values of the contractor's performance. However, it cannot handle and manage the Fuzzy model data and cannot function properly for group decision problems (Sawalei et al., 2007).

Lee and colleagues used a multi-criteria analysis technique to award contractors. A simple scoring technique that evaluates contractors on a descriptive scale can be a reliable measure of decision making. But at the same time, there is no uniformity in the decision making about the characteristics, and in addition, Lia and colleagues did not consider the specifications that have a numerical nature (Lee et al., 2004).
Kumarasawami used a performance-based scoring technique and aggregate individual privileges for the final score for each contactor. This technique is easy to use, but it depends on the decisions of the experts. Additionally, this technique cannot match specifications by measuring non-similar scales. This technique is also unable to determine the weight of the specifications (Kumarasawami,1996).
Huber and Misser used the single-objective method (bidding price) and the integrated planning model for contractor selection. However, they did not consider other important non-financial features such as quality, runtime, physical resources, and prior contractor performance (Huber and Maser, 2006).
Wang and colleagues chose the selection method based on the unit price to select features to convert into a single view. However, it is difficult to determine the various characteristics of the price (Wang, 2006)
The Models used in this research we have given weighing by Fuzzy method and Ranking with TOPSIS Method

Fuzzy Logic

The Modern fuzzy logic which sometimes called diffused logic was developed by Lotfi Zadeh in the mid-1960s against the classic method of two value method to solve the problems which are imprecise or formulated in very basic methods, which are used diffuse categories (Bart Kosko 1991).

The classic method has Greek rote in classic method there was two value for everything like (black or white , 0-1, right or wrong) of course there are many cases which are solved in this method but, we can't say it match for all the cases, in fuzzy logic there are several value it can contain all truth numbers. We are going to explain shortly about fuzzy method in here.

The fuzzy Set Concept: The membership function describes the different between classic methods and fuzzy, membership function in fuzzy set of Ã is an infinite set of X describe with membership function of$\mu_{\tilde{A}}(x)$. Which shows for each x of X a number$[0,1]$, the $\mu_{\tilde{A}}(x)$ function is shows the degree of truth value of x in set of Ã (Kaufmann Gupta 1991).
In function of $\mu_{\tilde{A}}(x)$ If the (x) close to 1 it shows the strong inclusiveness to Ã and it is close to zero it shows the weak inclusiveness to Ã in the case if $\mu_{\tilde{A}}(x) = 0$ the x is not a member of Ã (Adel Azar 2008).

In the below graph Shows the Fuzzy set in the R.

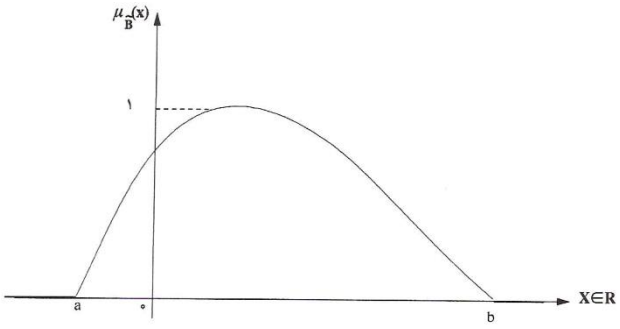

Figure 1-A fuzzy Set (Adel Azar 2008)

1

The fuzzy sets shows with different symbols as follow.

$$\tilde{A} = \left\{\frac{\mu_{\tilde{A}}(x_1)}{x_1}, \frac{\mu_{\tilde{A}}(x_2)}{x_2}, \dots, \frac{\mu_{\tilde{A}}(x_n)}{x_n}\right\}$$

$$\tilde{A} = \{(x, \mu_{\tilde{A}}(x)); x \in X\}$$

$$\tilde{A} = \sum_{i=1}^{n} \frac{\mu_{\tilde{A}}(x_i)}{x_i}$$

Fuzzy set Complement

The Fuzzy set complement shows with A^c symbol and describes as follow.

$$A^c = \{(x, \mu_{A^c}(x)) | \mu_{A^c}(x) = 1 - \mu_A(x)\} x \in X$$

Support, Height and Pass

The X function set elements which are more than zero are supports of Ã and shows with SuppÃ.

