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A Hybrid Moora-Fuzzy Algorithm For Special Education and Rehabilitation Center Selection

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Abstract- Special education and rehabilitation centers are established in order to train children and young people who need special education. The main goal of this study is to determine the most appropriate special education and rehabilitation center, in terms of various criteria by evaluating three different corporations which are active in Kayseri/Turkey. For that purpose, we apply Fuzzy Analytic Hierarchy Process and MOORA which are the methods of multi-criteria decision making. Education, compliance of ergonomic, compliance of corporation building, cost, public opinion and prestige and assessment of personnel are considered as the criteria. Firstly, these criteria are weighted by using Fuzzy Analytic Hierarchy Process, later MOORA method is used to choose the most appropriate corporation.

Keywords- Special Education and Rehabilitation Center; MOORA; Fuzzy Analytic Hierarchy Process; Multi Criteria Decision Making.

1. Introduction

Special Education and Rehabilitation Centers were established in order that individuals who can't adapt to living environment gain the skills that are necessary for self-reliance. This center is a school catering for students who have special educational needs due to severe learning difficulties, physical disabilities or behavioral problems. Special education alternatives in Turkey; Guidance and Research Centers, Special Classes in Regular Schools, Schools for Trainable Children, Primary Schools for Educable Children, Vocational Education Centers, Occupation Education Center, Residential Institutions, Private-special Schools, Private-Special Rehabilitation Centers, and University Affiliated Centers. (Cavkaytar, 2006). We have investigated private-special rehabilitation centers of those mentioned above. For that purpose, three different special education and rehabilitation centers have been evaluated in terms of various criteria. Then, we have applied MOORA (multi-objective optimization on the basis of ratio analysis) that is one of the methods of multi-criteria decision making. MOORA method is not used for the selection of special education and rehabilitation center in the literature. Firstly, the MOORA method was introduced by Willem Karel M. Brauers and Edmundas Kazimieras Zavadskas in 2006 (Brauers & Zavadskas, 2006). Although the MOORA is a newly proposed method; recently, it has been applied to solve many economic, managerial and construction problems.

Some studies in literature; Brauers and Zavadskas (2010, 2008) and Brauers and Ginevicius (2010, 2009) have proposed the use of MOORA method in economy.

Table 1. Comparative performance of some popular MODM methods

MODM method	Computational time	Simplicity	Mathematical calculations involved	Stability
MOORA	Very loss	Very simple	Minimum	Good
AHP	Very high	Very critical	Maximum	Poor
TOPSIS	Moderate	Moderately critical	Moderate	Medium
VIKOR	Less	Simple	Moderate	Medium
ELECTRE	High	Moderately critical	Moderate	Medium
PROMETHEE	High	Moderately critical	Moderate	Medium

Table 2. Criteria

Criteria	
C1. Education	
	C1.1. Awarding
	C1.2. Compliance with the curriculum
C2. Ergonomics	
	C2.1. Suitability of desks
	C2.2. Suitability of the use of the toilets for disabled
C3. Institution's Building	
C4. Cost	
C5. Image and Prestige	
C6. Assessment of Personnel	

Chakraborty (2010) uses the MOORA method to solve different decision making problems in the real-time manufacturing environment. Kracka et al., (2010) have ranked heating losses in a building by applying the MultiMOORA. The aim of his research is to create a technique for the selection of external walls and windows of buildings. In the mentioned field Brauers and Zavadskas (Brauers, Zavadskas 2009; Brauers *et al*. 2008) use the MOORA method for evaluating contractors in the facilities sector. The MOORA method has also been successfully used for determining the best alternative road design (Brauers et al. 2008a). Chakraborty (2011) has applied the MOORA method for decision making in manufacturing environment. Stanujkic et al., (2012) has studied multi-criteria approach to optimization using MOORA method and interval grey numbers. Krande & Chakraborty (2012) have applied the MOORA method for selection of materials. Brauers (2013) has planned the multi-objective seaport by MOORA decision making.

