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PERSONNEL SELECTION UTILIZING THE DECISION MAKING MECHANISM CREATED WITH THE INTUITIONISTIC FUZZY TOPSIS METHOD

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Abstract

In this study, a decision making mechanism for personnel selection was created by using the intuitionistic fuzzy based TOPSIS method, which is one of the multi-criteria decision making methods. According to the criteria determined by the decision makers, each candidate was evaluated individually by the decision makers and the most suitable personnel were selected. During the evaluation, the decision makers expressed their views through linguistic terms. Thanks to the intuitionistic fuzzy sets, situations where decision makers are undecided have become meaningful. This decision making mechanism prepared for personnel selection may be utilized by any company that will select personnel and the criteria may be changed in accordance with the purpose of the company. This study, which will attract the attention of many researchers in the field of decision making, will shed light on demanded application areas.

Keywords: Intuitionistic fuzzy sets, multi criteria decision making, TOPSIS method, personnel selection.

SEZGİSEL BULANIK TOPSIS YÖNTEMİ İLE OLUŞTURULAN KARAR VERME MEKANİZMASI KULLANILARAK PERSONEL SEÇİMİ

Özet

Bu çalışmada, çok kriterli karar verme yöntemlerinden biri olan sezgisel bulanık tabanlı TOPSIS yöntemi kullanılarak personel seçimi için bir karar verme mekanizması oluşturulmuştur. Karar vericiler tarafından belirlenen kriterlere göre her aday, karar vericiler tarafından ayrı ayrı değerlendirilmiş ve en uygun personel seçilmiştir. Değerlendirme sırasında karar vericiler görüşlerini dilsel terimlerle ifade etmişlerdir. Sezgisel bulanık kümeler sayesinde karar vericilerin kararsız kaldığı durumlar anlamlı hale gelmiştir. Personel seçimi için hazırlanan bu karar verme mekanizması, personel seçecek herhangi bir şirket tarafından kullanılabilir ve şirketin amacına göre kriterler değiştirilebilir. Karar verme alanında birçok araştırmacının ilgisini çekecek olan bu çalışma, talep edilen uygulama alanlarına ışık tutacaktır.

Anahtar Kelimeler: Sezgisel bulanık kümeler, çok kriterli karar verme, TOPSIS yöntemi, personel seçimi.

Cite

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1. Introduction

Researchers have used binary logic in application areas for years. Afterwards, the memberships of the elements were graded by the fuzzy logic [1]. Intuitionistic fuzzy (IF) set was described [2]. IF sets and many branches of mathematics, which attract the attention of researchers, are now used in application areas as a part of daily life, there are studies on these subjects; e.g; education, computers, agriculture, artificial intelligence, controlled sets, algebraic structures, statistics [3-11].

In a system where many criteria are included, the abundance of alternatives and the difference in the importance of the criteria make the choice between alternatives difficult. Multi-criteria decision making (MCDM) methods allow such problems to disappear. Many methods, AHP, ELECTRE, TOPSIS, PROMETHEE, etc. provide effective results in application areas. While MCDM methods were utilized in binary logic, they were redefined in fuzzy terms and then intuitionistic fuzzy based systems were developed.

TOPSIS, fuzzy TOPSIS and IF TOPSIS methods were used by researchers both theoretically and in many application areas: Supplier selection, facility location selection, mobile phone selection, distance measure, selecting school, furniture industry, departments' performances, selection of wind power plants, determination of physical conditions of schools, etc [12-19].

