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Research Article

Catering Company Selection with Fuzzy AHP, ELECTRE and VIKOR Method for a Company Producing Trailer

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Absract

It is very important to choose a catering company for all kinds of businesses where there is a need for bulk meals. Catering companies are often preferred because they offer a more practical and more economical food solution at workplaces or other community locations. Therefore, people are looking for food companies to meet their expectations. In order to make a selection that is meaningful and meets your expectations, it is necessary to choose a company that can provide this service in a complete way. The food break and quality are important for the employees to continue their daily life and get away from the work stress in a busy working environment. The food break and quality are important for the employees to continue their daily life and get away from the work stress in a busy working environment. Among the issues that employees complain to the human resources department in the companies is the fact that the selected catering companies cannot meet the expectations. It has been observed that companies have difficulty in choosing food supplier in order to meet the expectation of increase in people's awareness. While choosing a catering company, there are other important issues as much as the catering menus. There are some criteria to consider when working with a good catering firm. In this study, a catering company was selected by using multi-criteria decision making methods (MCDM) for a firm making a trailer. In choosing a catering company, quality, price, distance and service criteria are taken into consideration. The weight of the criteria was determined by the Fuzzy Analytic Hierarchy Process (FAHP), and alternatives were selected by ELECTRE (ELimination and Choice Expressing REality) and VIKOR methods.

Keywords: Multi-Criteria Decision making, Fuzzy Analytic Hierarchy Process, ELECTRE, VIKOR.

Treyler Üreten Bir İşletmede Bulanık AHP, ELECTRE ve VIKOR Yöntemi ile Catering Firma Seçimi

Öz

Toplu yemek ihtiyacının olduğu her işletme için anlaşma yapılacak catering firması oldukça önemlidir. Catering firmaları, iş yerlerinde veya topluluk olan diğer yerlerde daha pratik ve daha ekonomik bir yemek çözümü sundukları için, oldukça sık tercih edilmektedir. Dolayısıyla da insanlar toplu yemek siparişi vermek için beklentilerini karşılayacak yemek firmaları aramaktadırlar. Yoğun çalışma ortamında çalışanların günlük yaşama devam etmesi ve iş stresinden uzaklaşabilmesi için yemek molası ve kalitesi önemlidir. Çalışanların firmalarda, insan kaynakları departmanına en fazla şikayet ettikleri konular arasında, seçilen catering firmalarının beklentileri karşılayamaması olmaktadır. Günümüzde insanların bilinçlenmesinden kaynaklanan beklenti yükselmesini karşılayabilmek için firmaların catering firması seçerken zorlandıkları gözlenmiştir. Catering firması seçimi yaparken en az catering menüleri kadar

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önemli başka hususlar da vardır. İyi bir catering firmasıyla çalışmak için göz önünde bulundurulması gereken bazı kriterler vardır. Bu çalışmada, dorse üretimi yapan bir firma için çok kriterli karar verme yöntemleri (ÇKKV) kullanılarak catering firması seçimi yapılmıştır. Catering firması seçiminde, kalite, fiyat, mesafe ve hizmet kriterleri dikkate alınmıştır. Bulanik Analitik Hiyerarşi Prosesi (BAHP) ile kriterlerin ağırlıkları belirlenmiş, ELECTRE (ELimination and Choice Expressing REality) ve VIKOR yöntemleri ile altenatifler sıralanarak seçilmiştir.
Keywords: Çok kriterli karar verme, Bulanık Analitik Hiyerarşi Prosesi, ELECTRE, VIKOR.