2. Methods & Application

In this study, the MOORA method is used for selection problems. Table 1 depicts the comparative performance of some of the most widely used MODM (Multi Objective Decision Making) methods with respect to their computational time, simplicity, mathematical calculations involved and stability (Ginevicious & Podvezko, 2008). In fact, these results can help us to explain why the MOORA method is chosen.

Three of Kayseri Special Education and Rehabilitation Centers are evaluated in terms of criteria. The aim in this study is to determine the most appropriate Special Education and Rehabilitation Center. The considered criteria are shown in Table 2. Based on expert opinion; the matrix of responses of different alternatives related to different objectives is created. That initial matrix is shown in Table 3

Table 3. Initial matrix

	C1.1 (max)	C1.2 (max)	C2.1 (max)	C2.2 (max)	C4 (min)	C3 (max)	C5 (max)	C6 (max)
Parilti	3	7	2	2	1/8	4	5	5
Nida	4	6	2	4	1/8	4	6	7
Ilgim	2	8	2	3	1/9	5	5	6

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Table 4. Sum of squares & Square roots

	C1.1	C1.2	C2.1	C2.2	C4	C3	C5	C6
	(max)	(max)	(max)	(max)	(min)	(max)	(max)	(max)
Parilti	3	7	2	2	1/8	4	5	5
Nida	4	6	2	4	1/8	4	6	7
Ilgim	2	8	2	3	1/9	5	5	6
Sum of squares	**29**	**149**	**12**	**29**	**0,044**	**57**	**86**	**110**
Square roots	**5,39**	**12,21**	**3,46**	**5,39**	**0,21**	**7,55**	**9,27**	**10,49**

1.1. *The Ratio System*

In the ratio system, initial data of an alternative on an objective are internally normalized. Each response of an alternative on an objective is compared to a denominator which is a representative for all alternatives concerning that objective (Kracka et al, 2010). The denominator consists of the square root of the sum of squares of each alternative per objective (Van Delft and Nijkamp 1977) with: x_{ij} ; response of alternative *j* on objective *i*; *j* = 1, 2, …, m; m the number of alternatives; *i* = 1, 2, …, *n*; *n* is the number of objectives; x^*_{ij} ; a dimensionless number representing the normalized response of alternative *j* on objective *i* (Kracka et al, 2010).

$$x^*_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{m} x^2_{ij}}} \quad (1)$$

Firstly, Sum of Squares & Square Roots are determined and shown in Table 4. Then objectives divided by their square roots, normalized values obtained and shown in Table 5.

For optimization based on the Ratio system approach of MOORA method, normalized responses are added in case of maximization and subtracted in case of minimization, which can be expressed by the following formula (Stanujkic et al., 2012):

$$y^*_j = \sum_{i=1}^{g} x^*_{ij} - \sum_{i=g+1}^{i=n} x^*_{ij} \quad (2)$$

Table 5. Normalized values

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
	(max)	(max)	(max)	(max)	(min)	(max)	(max)	(max)
Parilti	0,557	0,573	0,578	0,371	0,598	0,53	0,539	0,478
Nida	0,742	0,491	0,578	0,742	0,598	0,53	0,647	0,667
Ilgim	0,371	0,655	0,578	0,557	0,532	0,662	0,539	0,572

Table 6. Ordinal ranking of the ratio system

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	Total	Rank
	(max)	(max)	(max)	(max)	(min)	(max)	(max)	(max)		
Parilti	0,557	0,573	0,578	0,371	0,598	0,530	0,539	0,478	**3,028**	**3**
Nida	0,742	0,491	0,578	0,742	0,598	0,530	0,647	0,667	**3,799**	**1**
Ilgim	0,371	0,655	0,578	0,557	0,532	0,662	0,539	0,572	**3,402**	**2**

with: x^*_{ij} as normalized response of alternative *j* on objective *i*; *i* = 1, 2, ..., *g* as the objectives to be maximized; *i* = *g* + 1, *g* + 2, ..., *n* as the objectives to be minimized; *j* = 1, 2, ..., *m* as the alternatives; and y^*_j as the overall ranking index of alternative *j*, $y^*_j\ E \in [-1, 1]$. An ordinal ranking of y_j shows the final preference. Thus, the best alternative has the highest y^*_j value, while the worst alternative has the lowest y^*_j value (Chakraborty, 2011). According to the results that are shown in Table 6, the best alternative is Nida.