The most important principle of companies, firms and most general of all business sectors is good personnel. Technological developments, the increase in qualified personnel candidates, the strengthening of the competitive environment and the increasing demands day by day have made the importance of personnel selection for the company the main focus. The quality of personnel selected should directly serve the company's purposes. Many characteristics of personnel such as foreign language knowledge, marketing ability, computer knowledge, business discipline, and field expertise are important features to be considered in order to increase the quality of the company. In the world sector where competition is strong, companies have started to be more sensitive about personnel selection. Established for these purposes, MCDM mechanisms greatly facilitate the work of companies. There are several important steps in the operating principle of MCDM mechanisms. First of all, there are many officials such as company owner(s), human resources manager, responsible for the department where the personnel will be recruited. These officials constitute the decision makers within the mechanism, so the determination of the authorities is very important. Afterwards, the authorities have indispensable expectations as per the company policies when evaluating the personnel. It is an important step for them to be able to express these expectations well and not have any difficulties while evaluating them. Therefore, these expectations of the companies constitute the criteria in the MCDM mechanism. However, the importance level of each of these expectations may be different from each other, and here the criterion weights come into play. In the next step, it is very important for the authorities to feel comfortable while evaluating the personnel candidates, to be able to approach them objectively and to express their thoughts freely. In this direction, thanks to the TOPSIS method in the MCDM mechanism used in this study, linguistic terms have facilitated the work of the authorities. Moreover, the authorities had no difficulty in expressing the undecided situations thanks to the intuitionistic fuzzy sets. In the last and most important step of the MCDM mechanism, when the candidate personnel is evaluated and when it comes to the selection stage, it is aimed to make the ranking in the fairest way by observing both positive and negative ideals at the same time. There are many studies in the literature on personnel selection [20-26]. A MCDM mechanism for personnel selection was created by utilizing the IF based TOPSIS. The necessary criteria for personnel selection were identified of the relevant company.

2. Preliminaries

Definition 1: [2] Let $X \neq \emptyset$. An intuitionistic fuzzy set A in X;

$$A = \{\langle x, \mu_A(x), \nu_A(x)\rangle |\; x \in X\}, \qquad (1.1)$$

The algorithm of IF TOPSIS:

Step 1. The interest of each DM was determined [27].
Table 1 represents I important, VI very I, M medium, B bad, VB very B.

Table 1. Equivalents for the Interest of DMs

Expressions	IFNs
VI	(0.8,0.1)
I	(0.5,0.2)
M	(0.5,0.5)
B	(0.3,0.5)
VB	(0.2,0.7)

λl values were determined as follows:

$$\lambda l = \frac{\left[\mu l + \pi l\left(\frac{\mu l}{\mu l + \nu l}\right)\right]}{\sum_{l=1}^{k}\left[\mu l + \pi l\left(\frac{\mu l}{\mu l + \nu l}\right)\right]} \qquad (1.2)$$

$\lambda 1 \in [0,1]$ and $\sum_{l=1}^{k} \lambda l = 1$.

Step 2 The weights was represented as follows:

In Table 2 expressions were represented that U is unimportant, VU is very U. The IFWA operator was defined by Xu [28].

Table 2. Equivalents for the Criterion

Expressions	IFNs
VI	(0.9,0.1)
I	(0.75,0.2)
M	(0.5,0.45)
U	(0.35,0.6)
VU	(0.1,0.9)

The weights were obtained as follows:

$$w_j = IFWAr_\lambda\left(w_j^{(1)}, w_j^{(2)}, \dots, w_j^{(l)}\right) = \lambda_1 w_j^{(1)} \oplus \lambda_2 w_j^{(2)} \oplus, \dots, \oplus \lambda_k w_j^{(k)}$$
$$= \left[1 - \prod_{l=1}^{k}\left(1 - \mu_{ij}^{(l)}\right)^{\lambda l}, \left(\prod_{l=1}^{k}\left(\nu_{ij}^{(l)}\right)^{\lambda l}\right), \prod_{l=1}^{k}\left(1 - \mu_{ij}^{(l)}\right)^{\lambda l} - \prod_{l=1}^{k}\left(\nu_{ij}^{(l)}\right)^{\lambda l}\right] \qquad (1.3)$$

Step 3 The interests of the alternatives were obtained thanks to numerical values:

Table 3 indicates that VG is very G, G is good, MG is medium G, F is fair, P is poor, MP is medium P, VP is very P.

Table 3. Equivalents for the Alternatives

Expressions	IFNs
VG	(1.00,0.00)
G	(0.85,0.05)
MG	(0.70,0.20)
F	(0.50,0.50)
MP	(0.40,0.50)
P	(0.25,0.60)
VP	(0.00,0.90)

$R^l = (r_{ij}^{(l)})_{m*n}$ is the IFDM of each DM.