1. Introduction

Companies have made significant efforts to make the most appropriate decision on different issues from past to present. Various methods have been developed to facilitate the decision making process. One of the issues that businesses need to decide is the selection of catering company. Today, there are many companies that provide catering services. Among these companies, it is difficult to find a quality and reliable company that will meet expectations. Catering company is a company that provides food and service to any person or organization. It is very important to choose a good catering company for the institutions that receive this service. The meals offered by catering companies are consumed by the staff working in these institutions. The good or bad quality of the meals directly affects the performance of the staff in the institution. For this reason, institutions should be careful in choosing a catering company and keep some criteria in mind. When choosing a catering company, should be selection made considering many criteria. Since there are multiple criteria in the selection of the catering company, multi-criteria decision making (MCDM) methods can be used in the selection of the catering company.

Managers' main tasks include making decisions in the right place at the right time. Managers should also make a correct and timely decision when choosing a catering firm. Managers can choose appropriate selection criteria and evaluate the alternatives according to these criteria while making a selection. In cases where more than one criterion takes place, the use of multi-criteria decision making (MCDM) methods will be effective in achieving the correct result.

MCDM methods are a methodological tool that allows the decision maker to choose the best option by optimizing multiple criteria (Atan et al., 2016). Another benefit of the MCDM methods is that it enables multiple disciplines to coexist and the decision maker can evaluate in multiple dimensions (Ersöz et al., 2018).

Dickson (1966) stated quality, price, delivery and previous performance as important criteria in supplier selection. In recent studies, multi-criteria decision-making methods have been applied together in many problems. For the supplier selection problem, Soner and Önüt (2006) used a combined AHP and ELECTRE method. Gal and Hanne (2006) studied the problem of choosing a laptop with the help of an approach based on a combination of multiple criteria decision-making methods and neural networks. Pi and Low (2006) used AHP in supplier evaluation and selection by using Taguchi loss function; Liu and Hui (2005) used AHP for supplier selection.

Vahidov and Ji (2005) developed a fuzzy model based on clustering analysis for the selection of laptops by proposing a method to support purchasing decisions of the customers in e-commerce. Vinodh et al. (2014) used Fuzzy AHP and TOPSIS methods for selecting plastic recycling method. Prakash and Barua (2015) proposed a methodology with TOPSIS and fuzzy AHP to overcome obstacles in reverse logistics. Macuzic et al. (2016) proposed a two-step model for sorting organizational flexibility factors in the process industry. Alarcin et al. (2014); made fault detection in marine diesel engines with Fuzzy AHP and Fuzzy TOPSIS method for the subsystems of ship engines.

In order to overcome the obstacles in the Supply Chain, Patil and Kant (2014) identified and prioritized the solutions of Knowledge Management (KM). To overcome the obstacles, they used fuzzy AHP-TOPSIS to rank the solutions to the adoption of Information Management in the Supply Chain. Taylan et al. (2014) made construction projects selection and risk assessment with fuzzy AHP and fuzzy TOPSIS methodologies. Junior et al. (2014) made a comparison for supplier selection problem with Fuzzy AHP and Fuzzy TOPSIS methods.

There are several studies about the catering company. Kahraman et al. (2004) selected a catering company for a textile company using the fuzzy analytical hierarchy process. In their work, five experts evaluated three alternative catering companies according to three main criteria and eleven sub criteria. In their work, hygiene, food quality and service quality are the main criteria. Sub criteria are food types, food calories, food taste, food hygiene, service personnel hygiene, service hygiene. Aytaç et al. (2011) used Fuzzy ELECTRE method proposed by Hatami-Marbini and Tavani (2011) for evaluating catering firm alternatives. In their work, hygiene, references, taste and variety of dishes, quality of service, price and adequacy of the structure are the criteria they use. In recent years, Ulutaş (2019) selected a catering company using the SWARA and MAIRCA methods in his study. While criteria weights were obtained with SWARA method, the performances of alternatives were evaluated and ranked with MAIRCA method. In their work, they used the criteria of hygiene, taste, food types, service time, references, service quality, and price. Fu (2019) has determined the best catering supplier for an airline company with its analytical hierarchy process, ARAS (Additive Ratio Assessment) and multi-choice target programming methods.