1.2. *Reference Point Approach*

In the reference point approach, a maximal objective reference point is considered (Brauers & Zavadskas, 2009). The maximal objective reference point approach is more realistic and non-subjective as the coordinates (r_i), which are selected for the reference point, are realized in one of the candidate alternatives. Given the normalized values of the decision matrix, the deviation of a criterion value from the set reference point (r_i) can be obtained in the formula (3). In this approach, the performance index (P_i) measures this total deviation for all the considered beneficial and non-beneficial criteria for i_{th} alternative, which can be expressed as in the formula (4) (Karande & Chakraborty, 2012). Reference values and the final table are shown in Table 7-8.

$$d_{ij} = \left| r_i - x_{ij}^* \right| \quad (3)$$

$$P_i = Min_{(i)} (\text{Max} \left| r_i x_{ij}^* \right|_{(j)}) \quad (4)$$

According to the reference point approach, still the most appropriate special education and rehabilitation center is Nida. Parilti and Ilgim have equal rank.

2.3. Significance Coefficient

In some cases, it is often observed that some attributes are more important than the others. In order to give more importance to an attribute, it could be multiplied with its corresponding weight (significance coefficient) (Brauers & Zavadskas, 2009) When those attribute significance coefficients are taken into consideration, Eq. 5 becomes as follows:

$$y_j^* = \sum_{i=1}^{g} w_i x_{ij}^* - \sum_{i=g+1}^{i=n} w_i x_{ij}^* \quad (5)$$

Table 7. Reference values

	x_1 (max)	x_2 (max)	x_3 (max)	x_4 (max)	x_5 (min)	x_6 (max)	x_7 (max)	x_8 (max)
r_i	0,742	0,655	0,578	0,742	0,598	0,662	0,647	0,667

Table 8. Ordinal ranking of reference point approach

	x_1 (max)	x_2 (max)	x_3 (max)	x_4 (max)	x_5 (min)	x_6 (max)	x_7 (max)	x_8 (max)	max	Rank
Parilti	0,185	0,082	0	**0,371**	0	0,132	0,108	0,189	**0,371**	**2-3**
Nida	0	**0,164**	0	0	0	0,132	0	0	**0,164**	**1**
Ilgim	**0,371**	0	0	0,185	0,066	0	0,108	0,095	**0,371**	**2-3**

where w_i is the weight of i_{th} attribute, which can be determined applying AHP (*analytic hierarchy process*) or entropy method. As the most effective way to include importance given to objectives into reference point approach of the MOORA method, we propose to adopt formula (3), after which adoption gets the following form (Stanujkic et al., 2012):

$$d_{ij} = w_i \left| r_i - x_{ij}^* \right| \quad (6)$$

3. Proposed Model

In this section, we applied to reference point approach using the significance coefficients. In this respect, FAHP (*fuzzy analytic hierarchy process*) is used for determination of significance coefficients of criteria.

The AHP has been widely used to solve MODM problems. However, due to the existence of vagueness and uncertainty in judgments, a crisp, pair-wise comparison with a classical AHP may be unable to accurately represent the decision-makers' ideas (Ayağ, 2005; Yazgan et.al; 2010). Even though the discrete scale of AHP has the advantages of simplicity and ease of use, it is not sufficient to take into account the uncertainty associated with the mapping of ones perception to a number. Therefore, fuzzy logic is also introduced into the pair-wise comparison to deal with the deficiency in the classical AHP, referred to as FAHP (Nooramin et al., 2012). FAHP is an efficient tool to handle the fuzziness of the data involved in deciding the preferences of different decision variables.