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

$$r_{ij} = IFWA r_{\lambda}(r_{ij}^{(1)}, r_{ij}^{(2)}, \dots, r_{ij}^{(l)}) = \lambda_1 r_{ij}^{(1)} \oplus \lambda_2 r_{ij}^{(2)} \oplus, \dots, \oplus \lambda_k r_{ij}^{(k)} \quad (1.4)$$

Step 4 S matrix was calculated.

$$S = R \times W$$

$$R \otimes W = (\mu'_{ij}, v'_{ij}) = \{\langle \mu_{ij} \times \mu_j, v_{ij} + v_j - v_{ij} \times v_j \rangle\} \quad (1.5)$$

Step 5 A^+ and A^- were determined as follows:

$$A^+ = (r_1'^*, r_2'^*, \dots, r_n'^*), r_j'^* = (\mu_j'^*, v_j'^*, \pi_j'^*), \quad j = 1,2, \dots, n \quad (1.6)$$

$$A^+ = (r_1'^-, r_2'^-, \dots, r_n'^-), r_j'^- = (\mu_j'^-, v_j'^-, \pi_j'^-), \quad j = 1,2, \dots, n \quad (1.7)$$

where

$$\mu_j'^* = \left\{\left(\max_i\{\mu'_{ij}\} j \in J_1\right), \left(\min_i\{\mu'_{ij}\} j \in J_2\right)\right\}$$

$$v_j'^* = \left\{\left(\min_i\{v'_{ij}\} j \in J_1\right), \left(\max_i\{v'_{ij}\} j \in J_2\right)\right\}$$

$$\mu_j'^- = \left\{\left(\min_i\{\mu'_{ij}\} j \in J_1\right), \left(\max_i\{\mu'_{ij}\} j \in J_2\right)\right\}$$

$$v_j'^- = \left\{\left(\max_i\{v'_{ij}\} j \in J_1\right), \left(\min_i\{v'_{ij}\} j \in J_2\right)\right\}$$

Step 6 Many distance measures were defined on intuitionistic fuzzy sets [29-31]. In this study, the normalized Hamming measure was used. The normalized Hamming measure is the most sensitive measure of distance compared to other distance measures.

S_i^+ and S_i^- are calculated.

$$S_i^+ = \frac{1}{2n} \sum_{i=1}^{n} [|\mu'_{ij} - \mu_{ij}'^*| + |v'_{ij} - v_{ij}'^*| + |\pi'_{ij} - \pi_{ij}'^*|] \quad (1.8)$$

$$S_i^- = \frac{1}{2n} \sum_{i=1}^{n} [|\mu'_{ij} - \mu_{ij}'^-| + |v'_{ij} - v_{ij}'^-| + |\pi'_{ij} - \pi_{ij}'^-|] \quad (1.9)$$

Step 7 The closeness coefficient was calculated by the formula:

$$C_i^* = \frac{S_i^-}{S_i^+ + S_i^-}, \quad (1.10)$$

and $0 \leq C_i^* \leq 1$. The resulting value is ranked from largest to smallest. A larger C_i^* value indicates better alternative.

3. Personnel Selection with the Intuitionistis Fuzzy TOPSIS

IF TOPSIS method was utilized for the personnel selection of a company in this study. There are 3 decision makers, 8 criteria and 6 alternatives in the study. Alternatives represent candidate personnel. CP show that set of alternatives. Classification of criteria are as follows:

- PSC_1: Experience
- PSC_2:Education/Training
- PSC_3: Teamwork Compatibility
- PSC_4: Skill of Computer Programs
- PSC_5: Work Capability
- PSC_6: Self-Reliance
- PSC_7: Skill of Foreign Language
- PSC_8:Verbal Communication Skill

The steps of applying the IF TOPSIS method to the alternatives and criteria mentioned above and explained in detail are like that:

Step 1: The representatives of the DMs are as follows:

- DM_1-Manager
- DM_2- Human Resources Manager
- DM_3- Expert in the Field

At the same time, the linguistic term equivalents of the contribution rates of the decision makers were shown on the basis of Table 1.

- DM_1: VI
- DM_2: VI
- DM_3: I

Step 2: Table 4 represents the weights. Assigned numeric values to the linguistic expressions were determined with the help of IF values in Table 2. Using of Equation 1.3, weights of criteria were determined.

Table 4. Importance of criteria based on DMs opinion

	DM_1	DM_2	DM_3
PSC_1	I	VI	VI
PSC_2	VI	I	VI
PSC_3	VI	VI	VI
PSC_4	I	I	VI
PSC_5	I	VI	I
PSC_6	M	I	M
PSC_7	VI	I	M
PSC_8	I	VI	M

Step 3: The interests of the candidates was determined in Table 5.