$$SuppA = \{x \in X | \mu_{\tilde{A}}(x) > 0\}$$

In Ã set $Sup(\mu_{\tilde{A}}(x))$ is the Height of set Ã as it is equal to 1 we call it normal and if it is opposite of 1 it is not Normal (Klir and Yuan 1995)

$hgt\ A = 1$ So Normal

$hgt\ A \neq 1$ Not Normal

It is clear that we could make Normal each fuzzy set by dividing to the Support as follow.

$$\mu_{\text{norm}\tilde{A}}(x) = \frac{\mu_{\tilde{A}}(x)}{Sup(\mu_{\tilde{A}}(x))}$$

Also if for an element like x in set Ã, $\mu_{\tilde{A}}(x) = \frac{1}{2}$ so x is the pass point of the set (Momini 2006).

Fuzzy Sub-Sets

In each $x \in X$ if we have $\mu_{\tilde{A}}(x) \leq \mu_{B}(x)$ in this case Ã is sub set of B and also we can say A and B are equal if we have $x \in X, \mu_{\tilde{A}}(x) = \mu_{B}(x)$

Intersection

If the degree of membership of that in fuzzy set Ã was equal to α where $0 < \alpha \leq 1$ then α is the intersection of A and shows as follow.

$A_{\alpha} = \{x \in X | \mu_{\tilde{A}}(x) \geq \alpha\}$

Sometimes says about concept of strong intersection which shows with.

$A_{\alpha} = \{x \in X | \mu_{\tilde{A}}(x) > \alpha\}$

Note that if $\alpha = 0$ $SuppA = A_{\alpha} = 0$ it means that the support of a set is the set intersection (Klir and Yuan 1995).

Fuzzy Number

From truth number set R we choose a fuzzy set of N and we called a truth fuzzy number if it has the following 3 charecteristic.

1. It should be convex (N)
2. It should be $x_0 \in X$ $\mu_{N}(x_0) = 1$
3. The graph line should be continually $\mu_{N}(x)$

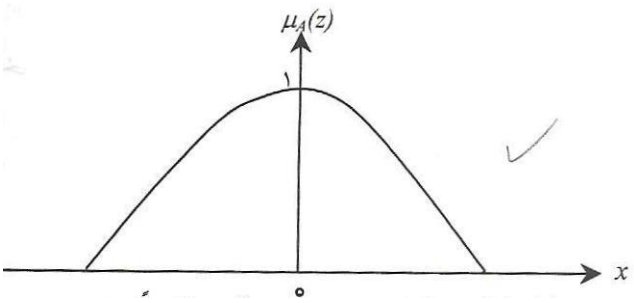

Figure 2-The graph shows the Fuzzy number (Momini 1)

As we know the membership function it has many fuzzy numbers one of these number is Triangle Fuzzy Number which shows (a,b,c) graph showed below.

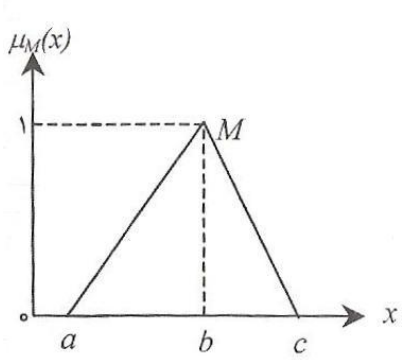

Figure 3-The Graph is Triangle

Fuzzy Number 1

$$\mu_{\tilde{N}}(x) = \begin{cases} 0 & x < n_1 \\ \dfrac{x - n_1}{n_2 - n_1} & n_1 \le x \le n_2 \\ \dfrac{n_3 - x}{n_3 - n_2} & n_2 \le x \le n_3 \\ 0 & x > n_3 \end{cases}$$

A. The distance between fuzzy triangle number is as follow if a= (a, b, c) and b= (a', b', c') be two fuzzy triangle number the distance between these two number given by this equation using vertex method.

$$d(a,b) = \sqrt{\frac{1}{1}(a - a')^2 + (b - b')^2 + (c - c')^2}$$

B. Linguistic Variables

In fuzzy set method, conversion scales are applied to change the linguistic terms into fuzzy numbers. In here we will apply a scale of 1 to 9 for each of the criteria and the alternatives. The linguistic variables and fuzzy ratings for the alternatives and the criteria are as shown in Table.

