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Selecting the Best Installation Location using the Fuzzy Multi-Criteria Decision Making

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Abstract- The location problem of an enterprise is very important strategically and plays a significant role in reducing corporate costs and making profits. In this paper, it has been tried to employ a model considering the criteria and sub-criteria to select the best choice among the alternatives suggested for installing the factory. Due to the subjective nature of qualitative criteria and selective nature of the problem, multi-criteria decision model-multiplayer model is selected among different methods. To regard this aspect, an appropriate model combining multiple models is designed and to have more realistic results fuzzy techniques are used. This model tries to select the location with the highest value among all other alternatives by considering all effective factors. The proposed model is designed based on fuzzy AHP (Analytic Hierarchy Process) and fuzzy TOPSIS (Technique for Order Preference by Similarity to Ideal Solution).At first, fuzzy AHP method is used to determine the weights of criteria and sub-criteria. Next, by using the fuzzy TOPSIS method the suggested alternatives are sorted based on the obtained weights.

Keywords- *Location, multi-criteria decision making, fuzzy AHP, fuzzy TOPSIS*

I. INTRODUCTION

One of the main concerns of managers in each category becomes the most convenient and efficient sources of capital through investment income may, appropriate time and place. So how and where to invest in today's economic climate it would be complicated and risky. Location of facilities, a major impact on the success of the investment is made. So how and where to invest in today's economic climate it would be complicated and risky. Location of facilities, a major impact on the success of the investment is made. So after a while, it's not something that the factory closed and moved elsewhere. Problems such as lack of access to raw materials and markets, lack of adequate land for development, skyrocketing costs of transportation, lack of compliance with the environment, culture and more[1]. The methods that can be used in selecting the proper location, using is MADM. This type of selection decision models (evaluation) the best of a finite number of choices is predetermined. In addition, there are several indicators of decision options must be specified carefully to their issues. The indicators associated with each of the alternatives are evaluated. [4]There are different methods for multi-criteria decision making. Techniques for ranking alternatives based on ideal or close to one of the classical TOPSIS is a multiple attribute decision making problems. . This technique was first used by Hwang and Yoon. [6] Other methods to solve multi-criteria decision AHP can be named; it has been suggested in 1980 by Thomas L. hour. This decision is based on paired comparisons. [10]In real-world decision- making process, giving points to each item and determine the weight of each criterion determined by a number of difficult decisions can not specify a numerical value to express their opinion. The use of fuzzy set theory is a valuable tool to resolve this problem is considered. [9]

II. FUZZY HIERARCHICAL ANALYSIS

In hierarchical decision analysis is often due to the fuzzy nature of the paired comparisons are unable to clear their minds about Honors are announced. For this reason, in their judgment, give a range rather than a fixed number prefer. Fuzzy hierarchical analysis technique to overcome this problem is presented [3]. This method is called by the Dutch scholar and Pdryk Larhvrn, was proposed based on least square method is based on logarithmic [2]. Chang in 1996 another method of analysis developed, and presented. The numbers used in this procedure are triangular fuzzy numbers [5].

III. METHOD SIMILAR TO FUZZY IDEAL OPTION (TOPSIS FUZZY)

In the classical TOPSIS method to determine the exact amount of weight and rank the options used [6]. While in many cases it is difficult to decide which to decide with certainty. Chen TOPSIS methodology for developing the decision-making problems in a fuzzy environment is presented. In this method, the matrix elements of the decision or weight or both criteria by linguistic variables represented by fuzzy numbers have been evaluated Thus, the classical TOPSIS method to overcome the problems [7].

IV. Companies Choose the Best Location For The Construction Of The Chassis Using A Combination Of Fuzzy AHP Method, TOPSIS Fuzzy

In this section, the method for selecting the best location for the construction of the factory chassis maker explains. Chassis Construction Company as a supplier of automotive chassis that can be put in place Obtain the maximum rating of the criteria and sub-criteria is. It has been used for a hybrid model. This model is composed of two stages: the first stage using fuzzy AHP to obtain the weight of criteria and sub-criteria, the second step is to get fuzzy TOPSIS weight of items, each of which will be explained below.

A. First step - using AHP FUZZY criteria and sub-criteria to gain weight

At this stage fuzzy AHP steps Chang previously described methods are implemented, The fuzzy AHP method to calculate the various stages of decision-making criteria for weighting each And the criteria for the main criteria was to summarize the present And the weight of repetition of similar cases only provides the criteria in Table (5) is satisfied.

B. Step Two

In order to place the company detection of chassis construction, 5 Options, 3 and 4 criteria and 11 sub-criteria decision defined. The option to choose the best places deploy chassis construction enterprises order of candidate sites include the cities of Tehran, Qazvin, Isfahan, Tabriz and Khuzestan And decision-making team of three experts in the fields of finance, commerce and Within and outside the organization have enough information to be strategic. Linguistic variables and fuzzy numbers corresponding to each table (1) are listed. Criteria and sub-criteria used by decision makers to evaluate options in Table (2) is presented.