Table 5. Importance of candidates according to DMs

	PSC_1	PSC_2	PSC_3	PSC_4	PSC_5	PSC_6	PSC_7	PSC_8
DM_1								
CP_1	G	VG	G	MP	MG	G	G	P
CP_2	MG	G	MG	P	MG	VG	G	G
CP_3	F	P	MP	MG	G	MG	MG	VG
CP_4	VG	VG	G	G	G	VG	VG	G
CP_5	P	MG	MG	P	MP	MG	MP	G
CP_6	VP	MP	P	P	P	MP	MG	MG
DM_2								
CP_1	MG	VG	MG	P	MG	G	VG	MP
CP_2	G	MG	MG	P	G	G	VG	MG
CP_3	P	F	P	G	G	G	G	VG
CP_4	G	VG	VG	VG	G	G	G	MG
CP_5	P	MG	MG	MP	MP	F	MP	G
CP_6	VP	P	MP	P	MP	MG	MG	G
DM_3								
CP_1	MG	G	MG	P	G	G	G	MP
CP_2	MG	G	F	MP	MG	G	VG	G
CP_3	MP	P	MP	MG	MG	MG	G	G
CP_4	MG	VG	MG	G	MG	G	VG	MG
CP_5	VP	F	G	P	P	MG	P	MG
CP_6	VP	MP	P	MP	P	MP	MP	G

AIFDM was calculated using by Equation 1.4. R matrix was obtained.

Step 4: S matrix was obtained in Table 6.

Step 5 A^+ and A^- were obtained using by Equation 1.6 and 1.7 in Table 7 and Table 8, as follows:

Table 7. The IF positive ideal solution A^+

A^+	
PSC_1	(0.861, 0.128)
PSC_2	(0.861, 0.128)
PSC_3	(0.900, 0.100)
PSC_4	(0.807, 0.163)
PSC_5	(0.669, 0.218)
PSC_6	(0.609, 0.336)
PSC_7	(0.780, 0.197)
PSC_8	(0.780, 0.197)

Table 8. The IF negative ideal solution A^-

A^-	
PSC_1	(0.336, 0.593)
PSC_2	(0.302, 0.618)
PSC_3	(0.315, 0.580)
PSC_4	(0.239, 0.640)
PSC_5	(0.618, 0.269)
PSC_6	(0.466, 0.417)
PSC_7	(0.630, 0.262)
PSC_8	(0.273, 0.625)

Step 6-7 Separation measures, namely, S^+ and S^- were obtained with use of by normalized Hamming distance measure (with by Equation 1.8 and 1.9) in Table 9 and were shown in Figure 1. Also, The closeness coefficient C_i^* between S^+ and S^- was obtained using by Equation 1.10 and shown in Figure 2.

Table 9. Separation measures and closeness coefficient values

	S^+	S^-	C_i^*
CP_1	0.1158	0.1001	0.4635
CP_2	0.1028	0.1143	0.5265
CP_3	0.1535	0.0624	0.2892
CP_4	0.0131	0.1941	0.9369
CP_5	0.2160	0.1315	0.3784
CP_6	0.2679	0.0954	0.2625