In this study, the problem of service procurement for a firm making a trailer is resolved with multi-criteria decision making techniques. Catering firm selection was made by using fuzzy AHP, ELECTRE and VIKOR methods. Weights of criteria were obtained with fuzzy AHP. The performances of alternatives were evaluated with the ELECTRE and VIKOR method and the alternatives were sorted. In this study, price, quality, distance and service criteria were used for the selection of the catering company. According to the BAHP method, the most important criterion was found as the quality criterion. Following the BAHP method, two alternatives were

proposed with the ELECTRE method, and the selection of an alternative with the VIKOR method was proposed. Then, methods were analyzed with ANOVA test.

2. Materyal ve Metot

Combined ELECTRE and VIKOR methods with Fuzzy AHP are used for selecting the catering company for the firm that manufactures trailers. In this section, fuzzy AHP, ELECTRE and VIKOR methods are described.

2.1. Fuzzy AHP

The steps of Chang's extended analysis method are shown one by one (Chang, 1996).

Step 1: Fuzzy artificial synthetic rank value is categorized according to the i. criteria as follows:

$$S_i = \sum_{j=1}^{m} M^j \times \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^j\right] \quad (1)$$

Step 2: $M_1 = (l_1,m_1,u_1) \leq M = (l_2,m_2,u_2)$ the probability value of the two triangular numbers is defined as follows:

$$V(M \geq M) = \sup_{y \geq x}\left[min\left(\mu_{M1}(x), \mu_{M2}(y)\right)\right] \quad (2)$$

$$V(M_2 \geq M_1) = hgt(M_1 \cap M_2) = \mu M_2(d) \quad (3)$$

$$\mu M_2(d) = \begin{cases} 1 & ,m_2 \geq m_1 \\ 0 & ,l_1 \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & ,other\ situation \end{cases} \quad (4)$$

The intersection of the triangle fuzzy numbers M_2 and M_1 is as in figure 1.

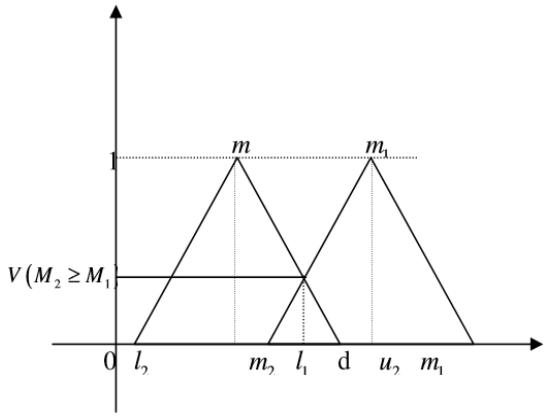

Figure 1. M_2 and M_1 intersection of triangle fuzzy numbers (Yılmaz, 2012)

V(M2 ≥ M1) and V(M1≥ M2) is needed for the comparison of M1= (l1,m1,u1) and M= (l2,m2,u2).4

Step 3: Third Step: The probability of a convex number to be Mi (I=1,2,…,k) greater than a k convex fuzzy number:

V(M≥M1, M2, …, Mk) = V[(M≥M1), (M≥M2) ,…, (M≥Mk)] = minV(M≥Mi),

I=1, 2, …, k (5)

k=1, 2, …, n ; k ≠ j ise d'(Aj), d'(An))T (6)

The weight vector is calculated as follows:

W'=(d'(Aj),d'(A2),…,d'(An) Ai (I=1,2,…,n) (7)

Step 4: The W value is normalized.

W= (d(Aj),d(A2),…,d(An))T (8)

The most commonly used fuzzy severity scale in the Fuzzy AHP method is given in Table 1.