C. Step Three

Table (3) shows that the scoring criteria by decision makers. As shown in Table (3) shows the scores for each criterion Cj decision by the Committee on the table (1) is obtained. Comprehensive comparison matrix for the opinions of the three decision makers in table (4) is presented.

TABLE I. The Importance of Criteria and Sub-Criteria Linguistic Fuzzy Numbers

Fuzzy preference	linguistic terms
(1 , 1 , 1)	Exactly egual
(1 ,1 , 3)	N=Equally preferred
(1, 3 , 5)	L=Mean preferred
(3 ,5 , 7)	M=Strongly preferred
(5, 7 , 9)	MH=Very strongly preferred
(7 , 9 ,9)	H=Extremely preferred

TABLE II. The Criteria and Sub-Criteria Defined

Sub criteria		criteria	
Facilities and communication infrastructure (proximity to major roads, rail axes, ports and airports)	C11	Infrastructure elements	C1
Reliability and availability of local support systems, technical services, Installation, repair and (specialized maintenance of machinery, technical and technological consultancy and contracting services)	C12		
Productive and non-productive areas for future development	C13		
Proximity to suppliers for raw materials (suppliers that have superior quality)	C21	Economic factors	C2
Close to potential and actual customers	C22		
Transportation costs of raw materials	C23		
Access to skilled labor and potential	C31	Social factors	C3
Area attractions include the quality of life (safety, welfare, education, and housing) to attract non-traditional staffing specialist.	C32		
Near the centers of education, research and treatment	C33		
There are certain advantages (tax breaks, simplifying the licensing of new installations)	C41	Factors related to politics and public policy - an organizational	C4
Mother of estimation strategies (Holding)	C42		

TABLE III. The Decision on Criteria

Criteria	First decision maker				Second decision maker				Third decision maker			
	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4
C1	-	L	M	MH	-	N	M	M	-	N	M	L
C2	1/L	-	M	M	1/N	-	M	L	1/N	-	L	M
C3	1/M		-	N	1/M	1/M	-	N	1/M	1/L	-	L
C4	1/MH	1/MH	1/N	-	1/L	1/L	1/N	-	1/L	1/M	1/L	-

TABLE IV. Comments Comprehensive Matrix of Decision Makers

Criteria	C1			C2			C3			C4		
C1	1.00	1.00	1.00	1.00	4.33	7.00	3.00	5.00	7.00	1.00	5.00	9.00
C2	0.14	0.24	1.00	1.00	1.00	1.00	1.00	4.33	7.00	1.00	5.00	9.00
C3	0.14	0.20	0.33	0.14	0.24	1.00	1.00	1.00	1.00	0.33	1.67	5.00
C4	0.11	0.23	1.00	0.11	0.23	1.00	0.20	0.78	3.00	1.00	1.00	1.00

D. Step Four: Calculate the ordinal paired comparison matrix for each row is calculated as follows:

S_1 :(6,15.33,24) (0.018,.032,.0.082) (0.11,0.5,1.97)

S_2 :(3.14,10.53,18) (0.018,.032,.0.082) (.06,0.34,1.48)

S_3 :(1.62,3.11,7.33) (0.018,.032,.0.082) (0.03,0.1,0.6)

S_4 :(1.42,2.23,6) (0.018,.032,.0.082) (0.03,0.07,0.49)

E. Step Five: Calculate large degree relative to each other is calculated as follows:

$V(S_1 \ S_2)\ 1.00 \quad V(S_1 \ S_3)\ 1.00 \quad V(S_1 \ S_4)\ 1.00$

$V(S_2 \ S_1)\ 0.89 \quad V(S_2 \ S_3)\ 1.00 \quad V(S_2 \ S_4)\ 1.00$

$V(S_3 \ S_1)\ 0.59 \quad V(S_3 \ S_2)\ 0.70 \quad V(S_3 \ S_4)\ 1.00$

$V(S_4 \ S_1)\ 0.48 \quad V(S_4 \ S_2)\ 0.62 \quad V(S_4 \ S_3)\ 0.94$

F. Sixth and seventh steps: measurement criteria and sub criteria in paired comparison matrix is calculated as follows:

$$W \quad (d(C_1), d(C_2), \ldots, d(C_n))^T \qquad C_i \ (i \quad 1,2,\ldots,n)$$

$$W \quad (1,\ 0.89,\ 0.59,\ 0.47)$$

$$W \quad (d(C_1), d(C_2), \ldots, d(C_n))^T \quad (0.339,\ 0.3014,\ 0.199,\ 0.1606)$$

All the above processes for decision makers to gather comments about any of the following criteria are also performed and the data in Table (5) is given.