TABLE
Fuzzy Rating Linguistic Variables

Fuzzy Number	Alternative Assessment	QA Weight
(1, 1, 3)	Very poor (VP)	Very Low
(1, 3, 5)	Poor (P)	Low
(3, 5, 7)	Fair (F)	Medium
(5, 7, 9)	Good (G)	High
(7, 9, 9)	Very Good (VG)	Very High

Table 1-Fuzzy Rating Linguistic Variables 1

TOPSIS Method

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is a multi-criteria decision analysis method, which was originally developed by Ching-Lai Hwang and Yoon in 1981 with further developments by Yoon in 1987, and Hwang, Lai and Liu in 1993. It is a method of compensatory aggregation that compares a set of alternatives by identifying weights for each criterion, normalizing scores for each criterion and calculating the geometric distance between each alternative and the ideal alternative, which is the best score in each criterion. An assumption of TOPSIS is that the criteria are monotonically increasing or decreasing. Normalization is usually required as the parameters or criteria are often of incongruous dimensions in multi-criteria problems. Compensatory methods such as TOPSIS allow trade-offs between criteria, where a poor result in one criterion can be negated by a good result in another criterion. This provides a more realistic form of modeling than non-compensatory methods, which include or exclude alternative solutions based on hard cut-offs. An example of application on nuclear power plants is provided in.

TOPSIS Method Calculation steps: TOPSIS is based on the concept that the chosen alternative should have the shortest geometric distance from the positive ideal solution (PIS) and the longest geometric distance from the negative ideal solution (NIS)

The TOPSIS process is carried out as follows:

Step 1

Create an evaluation matrix consisting of m alternatives and n criteria, with the intersection of each alternative and criteria given

as, we therefore have a matrix.

$$x_{ij} \qquad (x_{ij})_{m\times n}$$

Step 2

The matrix $(x_{ij})_{m\times n}$ is then normalised to form the matrix

, using the normalisation method

$$R = (r_{ij})_{m\times n}$$

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{k=1}^{m} x_{kj}^2}}, \quad i = 1, 2, \ldots, m, \qquad j = 1, 2, \ldots, n$$

Step 3

Calculate the weighted normalised decision matrix

$$t_{ij} = r_{ij} \cdot w_j, \quad i = 1, 2, \ldots, m, \quad j = 1, 2, \ldots, n$$

$$w_j = W_j \Big/ \sum_{k=1}^{n} W_k, j = 1, 2, \ldots, n$$

v_j, Where $j = 1, 2, \ldots, n.$ so that $\sum_{i=1}^{n} w_i = 1$ and is W_j the original weight given to the indicator

Step 4

Determine the worst alternative (A_w) and the best alternative (A_b) :

$$A_w = \{\langle \max(t_{ij} \mid i = 1, 2, \ldots, m) \mid j \in J_- \rangle, \langle \min(t_{ij} \mid i = 1, 2, \ldots, m) \mid j \in J_+ \rangle\} \equiv \{t_{wj} \mid j = 1, 2, \ldots, n\},$$

$$A_b = \{\langle \min(t_{ij} \mid i = 1, 2, \ldots, m) \mid j \in J_- \rangle, \langle \max(t_{ij} \mid i = 1, 2, \ldots, m) \mid j \in J_+ \rangle\} \equiv \{t_{bj} \mid j = 1, 2, \ldots, n\},$$

Where,

$J_+ = \{j = 1, 2, \ldots, n \mid j\}$ associated with the criteria having a positive impact,

and $J_- = \{j = 1, 2, \ldots, n \mid j\}$ associated with the criteria having a negative impact.

Step 5

Calculate the L2-distance between the target alternative and the worst condition A_w

$$d_{iw} = \sqrt{\sum_{j=1}^{n}(t_{ij} - t_{wj})^2}, \quad i = 1, 2, \ldots, m,$$

and the distance between the i alternative and the best condition A_b

$$d_{ib} = \sqrt{\sum_{j=1}^{n}(t_{ij} - t_{bj})^2}, \quad i = 1, 2, \ldots, m$$

Where d_{iw} and d_{ib} are L2-norm distances from the target alternative to the worst and best conditions, respectively.