Table 1. Fuzzy importance level (Chang,1996)

Verbal Importance	Fuzzy Scale	Counter Scale
Almost Equal	(1, 1, 1)	(1, 1, 1)
Secondary	(2/3, 1, 3/2)	(2/3, 1, 3/2)
Strong	(3/2, 2, 5/2)	(2/5, 1/2, 2/3)
Very Strong	(5/2, 3, 7/2)	(2/7, 1/3, 2/5)
Exactly	(7/2, 4, 9/2)	(2/9, 1/4, 2/7)

2.2. ELECTRE Method

An et. al (2011), indicated the steps of the ELECTRE method as follows:

Step 1: Creation of decision matrix A. In the decision matrix;

- The column of the table contains the criteria used in decision-making,
- The row contains the desired alternatives to be outranked.

The decision matrix is an initial matrix and is generated by the decision maker. The decision matrix is shown below:

$$A_{ij} = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{m1} & \cdots & a_{mn} \end{bmatrix}$$

Aij shows m alternative number, n shows the number of evaluation factor.

Step 2: Creation of the normalized decision matrix X. The matrix X is calculated using the elements of matrix A.

For cost criterion;

$$X_{ij} = \frac{{}^{1}/_{a_{ij}}}{\sqrt{\sum_{k=1}^{m}\left(\frac{1}{a_{kj}}\right)^2}} \quad (9)$$

i=1,2,…,m j=1,2,…,n

For benefit criterion;

$$X_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^{m}(a_{ij})^2}} \quad (10)$$

i=1,2,…,m j=1,2,…,n

After making the above calculations, X matrix is obtained:

$$X_{ij} = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} \quad (11)$$

Step 3: Creation of weighted normalized decision matrix Y. The importance of evaluation factors may be different with regards to the decision-maker. The y matrix is calculated to reflect the significance differences to the ELECTRE solution. The decision-maker must first determine the weight of the evaluation (wi) ($\sum_{i=1}^{m} w_i = 1$) factors. The weighted normalized matrix y is generated by multiplying the elements in each column of the normalized x matrix by the corresponding wi value:

$$y_{ij} = \begin{bmatrix} x_{11}w_1 & \cdots & x_{1n}w_n \\ \vdots & \ddots & \vdots \\ x_{m1}w_1 & \cdots & x_{mn}w_n \end{bmatrix} \quad (12)$$

Step 4: Determining the Concordance (Cpq) and Disconcordance (Dpq) sets: The Y matrix is used to determine concordance sets. Decision points are compared with each other in terms of evaluation factors. The criteria for binary alternative sets are Ap and Aq (1,2,…,m and p≠q)

If the concordance set is better than Ap and Aq;

Cpq={j,ypj≥vqj} (13)

If the discordance set is worse than Ap and Aq;

Dpq={j,ypj<vqj} (14)

is created. There are as many discordance sets as concordance sets in ELECTRE method. A discordance set corresponds to each concordance set.

Step 5: Calculation of concordance and discordance indices. Assistance is obtained from concordance sets in the creation of the compliance matrix C. Calculation of C matrix elements:

$$C_{pq} = \sum w_j \quad (15)$$

The matrix C is formed as follows;

$$C = \begin{bmatrix} c_{11} & \cdots & c_{1m} \\ \vdots & \ddots & \vdots \\ c_{m1} & \cdots & c_{mm} \end{bmatrix} \quad (16)$$

Formation of discordance matrix D:

$$D_{pq} = \frac{\sum_{j=0} |v_{pj0} - v_{qj0}|}{\sum_j |v_{pj} - v_{qj}|} \quad (17)$$

The matrix D is created as follows;

$$D = \begin{bmatrix} d_{11} & \cdots & d_{1m} \\ \vdots & \ddots & \vdots \\ d_{m1} & \cdots & d_{mm} \end{bmatrix} \quad (18)$$

Step 6: Superiority Comparison: Averages of C and D values are taken.