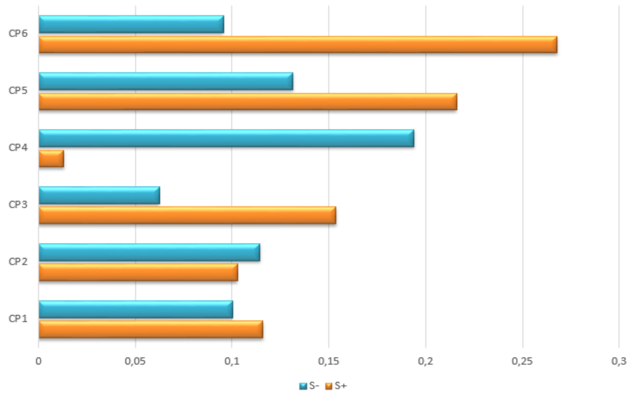

Figure 1. The Separation Measures Values

Table 6. S Matrix

	CP_1	CP_2	CP_3	CP_4	CP_5	CP_6
PSC_1	(0.659, 0.234)	(0.659, 0.234)	(0.337,0.593)	(0.861, 0.128)	(0.159, 0.715)	(0.000,0.912)
PSC_2	(0.861, 0.128)	(0.696, 0.199)	(0.302, 0.618)	(0.861, 0.128)	(0.562, 0.354)	(0.302, 0.593)
PSC_3	(0.689,0.209)	(0.587, 0.334)	(0.315, 0.580)	(0.900, 0.100)	(0.679, 0.221)	(0.276, 0.606)
PSC_4	(0.248,0.634)	(0.239, 0.640)	(0.618, 0.265)	(0.807, 0.163)	(0.248, 0.634)	(0.239, 0.640)
PSC_5	(0.618,0.269)	(0.627, 0.259)	(0.669, 0.218)	(0.669, 0.218)	(0.295, 0.601)	(0.251, 0.631)
PSC_6	(0.518,0.370)	(0.609, 0.336)	(0.466, 0.417)	(0.609, 0.336)	(0.390, 0.521)	(0.750, 0.200)
PSC_7	(0.780,0.197)	(0.780, 0.197)	(0.630, 0.263)	(0.780, 0.197)	(0.281, 0.620)	(0.495, 0.406)
PSC_8	(0.273,0.626)	(0.630, 0.263)	(0.780, 0.197)	(0.597, 0.295)	(0.637, 0.256)	(0.630, 0.263)

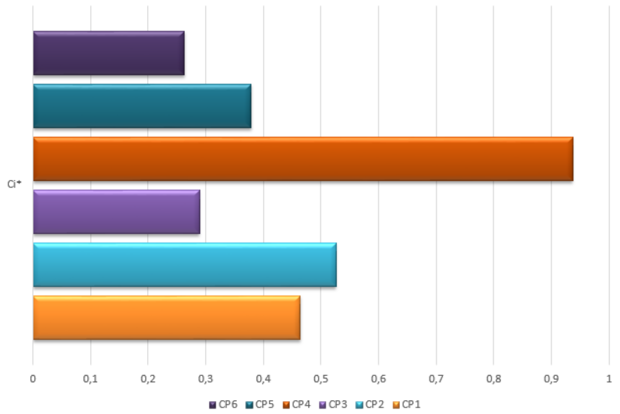

Figure 2. The Closeness Coefficient Values

When ranking the closeness coefficient values, the larger value shows a better alternative. Accordingly, when the closeness coefficient values are ordered, ranking from the most suitable candidate to the most unsuitable candidate:
$CP_4 - CP_2 - CP_1 - CP_5 - CP_3 - CP_6$.

According to this ranking, the best personnel candidate for the company's criteria is CP_4. Among the personnel candidates, the candidate who does not meet the company criteria is CP_6. Considering the above-mentioned company criteria and the decision-making mechanism prepared based on the views of the DMs, the company should select the CP_4 candidate.

4. Conclusion

An original mechanism was created for the purpose of company personnel selection, thanks to the intuitionistic fuzzy TOPSIS method. DMs determined the importance of each criterion in personnel selection. Candidate personnel were evaluated separately by the DMs. As a result of the evaluations, the DMs expressed their opinions in linguistic terms. At the end of all these steps, 6 candidate personnel were evaluated by 3 DMs with respect to 8 criteria and the most suitable personnel for the company was determined. The biggest advantage of the IF TOPSIS method is that DMs have the ease of expressing their ideas in linguistic terms, and the undecided situations in the views have gained meaning thanks to the IF sets. In this MCDM mechanism, which will give very effective results in personnel selection, criteria and decision makers may be changed. It may be integrated into different application areas. It is a study that will offer a new perspective to all researchers working in every application area where there is a MCDM mechanism.

Thanks to this mechanism, companies may develop themselves in line with their goals. Also, personnel may be recruited or evaluated in matters such as personnel recruitment, strengthening the company's reputation or increasing the company's earnings. The criteria set by company policies may vary between companies. Because companies determine the features they are looking for in the personnel they will hire in line with their targets. The quality of the personnel, their high work efficiency, strong communication and openness to cooperation are generally sought by most companies. The established mechanism may be easily used by the requesting company by determining the candidate personnel and desired features individually because all the steps are explained and detailed.

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