Step 6

Calculate the similarity to the worst condition:

$$s_{iw} = d_{iw}/(d_{iw} + d_{ib}), \quad 0 \leq s_{iw} \leq 1, \quad i = 1, 2, \ldots, m.$$

Step 7

Rank the alternatives according to s_{iw} $(i = 1, 2, \ldots, m)$.

Research findings

After reviewing the literature that belongs on identifying the criteria and interview with experts, 13 primitive criteria for contractor selection and evaluation then, 7 criteria were identified as the most important criteria affecting contractors were selected.

Then, the fuzzy analysis technique was used to determine the criteria and finally, by fuzzy TOPSIS method, 13 municipal construction's contractors were evaluated and ranked.

The objectives of this study are:

A. Identification and Determination of Contractor Selection Criteria

The evaluation and selection of project contractors should be based on a comprehensive set of criteria and indicators that cover all functional aspects of the contractor's capabilities, competencies and abilities. In other words, the comprehensiveness of contractor evaluation criteria and indicators means that the relevant criteria and indicators must be capable of predicting the likely performance of the contractor in relation to the project. In this study, according to the research literature and the opinions of relevant experts, seven main criteria and were discovered to evaluate the contractors of the municipality. These criteria are:

1) **Proposed Price**

Price of indicators related to technical and professional capabilities: Status and availability of equipment and machinery, type and suitability of equipment and machinery, level of experience of technical staff, number and extent of technical staff or experts.

2) **Experience**

Scale of completed projects, experience of executing similar projects, duration of activity in industry and business, geographical experience at project site

3) **Indicators of financial authority and sustainability:**

Credit ratings, current ratios, profitability ratios, adequacy of bank guarantees and treaties, cash flow records.

4) **Indicators of new project capacity:**

Current workload, Future workload

5) **Technical and Specialist Capacity:**

6) **The actual quality obtained in previous projects:**

Failure to complete a project or previous contracts, actual quality achieved in previous projects.

7) **Safety and health performance in previous projects**

Relationship with subcontractors, tendency to claim damages and disputes Contractual, amount of projects completed with time delays, volume and type of work referred to subcontractors, relationship with previous employer, project costs exceeding planned amounts. The first questionnaire was designed and adjusted to screen the criteria and determine the most important criteria affecting contractor selection. After collecting the questionnaires, using the fuzzy hypothesis test, the most important effective criteria consisting of 15 criteria were identified; the criteria of price, status and usability of machinery and equipment, type and proportion of machinery and equipment, scale Completed projects, similar project execution experience, current ratio, current workload, quality control system and program, project management capability, ability to claim damages and contractual disputes, senior management qualifications, actual quality Achieved in previous projects, safety and health performance in previous projects, amount of projects completed by Time delays and inability to complete a previous project or contract.

Final Accepted Criteria

In order to provide a systematic and practical model for the selection of municipal construction projects, 13 criteria were identified and 7 main criteria have been selected by using an interview which has been interviewed with 25 specialist and 20 of them has returned. The Final 7 criteria which have been selected are as follow.

- Proposed price
- Experience criteria
- Financial criteria
- Technical and Specialist Capacity
- The actual quality obtained in previous projects
- The experience of implementing similar projects
- Health and safety performance in previous projects

Final Contractor Selection Criteria method

The fuzzy hypothesis test was used to determine the effective factors for selection of final criteria of selecting contractor of the municipal. An interview containing 13 criteria was developed in the previous section and designed by 25 experts and specialists of procurement and Construction. The work experience was in the contractors' evaluation section and 20 interviews were returned, using a five-point scale. Respondents were asked to rate the significance of each of the proposed criteria at (very low, low, medium, high and very high); for each criterion, the hypotheses C0 to C4 were modeled as follows: By defining and using expert opinions, the degree of verification of each assumption is determined.

H0: In Contractor ranking has Highest importance Point
H1: In Contractor ranking has High importance Point
H2: In Contractor ranking has Medium importance Point
H3: In Contractor ranking has Low importance Point
H4: In Contractor ranking has Lowest importance Point

After that as shown in Table below the important and most effective have selected.