Table 9. Pairwise comparison matrix and fuzzy weights for sub-criteria related education & ergonomics

Pairwise comparison matrix and fuzzy weights for sub-criteria related education			
Criteria	C1.1	C1.2	**Fuzzy Weights**
C1.1	(1, 1, 1)	(1, 2, 4)	**(0.33, 0.67, 1.33)**
C1.2	(1/4, 1/2, 1)	(1, 1, 1)	**(0.16, 0.33, 0.67)**
Pairwise comparison matrix and fuzzy weights for sub-criteria related ergonomics			
Criteria	C2.1	C2.2	**Fuzzy Weights**
C2.1	(1, 1, 1)	(1, 3, 5)	**(0.31, 0.75, 1.54)**
C2.2	(1/5, 1/3, 1)	(1, 1, 1)	**(0.14, 0.25, 0.69)**

Table 11. Criteria & fuzzy significance coefficients

Global fuzzy significance coefficients for sub-factors		
	Criteria & fuzzy significance coefficients	**Global fuzzy significance coefficients**
C1 **(0.13, 0.29, 0.62)**	C1.1 **(0.33, 0.67, 1.33)**	**(0.04, 0.19, 0.82)**
	C1.2 **(0.16, 0.33, 0.67)**	**(0.02, 0.10, 0.42)**
C2 **(0.09, 0.21, 0.47)**	C2.1 **(0.31, 0.75, 1.54)**	**(0.03, 0.16, 0.72)**
	C2.2. **(0.14, 0.25, 0.69)**	**(0.01, 0.05, 0.32)**
	C3	**(0.03, 0.06, 0.14)**
	C4	**(0.04, 0.08, 0.20)**
	C5	**(0.11, 0.26, 0.59)**
	C6	**(0.05, 0.10, 0.24)**

The comparisons made by experts are represented in the form of Triangular Fuzzy Numbers (TFNs) to construct fuzzy pair-wise comparison matrices (Ghodsypour and O'Brien, 1998). In this respect; firstly, institutions are visited and points are given by making observations. Fuzzy triangular numbers that are developed by Prakash (2003) are considered and pairwise comparison matrices for criteria and sub-criteria created in Table (9-10, See Appendix A) for Table 10. Then the obtained global fuzzy criteria significance coefficients are defuzzified and shown in Table (11-13). For the defuzzification, firstly lower and upper bound are determined for every factor at every α-cut value (*Equation 7-8*). Later, combined lower (**$w_{i(lower)}$**) and upper bound values (**$w_{i(upper)}$**) are calculated for every factor (*Equation 9-10*) (Dagdeviren, 2007). Defuzzification for the first factor is mentioned in the below, the defuzzified weight of awarding factor is obtained as 0,278.

$$Lower\ Bound(\text{LB}) = \alpha(\text{m}_i - l_i) + l_i \tag{7}$$

$$Upper\ Bound(\text{UB}) = u_i - \alpha(\text{u}_i - m_i) \tag{8}$$

$$w_{i(lower)} = \frac{\sum_{i=1}^{l} \alpha_i (LB)_i}{\sum_{i=1}^{l} \alpha_i} \tag{9}$$

$$w_{i(upper)} = \frac{\sum_{i=1}^{l} \alpha_i (UB)_i}{\sum_{i=1}^{l} \alpha_i} \tag{10}$$

$$W_i^{'} = \lambda w_{i(lower)} + (1-\lambda) w_{i(upper)};\ \lambda \in [0,1] \tag{11}$$

In practical applications, λ=1; λ=0,5, and λ=0 are used to indicate that the decision maker involved has an optimistic, moderate, or pessimistic view, respectively. An optimistic decision maker is apt to prefer higher values of his/her fuzzy assessments, while a pessimistic decision maker tends to favor lower values (Deng, 1999). In this study; λ, is considered as 0,5. According to Eq (11); defuzzified significance coefficient is calculated for awarding factor. Since the sum of defuzzied significance coefficients is more than 1, weights are normalized. According to the results, the most appropriate special education and rehabilitation center is Nida, Parilti and Ilgim, respectively. The results are shown in Table 14.