Cpq≥ortC veDpq≤ortD ise gpq=0 dır. (19)

Step 7: Calculation of net concordance and discordance sets: Net concordance is shown by Cp and net discordance is shown by Dp. The Cp values are sorted from large to small and the Dp values are sorted from small to large.

$$C_p = \sum_{k=1_{k\neq p}}^{m} C_{pk} - \sum_{k=1_{k\neq p}}^{m} C_{kp} \quad (20)$$

$$D_p = \sum_{k=1_{k\neq p}}^{m} D_{pk} - \sum_{k=1_{k\neq p}}^{m} D_{kp} \quad (21)$$

2.2. VIKOR Method

VIKOR method, (Vise Kriterijumska Optimizacija I Kompromisno Resenje; Multi-Criteria Optimization and Compromise Solution) was developed as a viable technique in 1998 by Opricovic (Opricovic and Tzeng, 2004). This method is a MCDM method used for ranking and makes a ranking among the available alternatives for the various characteristics of alternatives determined by the decision maker (Peng et.al., 2015). VIKOR method consists of five steps (Opricovic and Tzeng, 2004; Ho et al., 2011). The steps are given one by one as below.

Step 1: Determining the best and worst value criteria. For each criteria f_i^+; shows the best and f_i^- shows the worst and i=1,2,…,n.

$$f_i^+ = max f_j^{ij} \quad (22)$$

It is defined as $f_i^- = min f_j^{ij}$ (23)

Step 2: Calculating the average and the worst set score. Sj and Rj values are calculated as j=1,2,…,J

$$S_j = \sum_{i=1}^{n} w_i (f_i^+ - f_{ij}) \div (f_i^+ - f_i^-) \quad (24)$$

$$R_j = max_i [w_i (f_i^+ - f_{ij}) \div (f_i^+ - f_i^-)] \quad (25)$$

Step 3: Calculating the maximum group benefit. Qj values are calculated as j=1,2,…,J. V value is accepted as 0,5 and called weight.

$Qj=v(Sj - S^+)/(S^- - S^+)+(1 - v)(Rj - R^+)(R^- - R)$ (26)

$$S^+ = min_j S_j \qquad S^- = max_j S_j \quad (27)$$

$$R^+ = \min_j R_j \qquad R^- = \max_j R_j \quad (28)$$

Step 4: Sorting the average group, worst group score and maximum group benefit values. The S, R, and Q values are sorted from large to small in the VIKOR method.

Step 5: Supervision of conditions. The VIKOR method has two conditions. The results are expected to meet one of these conditions.

Condition 1: "Acceptable Advantage"

Q(a") – Q(a') ≥ DQ

(a') The best supplier in order of Q value

(a") Q is the second best supplier in the ranking by value.

DQ=1/(j-1)

j is the number of suppliers. It is a condition that the best supplier should be clearly advantageous over the second best supplier.

Condition 2: "Acceptable Stability in Decision Making". If it does not meet only second condition, a compromise solution set occurs with (a') and (a") alternatives, if it does not meet first condition a compromise solution test occurs with a',a",…,ax and Q values are sorted from small to large and the supplier with the smallest Q value is chosen.

$Q(ax) - Q(a') < DQ$

3. The Application of Catering Company Selection and Definition of Evaluation Criteria

In this study, the decision making process of a catering firm for a small company that manufactures trailers in Sakarya is discussed. The process of selecting a catering company is considered as a multi-criteria decision problem and solved with the help of Fuzzy AHP and a combined ELECTRE and VIKOR methods. The weights of the criteria were determined by the Fuzzy AHP method and alternative catering companies were evaluated by ELECTRE and VIKOR methods and a preference ranking was created.