No	Criteria	Percentage
1	Proposed Cost	Very High Importance
2	Experience	High Importance
3	Financial capacity	Importance
4	Technical Capacity	Average Importance
5	Real Quality obtained Last Projects	Low Importance
6	Similar project Experience	Very low Importance
7	Safety Performance in previous projects	Very Low Importance

Evaluating Contractors by Using Fuzzy-TOPSIS Technique

In this step the Contractors will rank with criteria above and the data we have gotten before from 3 organizations.

The companies which will rank are as follow

Ashianeh Sazan, Plannet, Aseman Sharqe, Emar-e-Berter, Afghan Sef, Bakhter, Kawishgram and Paida, Diar Sazan, Sodais Saber, Safi, Behsazan-e-Sharq, Hosay-e-Sharq, Benahgran Afghan and Criteria have written in the table above. We would write A1 to A13 behalf of Company names.

And Behalf of Criteria we will write symbols from C1 to C7

No	Criteria	Symbol
1	Proposed Cost	C1
2	Experience	C2
3	Financial capacity	C3
4	Technical Capacity	C4
5	Real Quality obtained Last Projects	C5
6	Similar project Experience	C6
7	Safety Performance in previous projects	C7

Table 2-Table C1, C3, C7 are financial Criteria 1

In above Table C1, C3, C7 are financial Criteria and the others are Technical Criteria

Table 3-The Combine Fuzzy Matrix table

Weight	Combine Decision Matrix																						
	Candidate Companies		Criterias																				
	No	Name	C1			C2			C3			C4			C5			C6			C7		
	1	A1	5	7	9	7	9	9	5	7	9	3	5	7	3	5	7	5	7	9	3	5	7
	2	A2	7	9	9	5	7	9	3	5	7	7	9	9	3	5	7	3	5	7	1	3	5
	3	A3	5	7	9	3	5	7	7	9	9	3	5	7	7	9	9	1	3	5	5	7	9
	4	A4	5	7	9	5	7	9	7	9	9	5	7	9	3	5	7	3	5	7	1	1	3
	5	A5	3	5	7	3	5	7	5	7	9	3	5	7	5	7	9	5	7	9	1	3	5
	6	A6	1	3	5	1	3	5	5	7	9	1	3	5	1	3	5	3	5	7	3	5	7
	7	A7	3	5	7	5	7	9	1	1	3	3	5	7	3	5	7	5	7	9	5	7	9
	8	A8	5	7	9	7	9	9	1	3	5	7	9	9	5	7	9	3	5	7	7	9	9
	9	A9	7	9	9	5	7	9	3	5	7	5	7	9	3	5	7	1	3	5	1	3	5
	10	A10	7	9	9	5	7	9	5	7	9	1	3	5	1	3	5	5	7	9	3	5	7
	11	A11	5	7	9	5	7	9	5	7	9	1	3	5	1	3	5	3	5	7	5	7	9
	12	A12	5	7	9	1	3	5	7	9	9	1	3	5	1	3	5	3	5	7	5	7	9
	13	A13	5	7	9	3	5	7	1	1	3	7	9	9	1	3	5	1	3	5	3	5	7

As data we collected before from the decision makers' opinion in shown as a quantitative table below based on fuzzy numbers and weighted the Criteria by percent of importance.

Weight	Combine Decision Matrix																						
	Candidate Companies		Criterias																				
			7	9	9	5	7	9	3	5	7	1	3	5	1	1	3	1	1	1	1	1	1
	No	Name	C1			C2			C3			C4			C5			C6			C7		
	1	A1	5	7	9	7	9	9	5	7	9	3	5	7	3	5	7	5	7	9	3	5	7
	2	A2	7	9	9	5	7	9	3	5	7	7	9	9	3	5	7	3	5	7	1	3	5
	3	A3	5	7	9	3	5	7	7	9	9	3	5	7	7	9	9	1	3	5	5	7	9
	4	A4	5	7	9	5	7	9	7	9	9	5	7	9	3	5	7	3	5	7	1	1	3
	5	A5	3	5	7	3	5	7	5	7	9	3	5	7	5	7	9	5	7	9	1	3	5
	6	A6	1	3	5	1	3	5	5	7	9	1	3	5	1	3	5	3	5	7	3	5	7
	7	A7	3	5	7	5	7	9	1	1	3	3	5	7	3	5	7	5	7	9	5	7	9
	8	A8	5	7	9	7	9	9	1	3	5	7	9	9	5	7	9	3	5	7	7	9	9
	9	A9	7	9	9	5	7	9	3	5	7	5	7	9	3	5	7	1	3	5	1	3	5
	10	A10	7	9	9	5	7	9	5	7	9	1	3	5	1	3	5	5	7	9	3	5	7
	11	A11	5	7	9	5	7	9	5	7	9	1	3	5	1	3	5	3	5	7	5	7	9
	12	A12	5	7	9	1	3	5	7	9	9	1	3	5	1	3	5	3	5	7	5	7	9
	13	A13	5	7	9	3	5	7	1	1	3	7	9	9	1	3	5	1	3	5	3	5	7