Table 12. Defuzzification for the first criterion

Defuzzification for the first criterion (Awarding)									
α-cut	**0,1**	**0,2**	**0,3**	**0,4**	**0,5**	**0,6**	**0,7**	**0,8**	**0,9**
lower bound	0,055	0,07	0,085	0,1	0,115	0,13	0,145	0,16	0,175
upper bound	0,757	0,694	0,631	0,568	0,505	0,442	0,379	0,316	0,253

Table 13. Weights, defuzzified & normalized significance coefficients

Criteria	**li**	**mi**	**ui**	**Com. Lower Bound**	**Com. Upper Bound**	**Coeff.**	**Nor. Coeff.**
C1.1	0.04	0.19	0.82	0,135	0,421	**0,278**	**0,21**
C1.2	0.02	0.10	0.42	0,07	0,217	**0,144**	**0,109**
C2.1	0.03	0.16	0.72	0,112	0,365	**0,238**	**0,18**
C.2.2	0.01	0.05	0.32	0,035	0,149	**0,092**	**0,069**
C3	0.03	0.06	0.14	0,049	0,089	**0,069**	**0,052**
C4	0.04	0.08	0.20	0,065	0,124	**0,094**	**0,071**
C5	0.11	0.26	0.59	0,205	0,381	**0,293**	**0,221**
C6	0.05	0.10	0.24	0,081	0,151	**0,116**	**0,088**

Table 14. Ordinal ranking of reference point approach with significance coefficient

	x_1	**x_2**	**x_3**	**x_4**	**x_5**	**x_6**	**x_7**	**x_8**	**MAX**	**Rank**
	(max)	**(max)**	**(max)**	**(max)**	**(min)**	**(max)**	**(max)**	**(max)**		**(MIN)**
Normalized S.C.	**0,21000**	**0,10900**	**0,18000**	**0,06900**	**0,05200**	**0,07100**	**0,22100**	**0,08800**	-	-
Parilti	**0,03885**	0,00893	0,00000	0,02559	0,00343	0,00937	0,02386	0,01663	**0,03885**	**2**
Nida	0,00000	**0,01787**	0,00000	0,00000	0,00343	0,00937	0,00000	0,00000	**0,01787**	**1**
Ilgim	**0,07791**	0,00000	0,00000	0,01276	0,00000	0,00000	0,02386	0,00836	**0,07791**	**3**

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3.1. Full-Multiplicative Form

Brauers and Zavadskas developed the following equation for the full multiplicative form of MOORA (MULTIMOORA) method to distinguish it from the mixed forms (Karande & Chakraborty, 2012; Brauers and Zavadskas, 2010; Brauers and Zavadskas, 2011).

$$U_i = \frac{A_i}{B_i} \qquad (13)$$

where $A_i = \prod_{j=1}^{g} x_{ij}^*$, $B_i = \prod_{j=g+1}^{n} x_{ij}^*$ and U_i is the degree of utility for i_{th} alternative. In Eq. (12), the criteria to be maximized (beneficial attributes) are taken as the numerator and the criteria to be minimized (non-beneficial attributes) are taken as denominator (Balezentis et al., 2010).

Brauers and Zavadskas suggested that if any of the x_{ij} value is 0, which signifies the absence of a particular criterion in the decision matrix, a foregoing filtering stage or withdrawal of that criterion from the decision matrix can be considered (Karande & Chakraborty, 2012; Brauers and Zavadskas, 2010; Brauers and Zavadskas, 2011). According to the multiplicative form method, Nida is also the best special education and rehabilitation center. The results are shown in Table 15 (See Appendix B).