As a result of the literature surveys and interviews with the company authorities, the criteria of supplier selection were determined as follows:

- Product use quality
- Pricing policies
- Distance to service on time
- Before and after sales service concept

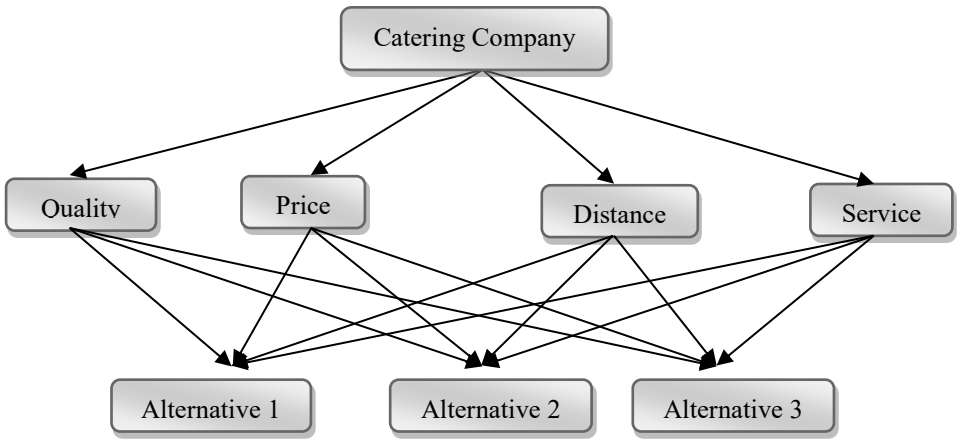

Figure 2. Hierarchical model for catering firm selection

3.1. Determination of Weights of Selection Criteria with Fuzzy AHP

In this study, Fuzzy AHP method was used for determining the weights for the selection of catering firms. The results of the mutual evaluation of the selection criteria in Table 2 were obtained by interviews with the production manager of the company and human resources manager. Table 3 shows the fuzzy severity levels found by Chang (1996). In order to solve the problem by fuzzy AHP method, the main criteria are compared by considering the triangular fuzzy numbers given in Table 1 according to the determined criteria and the importance values are shown in Table 3.

Table 2. Supplier Evaluation Results

	Criteria			
Alternatives	**Quality**	**Price**	**Distance**	**Service**
A1	6	6	12	7
A2	7	7	8.3	9
A3	8	6.5	9.6	6

Table 3. Supplier Evaluation Criteria Evaluation Results

	Criteria			
Alternatives	Quality	Price	Distance	Service
Quality	(1, 1, 1)	(3/2, 2, 5/2)	(5/2, 3, 7/2)	(3/2, 2, 5/2)
Price	(2/5, 1/2, 2/3)	(1, 1, 1)	(5/2, 3, 7/2)	(2/3, 1, 3/2)
Distance	(2/7, 1/3, 2/5)	(2/7, 1/3, 2/5)	(1, 1, 1)	(2/9, 1/4, 2/7)
Service	(2/5, 1/2, 2/3)	(2/3, 1, 3/2)	(7/2, 4, 9/2)	(1, 1, 1)

Step 1: The synthetic dimension values of the binary comparison from the fuzzy evaluation matrix were obtained as follows. Si values were calculated using the evaluation results in Table 3:

$S_{quality}$ = (6.5 , 8 , 9.5) × (1/ 25.92 , 1/ 21.92 , 1/ 18.43) = (0.25, 0.36, 0.52)

S_{price} = (4.57, 5.5, 6,67) × (1/ 25.92 , 1/ 21.92 , 1/ 18.43) = (0.17, 0.25, 0.36)

$S_{distance}$ = (1.79, 1.92, 2.08) × (1/ 25.92, 1/ 21.92, 1/ 18.43) = (0.07, 0.09, 0.11)

$S_{service}$ = (5.57,6.5, 7.67) × (1/ 25.92, 1/ 21.92, 1/ 18.43) = (0.21, 0.29, 0.42)

Step 2: When comparison is done by using these vectors:

$SV\left(S_{quality} \geq S_{prise}\right) = m_2 \geq m_1 = 0{,}36 \geq 0{,}25 = 1$

$V\left(S_{quality} \geq S_{distance}\right) = m_2 \geq m_1 = 0{,}36 \geq 0{,}09 = 1$