The Normalized Combine Matrix

In next step the table will show the normalized fuzzy decision matrix by using the below formula.

$$\bar{v}_{ij}^{L} = w_i \bar{n}_{ij}^{L} j = 1, 2, \dots, mi = 1, 2, \dots, n$$

$$\bar{v}_{ij}^{U} = w_i \bar{n}_{ij}^{U} j = 1, 2, \dots, mi = 1, 2, \dots, n$$

$$\sum_{i=1}^{n} w_i = 1$$

Normalized fuzzy decision matrix																					
Candidate Companies		Criterias																			
		7	9	9	5	7	9	3	5	7	1	3	5	1	1	3	1	1	1	1	1	1
No	Name	C1			C2			C3			C4			C5			C6			C7		
1	A1	0.56	0.78	1.00	0.78	1.00	1.00	0.56	0.78	1.00	0.33	0.56	0.78	0.33	0.56	0.78	0.56	0.78	1.00	0.33	0.56	0.78
2	A2	0.78	1.00	1.00	0.56	0.78	1.00	0.33	0.56	0.78	0.78	1.00	1.00	0.33	0.56	0.78	0.33	0.56	0.78	0.11	0.33	0.56
3	A3	0.56	0.78	1.00	0.33	0.56	0.78	0.78	1.00	1.00	0.33	0.56	0.78	0.78	1.00	1.00	0.11	0.33	0.56	0.56	0.78	1.00
4	A4	0.56	0.78	1.00	0.56	0.78	1.00	0.78	1.00	1.00	0.56	0.78	1.00	0.33	0.56	0.78	0.33	0.56	0.78	0.11	0.11	0.33
5	A5	0.33	0.56	0.78	0.33	0.56	0.78	0.56	0.78	1.00	0.33	0.56	0.78	0.56	0.78	1.00	0.56	0.78	1.00	0.11	0.33	0.56
6	A6	0.11	0.33	0.56	0.11	0.33	0.56	0.56	0.78	1.00	0.11	0.33	0.56	0.11	0.33	0.56	0.33	0.56	0.78	0.33	0.56	0.78
7	A7	0.33	0.56	0.78	0.56	0.78	1.00	0.11	0.11	0.33	0.33	0.56	0.78	0.33	0.56	0.78	0.56	0.78	1.00	0.56	0.78	1.00
8	A8	0.56	0.78	1.00	0.78	1.00	1.00	0.11	0.33	0.56	0.78	1.00	1.00	0.56	0.78	1.00	0.33	0.56	0.78	0.78	1.00	1.00
9	A9	0.78	1.00	1.00	0.56	0.78	1.00	0.33	0.56	0.78	0.56	0.78	1.00	0.43	0.71	1.00	0.11	0.33	0.56	0.11	0.33	0.56
10	A10	0.78	1.00	1.00	0.56	0.78	1.00	0.56	0.78	1.00	0.11	0.33	0.56	0.20	0.60	1.00	0.56	0.78	1.00	0.33	0.56	0.78
11	A11	0.56	0.78	1.00	0.56	0.78	1.00	0.56	0.78	1.00	0.11	0.33	0.56	0.20	0.60	1.00	0.43	0.71	1.00	0.56	0.78	1.00
12	A12	0.56	0.78	1.00	0.11	0.33	0.56	0.78	1.00	1.00	0.11	0.33	0.56	0.20	0.60	1.00	0.43	0.71	1.00	0.56	0.78	1.00
13	A13	0.56	0.78	1.00	0.33	0.56	0.78	0.14	0.14	0.43	0.78	1.00	1.00	0.20	0.60	1.00	0.20	0.60	1.00	0.43	0.71	1.00