3.2. MultiMOORA

MultiMOORA is the further sequence of the MOORA method and of the full multiplicative form of multiple-objectives. MultiMOORA was introduced by Brauers and Zavadskas for the first time at the beginning of 2010. MultiMOORA becomes the most robust system of multiple optimizations under condition of support from the ameliorated nominal group technique and Delphi (Brauers and Zavadskas 2010). In fact, MultiMOORA determines dominant alternative. The results are shown in Table 16.

Table 16. MutiMOORA ranking

	MOORA Ratio System	MOORA Reference Point Tchebycheff	MOORA Reference Point with Sig. Coef.	Full Multiplicative Form	MultiMOORA
Parilti	3	2 - 3	2	3	**3**
Nida	1	1	1	1	**1**
Ilgim	2	2 - 3	3	2	**2**

4. Conclusion

All calculation results show that the best alternative is Nida. According to MultiMOORA, the best center is Nida, the second center is Ilgim and the third center is Parilti. In this study it is shown that MOORA is an effective method for the selection of alternatives. The ranking of this case study is summarized in Fig 1.

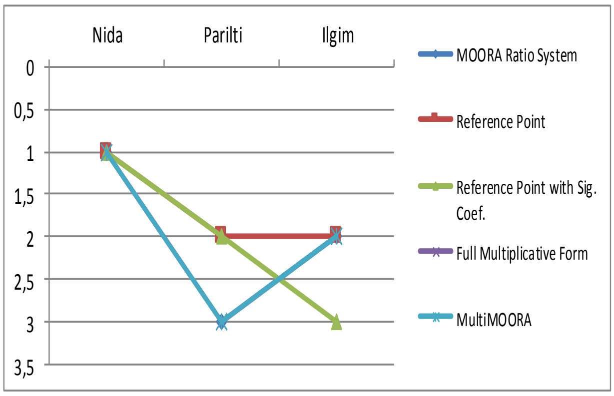

Fig 1. Ranking for all methods

The main advantage of these methods is that a simple ratio system is adopted to make the decision matrices dimensionless and comparable. The performance of these methods is also comparable with other popular and widely used Multi-Criteria Decision Making methods. Thus, these methods can also be applied to the other decision-making scenario with any number of alternatives and criteria.

MOORA and MULTIMOORA optimization technique with discrete alternatives was used for ranking alternatives in the selection of the special education and rehabilitation center. In the future work, the case study will be analyzed using grey numbers. Moreover, the results will be compared results with other multi-criteria decision making methods.