$V(S_{quality} \geq S_{service} = 1$

$V_{(S\ price \geq S\ quality)} = 0.5$ $V_{(S\ distance \geq S\ quality)} = 0$ $V_{(S\ service \geq S\ quality)} = 0.708$

$V_{(S\ price \geq S\ distance)} = 1$ $V_{(S\ distance \geq S\ price\ )} = 0$ $V_{(S\ service \geq S\ price)} = 1$

$V_{(S\ price \geq S\ service)} = 0.789$ $V_{(S\ distance \geq S\ service)} = 0$ $V_{(S\ service \geq S\ distance)} = 1$

Step 3: The weight vector is defined as follows. The weight vector (w) is reached with the minimum V values of the criteria:

W' = ((d ' (A1), d ' (A2),….. d ' (An))T Ai = (i = 1,2,3……..n)

minVquality = 1 minV price = 0.5 minVdistance = 0 minVservice = 0.708

∑ minV = 2,208

Step 4: After the normalization process, the weight vector for subjective criteria is as follows.

W=(minVQuality/topminV, minVPrice/topminV, minVdistance/topminV, minVservice/topminV) with formula is calculated weight vector;

W = (0.453, 0.226, 0, 0.321).

Weights are sorted from small to large;

0,453> 0,321> 0,226> 0.

According to this order, the most important criteria is quality with 0,453 weight. The second one is the service with a weight of 0,321; the third one is the price with a weight of 0,226 and the fourth one is the distance with a weight of 0.

3.2. Catering Firm Selection with ELECTRE Method

After obtaining the weights with fuzzy AHP, ELECTRE method was used to determine the most suitable catering company. The decision matrix of supplier selection results is shown in Table 2. First the decision matrix is normalized and it was shown as in Table 4.

Table 4. Normalized Decision Matrix

	Criteria			
Alternatives	Quality	Price	Distance	Service
A1	0,491	0,622	0,687	0,543
A2	0,573	0,533	0,475	0,698
A3	0,655	0,574	0,450	0,466

The weights obtained with the fuzzy AHP method are multiplied by the values in the normalized decision matrix and the weighted normalized decision matrix in Table 5 is obtained.

Table 5. Weighted normalized decision matrix

	Criteria			
Alternatives	Quality	Price	Distance	Service
A1	0,222	0,2	0,155	0
A2	0,260	0,171	0,108	0
A3	0,3	0,184	0,102	0

Concordance and discordance sets are obtained from weighted normalized decision matrix. Net concordance sets are shown in Table 6 and net discordance sets are shown in Table 7.

Table 6. Net Compliance

$C(A_1,A_2)$	(F)
$C(A_1,A_3)$	(F,H)
$C(A_2,A_1)$	(K,M,H)
$C(A_2,A_3)$	(H)
$C(A_3,A_1)$	(K,M)
$C(A_3,A_2)$	(K,F,M)

Table 7. Net Mismatch

$D(A_1,A_2)$	(K,M,H)
$D(A_1,A_3)$	(K,M)
$D(A_2,A_1)$	(F)
$D(A_2,A_3)$	(K,F,M)
$D(A_3,A_1)$	(F,H)
$D(A_3,A_2)$	(H)

Concordance and discordance sets and concordance and discordance indices are shown in Table 8 and Table 9. The sum of C and D values and the average of C and D values are also shown in these tables.

Table 8. Net Compliance index

$C(A_1,A_2)$	0,351
$C(A_1,A_3)$	0,848
$C(A_2,A_1)$	0,648
$C(A_2,A_3)$	0,497
$C(A_3,A_1)$	0,151
$C(A_3,A_2)$	0,502
$\sum C$	2,997
Avg. C	0,4995

Table 9. Net incompatibility index

$D(A_1,A_2)$	1
$D(A_1,A_3)$	1
$D(A_2,A_1)$	0,4198
$D(A_2,A_3)$	0,3534
$D(A_3,A_1)$	0,3249
$D(A_3,A_2)$	1
$\sum D$	4,0981
Avg. D	0,683

After the average values are calculated, the superiority comparison is shown as in Table 10.