The Weighted Normalized Decision Matrix

Weighted Normalized Decision matrix																					
Candidate Companies		Criterias																			
		7	9	9	5	7	9	3	5	7	1	3	5	1	1	3	1	1	1	1	1	1
No	Name	C1			C2			C3			C4			C5			C6			C7		
1	A1	3.89	7.00	9.00	3.89	7.00	9.00	1.67	3.89	7.00	0.33	1.67	3.89	0.33	0.56	2.33	0.56	0.78	1.00	0.33	0.56	0.78
2	A2	5.44	9.00	9.00	2.78	5.44	9.00	1.00	2.78	5.44	0.78	3.00	5.00	0.33	0.56	2.33	0.33	0.56	0.78	0.11	0.33	0.56
3	A3	3.89	7.00	9.00	1.67	3.89	7.00	2.33	5.00	7.00	0.33	1.67	3.89	0.78	1.00	3.00	0.11	0.33	0.56	0.56	0.78	1.00
4	A4	3.89	7.00	9.00	2.78	5.44	9.00	2.33	5.00	7.00	0.56	2.33	5.00	0.33	0.56	2.33	0.33	0.56	0.78	0.11	0.11	0.33
5	5	2.33	5.00	7.00	1.67	3.89	7.00	1.67	3.89	7.00	0.33	1.67	3.89	0.56	0.78	3.00	0.56	0.78	1.00	0.11	0.33	0.56
6	A6	0.78	3.00	5.00	0.56	2.33	5.00	1.67	3.89	7.00	0.11	1.00	2.78	0.11	0.33	1.67	0.33	0.56	0.78	0.33	0.56	0.78
7	A7	2.33	5.00	7.00	2.78	5.44	9.00	0.33	0.56	2.33	0.33	1.67	3.89	0.33	0.56	2.33	0.56	0.78	1.00	0.56	0.78	1.00
8	A8	3.89	7.00	9.00	3.89	7.00	9.00	0.33	1.67	3.89	0.78	3.00	5.00	0.56	0.78	3.00	0.33	0.56	0.78	0.78	1.00	1.00
9	A9	5.44	9.00	9.00	2.78	5.44	9.00	1.00	2.78	5.44	0.56	2.33	5.00	0.43	0.71	3.00	0.11	0.33	0.56	0.11	0.33	0.56
10	A10	5.44	9.00	9.00	2.78	5.44	9.00	1.67	3.89	7.00	0.11	1.00	2.78	0.20	0.60	3.00	0.56	0.78	1.00	0.33	0.56	0.78
11	A11	3.89	7.00	9.00	2.78	5.44	9.00	1.67	3.89	7.00	0.11	1.00	2.78	0.20	0.60	3.00	0.43	0.71	1.00	0.56	0.78	1.00
12	A12	3.89	7.00	9.00	0.56	2.33	5.00	2.33	5.00	7.00	0.11	1.00	2.78	0.20	0.60	3.00	0.43	0.71	1.00	0.56	0.78	1.00
13	A13	3.89	7.00	9.00	1.67	3.89	7.00	0.43	0.71	3.00	0.78	3.00	5.00	0.20	0.60	3.00	0.20	0.60	1.00	0.43	0.71	1.00
	A*	5.444	9	9	3.889	7	9	2.333	5	7	0.778	3	5	0.778	1	3	0.556	0.78	1	0.778	1	1
	A-	0.78	3.00	5.00	0.56	2.33	5.00	0.33	0.56	2.33	0.11	1.00	2.78	0.11	0.33	1.67	0.11	0.33	0.56	0.11	0.11	0.33

Table 4-The Weighted Normalized Decision Matrix.