TABLE V. THE WEIGHT OF THE TOTAL WEIGHT OF EACH CRITERIA AND SUB-CRITERIA AND SUB-CRITERIA

Criteria	Criteria Weight	Sub Criteria	Sub Criteria Weight	Total Weight
Ci	Wi	Cij	Wj	Wij
C1	0.339	C11	0.304	0.103
		C12	0.458	0.155
		C13	0.238	0.081
C2	0.301	C21	0.336	0.101
		C22	0.422	0.127
		C23	0.242	0.073
C3	0.199	C31	0.406	0.081
		C32	0.289	0.057
		C33	0.305	0.061
C4	0.161	C41	0.497	0.080
		C42	0.503	0.081

Second: Ranking of alternatives by TOPSIS FUZZY method using weights obtained from AHP FUZZY

Fuzzy TOPSIS method, this step by step method can be applied hands:

Step one: linguistic variables and respective fuzzy numbers to evaluate the options on the table (6) is given. Comments decision makers about options based on the criteria under criterion C1 and the integration of relevant comments in tables (7) is given.

TABLE VI. MATTERS OF LANGUAGE AND RESPECTIVE FUZZY NUMBERS TO EVALUATE OPTIONS

Fuzzy preference	linguistic terms
(∘ , ∘ , 1)	VP= Very poor
(∘ , 1 , 3)	P= Poor
(1 , 3 , 5)	MP= Mean Poor
(3 , 5 , 7)	F= Mean
(5 , 7 , 9)	MG= Mean Good
(7 , 9 , 10)	G= Good
(9 , 10 , 10)	VG= Very Good

TABLE VII. STANDARDS INFRASTRUCTURE THEORIES OF DECISION MAKERS

Criteria	Alternative	Sub criteria	Decision makers			MEAN (D)		
			D1	D2	D3			
C1	A1	C11	MG	G	G	6.33	8.33	9.67
		C12	VG	VG	G	8.33	9.67	10.00
		C13	MP	P	P	0.33	1.67	3.67
	A2	C11	G	G	MG	6.33	8.33	9.67
		C12	G	P	MG	4.00	5.67	7.33
		C13	MG	VG	F	5.67	7.33	8.67
	A3	C11	MG	VG	G	7.00	8.67	9.67
		C12	MG	G	G	6.33	8.33	9.67
		C13	F	MG	F	3.67	5.67	7.67
	A4	C11	MG	MP	G	4.33	6.33	8.00
		C12	VG	MG	G	7.00	8.67	9.67
		C13	F	G	MP	3.67	5.67	7.33
	A5	C11	VG	VG	VG	9.00	10.00	10.00
		C12	P	P	MP	0.33	1.67	3.67
		C13	G	VG	VG	8.33	9.67	10.00

Second and third weighted normalized fuzzy decision matrix (WNFDM) and positive ideal solution and fuzzy negative ideal solution for options on the table (8) is given.

TABLE VIII. NORMALIZED DECISION MATRIX AND IDEAL SOLUTIONS

WEIGHTED MEAN NORMALIZED MATRIX									
Criteria / Alternative	C1								
	C11			C12			C13		
A1	0.065	0.086	0.100	0.129	0.150	0.155	0.003	0.013	0.030
A2	0.065	0.086	0.100	0.062	0.088	0.114	0.046	0.059	0.070
A3	0.072	0.089	0.100	0.098	0.129	0.150	0.030	0.046	0.062
A4	0.045	0.065	0.082	0.109	0.135	0.150	0.030	0.000	0.000
A5	0.093	0.103	0.103	0.005	0.026	0.057	0.067	0.078	0.081
MAX(S+)	0.093	0.103	0.103	0.129	0.150	0.155	0.067	0.078	0.081
MIN(S-)	0.045	0.065	0.082	0.005	0.026	0.057	0.003	0.000	0.000

TABLE IX. RANKED OPTIONS

Alternative	d+	d-	CCi	RANK
A1	0.16	0.33	0.6659	1
A2	0.18	0.25	0.5927	4
A3	0.16	0.30	0.6513	2
A4	0.17	0.29	0.6240	3
A5	0.27	0.31	0.5273	5

V. CONCLUSION

In this paper a decision-making group of language for solving multiple criteria decision making in fuzzy environment is proposed multiplayer. Considering the fuzziness of the group decision making process, evaluation criteria and sub-criteria weights and scores -packaging options, from linguistic variables are used. In this paper, a fuzzy AHP method to calculate the weights of criteria and sub-criteria by which the classical AHP method has higher accuracy And decision- makers can better express their views and be more careful decision. Then fuzzy TOPSIS method is used to rank options. In this technique, a fuzzy decision matrix, decision makers to gather opinions about the each item is composed of the following criteria in the following weights derived from Fuzzy AHP method that is effective. In total weighted benchmarks by using fuzzy and fuzzy AHP method in which all criteria Together, the paired comparison and ranking of alternatives by TOPSIS also has enhanced the accuracy of the answers.

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