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APPENDIX A

Table 10. Pairwise comparison matrix and fuzzy weights for criteria

Pairwise comparison matrix and fuzzy weights for criteria						
Criteria	ED	ER	IB	CO	IP	AP
Education (ED)	(1, 1, 1)	(1, 2, 4)	(5, 7, 9)	(3, 5, 7)	(1/7, 1/5, 1/3)	(3, 5, 7)
Ergonomics (ER)	(1/4, 1/2, 1)	(1, 1, 1)	(1, 1, 1)	(3, 5, 7)	(1, 2, 4)	(1, 2, 4)
Institution's Building (IB)	(1/9, 1/7, 1/5)	(1, 1, 1)	(1, 1, 1)	(1/4, 1/2, 1)	(1/7, 1/5, 1/3)	(1/4, 1/2, 1)
Cost (CO)	(1/7, 1/5, 1/3)	(1/7, 1/5, 1/3)	(1, 2, 4)	(1, 1, 1)	(1, 2, 4)	(1/7, 1/5, 1/3)
Image and Prestige (IP)	(3, 5, 7)	(1/4, 1/2, 1)	(3, 5, 7)	(1/4, 1/2, 1)	(1, 1, 1)	(5, 7, 9)
Assessment of Personnel (AP)	(1/7, 1/5, 1/3)	(1/4, 1/2, 1)	(1, 2, 4)	(3, 5, 7)	(1/9, 1/7, 1/5)	(1, 1, 1)
Geometric mean of the 1th row: $\{(1\times1\times5\times3\times1/7\times3)^{1/6},(1\times2\times7\times5\times1/5\times5)^{1/6},(1\times4\times9\times7x1/3\times7)^{1/6}\}$=(1.36, 2.03, 2.89)						
Geometric mean of the ^{2nd} row: $\{(1/4\times1\times1\times3\times1\times1)^{1/6},(1/2\times1\times1\times5\times2\times2)^{1/6},(1\times1\times1\times7\times4\times4)^{1/6}\}$=(0.95, 1.47, 2.20)						
Geometric mean of the 3rd row: $\{(1/9\times1\times1\times1/4\times1/7\times1/4)^{1/6},(1/7\times1\times1\times1/2\times1/5\times1/2)^{1/6},(1/5\times1\times1\times1\times1/3\times1)^{1/6}\}$=(0.31, 0.44, 0.64)						
Geometric mean of the 4th row: $\{(1/7\times1/7\times1\times1\times1\times1/7)^{1/6},(1/5\times1/5\times2\times1\times2\times1/5)^{1/6},(1/3\times1/3\times4\times1\times4\times1/3)^{1/6}\}$=(0.38, 0.56, 0.92)						
Geometric mean of the 5th row: $\{(3\times1/4\times3\times1/4\times1\times5)^{1/6},(5\times1/2\times5\times1/2\times1\times7)^{1/6},(7\times1\times7\times1\times1\times9)^{1/6}\}$=(1.19, 1.88, 2.76)						
Geometric mean of the 6 throw: $\{(1/7\times1/4\times1\times3\times1/9\times1)^{1/6},(1/5\times1/2\times2\times5\times1/7\times1)^{1/6},(1/3\times1\times4\times7\times1/5\times1)^{1/6}\}$=(0.48, 0.72, 1.11)						
The sum of the fuzzy geometric averages: (4.67, 7.1, 10.52)						
The fuzzy weight of ED Factor: {(1.36/10.52, 2.03/7.1, 2.89/4.67)}=(0.13, 0.29, 0.62)						
The fuzzy weight of ER Factor: {(0.95/10.52, 1.47/7.1, 2.20/4.67)}= (0.09, 0.21, 0.47)						
The fuzzy weight of IB Factor: {(0.31/10.52, 0.44/7.1, 0.64/4.67)}=(0.03, 0.06, 0.14)						
The fuzzy weight of CO Factor: {(0.38/10.52, 0.56/7.1, 0.92/4.67)}=(0.04, 0.08, 0.20)						
The fuzzy weight of IP Factor: {(1.19/10.52, 1.88/7.1, 2.76/4.67)}=(0.11, 0.26, 0.59)						
The fuzzy weight of AP Factor: {(0.48/10.52, 0.72/7.1, 1.11/4.67)}= (0.05, 0.10, 0.24)						

APPENDIX B

Table 15. Ordinal ranking of multiplicative form

	x_1	x_2	2.1	x_3	3.1	x_4	4.1	x_5	5.1
	(max)	(max)	2.1=1*2	(max)	3.1=2.1*3	(max)	4.1=3.1*4	(min)	5.1=4.1:5
Parilti	3	7	21,0	2,0	42,0	2,0	84,0	1/8,0	**672,0**
Nida	4	6	24,0	2,0	48,0	4,0	192,0	1/8,0	**1536,0**
Ilgim	2	8	16,0	2,0	32,0	6,0	96,0	1/9,0	**864,0**

	x_6	6.1	x_7	7.1	x_8	8.1	Result
	(max)	6.1=5.1*6	(max)	7.1=6.1*7	(max)	8.1=7.1*8	
Parilti	4,0	2688,0	5,0	13440,0	5,0	67200,0	**3**
Nida	4,0	6144,0	6,0	36864,0	7,0	258048,0	**1**
Ilgim	5,0	4320,0	5,0	21600,0	6,0	129600,0	**2**