The positive Distance of FPIS Matrix

Distance From FPIS								
Candidate Companies		Criterias						
No	Name	C1	C2	C3	C4	C5	C6	C7	di*
1	A1	1.463	0.000	0.748	1.034	0.529	0.000	0.385	4.159
2	A2	0.000	1.104	1.745	0.000	0.529	0.222	0.602	4.202
3	A3	1.463	2.491	0.000	1.034	0.000	0.444	0.181	5.614
4	A4	1.463	1.104	0.000	0.406	0.529	0.222	0.748	4.472
5	A5	3.145	2.491	0.748	1.034	0.181	0.000	0.602	8.202
6	A6	4.959	4.037	0.748	1.768	0.943	0.222	0.385	13.062
7	A7	3.145	1.104	3.896	1.034	0.529	0.000	0.181	9.890
8	A8	1.463	0.000	2.875	0.000	0.181	0.222	0.000	4.741
9	A9	0.000	1.104	1.745	0.406	0.260	0.444	0.602	4.561
10	A10	0.000	1.104	0.748	1.768	0.406	0.000	0.385	4.411
11	A11	1.463	1.104	0.748	1.768	0.406	0.082	0.181	5.752
12	A12	1.463	4.037	0.000	1.768	0.406	0.082	0.181	7.937
13	A13	1.463	2.491	3.559	0.000	0.406	0.230	0.260	8.409

Table 5-The positive Distance of FPIS Matrix

The negative distance of FNIS

Distance from FNIS								
Candidate Companies		Criterias						
No	Name	C1	C2	C3	C4	C5	C6	C7	di-
1	A1	3.73	4.04	3.40	0.76	0.43	0.44	0.38	13.18
2	A2	4.96	3.19	2.24	1.77	0.43	0.22	0.18	12.99
3	A3	3.73	1.60	3.90	0.76	0.94	0.00	0.60	11.52
4	A4	3.73	3.19	3.90	1.52	0.43	0.22	0.00	12.98
5	A5	1.86	1.60	3.40	0.76	0.85	0.44	0.18	9.10
6	A6	0.00	0.00	3.40	0.00	0.00	0.22	0.38	4.01
7	A7	1.86	3.19	0.00	0.76	0.43	0.44	0.60	7.29
8	A8	3.73	4.04	1.10	1.77	0.85	0.22	0.75	12.46
9	A9	4.96	3.19	2.24	1.52	0.82	0.00	0.18	12.92
10	A10	4.96	3.19	3.40	0.00	0.79	0.44	0.38	13.17
11	A11	3.73	3.19	3.40	0.00	0.79	0.38	0.60	12.09
12	A12	3.73	0.00	3.90	0.00	0.79	0.38	0.60	9.40
13	A13	3.73	1.60	0.40	1.77	0.79	0.30	0.55	9.13

Table 6-The negative distance of FNIS

And the Last step the CC_i and Rank Table as follow

CC_i	Rank	Contractors
0.76009	**1**	A1
0.755625	**2**	A2
0.672414	**8**	A3
0.743825	**4**	A4
0.525844	**10**	A5
0.234722	**13**	A6
0.424311	**12**	A7
0.724335	**6**	A8
0.739009	**5**	A9
0.749096	**3**	A10
0.677682	**7**	A11
0.542078	**9**	A12
0.520662	**11**	A13

Table 7-the CCi and Rank Table as follow

Recommendations.

1) Since criteria identification is the basis of applied studies and research and no endpoints can be recognized for the identified criteria, expanding the range of identified criteria for better selection adds to the richness of the work.

2) When evaluating and selecting contractors, it should always be borne in mind that real-world decision making is based on interdependent criteria, so using statistical techniques to determine the dependency of criteria to achieve more accurate results and more realistic is a must.

3) In order to select and categorize a set of criteria for selecting contractors, one can use decision making methods such as fuzzy set theory and multi-attribute utility theory and so on.

4) As a broad research field, it is recommended to develop and design software for municipal project contractor selection. This is done through the collaboration of a team of management students and software engineering students. For example, the software can perform various functions such as: determining decision options, choosing the type of decision model, sensitivity analysis, determining decision makers' view of risk, selecting key decision indicators, deleting one or more options, Graphics Images of Different Options for Decision Indicators, weight and importance of indices and criteria, and so on.

Modeling, selection of indicators, process logic, calculation of individual utility functions of indicators, determination of weights, process and stages of decision modeling. . . In the field of student management, computer programming and design, and the creation of an intuitive visual environment, are also specialized in software engineering students.

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