Tablo 10. Superiority comparison chart

C_{pq}	$C_{pq} \geq C_{ort}$	D_{pq}	$D_{pq} \leq D_{ort}$
$C(A_1,A_2)$	No	$D(A_1,A_2)$	No
$C(A_1,A_3)$	Yes	$D(A_1,A_3)$	No
$C(A_2,A_1)$	Yes	$D(A_2,A_1)$	Yes
$C(A_2,A_3)$	No	$D(A_2,A_3)$	Yes
$C(A_3,A_1)$	No	$D(A_3,A_1)$	Yes
$C(A_3,A_2)$	Yes	$D(A_3,A_2)$	No

When choosing the catering company according to ELECTRE method, Cp and Dp values are calculated as follows. Cp values show the net maximum value, Dp values show the net lowest values. Net top value ranking and net low value ranking for alternative catering companies are as in table 11.

CA1=(C(A1,A2)+C(A1,A3)) – (C(A2,A1)+ C(A3,A1))

DA1=(D(A1,A2)+D(A1,A3)) – (D(A2,A1)+ D(A3,A1))

Table 11. Net top value ranking and net lowest value order

Catering alternative	Net top value	Net lowest value	Net top value ranking	Net lower value ranking
A1	0,4	1,2553	1	3
A2	0,292	-1.2268	2	1
A3	-0,692	-0,0285	3	2

According to the results obtained by ELECTRE method;

- Alternative 1 is recommended when the highest value is taken into consideration,
- Alternative 2 is recommended when the lowest value is taken into consideration.

3.3. Catering Firm Selection with VIKOR Method

After obtaining the weights with fuzzy AHP, ELECTRE method was used to determine the most suitable catering company. The decision matrix of supplier selection results is shown in Table 2. After that, S and R values are calculated with the help of (f+) and (f-) values and they are shown in Table 21.

Table 12. Decision Matrix Best and Worst Values

	Quality	Price	Distance	Service
f^+	8	7	12	9
f^-	6	6	8.3	6

$S_{11} = 0.453 \times [\frac{8-6}{8-6}] = 0.453$

$S_{21} = 0.453 \times [\frac{8-7}{8-6}] = 0.227$

$S_{31} = 0.453 \times [\frac{8-8}{8-6}] = 0$

S and R values for alternative catering companies are as in Table 13.

Table 13. Supplier S and R Values

	Criterias					
Alternatives	Quality	Price	Distance	Service	S	R
A1	0.453	0.321	0	0	0,774	0.453
A2	0.227	0	0,226	0	0,453	0.227
A3	0	0.161	0,147	0	0,308	0.147

The lowest and highest S and R values are shown in Table 14.

Table 14. Highest and Lowest S and R Values

S^-	0,774
S^+	0,308
R^-	0,453
R^+	0.147

In the selection of catering companies, weights were determined by fuzzy AHP method and these weights were used in ELECTRE and VIKOR methods. Catering companies are listed by applying ELECTRE and VIKOR methods. In these rankings, suggestions were made to the factory for selecting the appropriate catering service from the three alternatives.

When choosing the catering company according to VIKOR method, Q values were calculated for each alternative. Q values are calculated by the following formula. Table 15 shows the order of the calculated S, R and Q values.

$Q= V \times (Sj - S^+) / (S^- - S^+) + (1 - V) \times (R_J - R^+) / (R^- - R^+)$

Q value for alternative 1 Q = 1

Q value for alternative 2 Q = 0.29

Q value for alternative 3 Q = 0.57

Table 15. S and R Values Specified for Suppliers

	Criteria					
Alternatives	S	R	Q	S	R	Q
A1	0,774	0.453	1	3	3	3
A2	0,453	0.227	0.29	1	1	1
A3	0,308	0.147	0.57	2	2	2

The conditions of the VIKOR method are given below;

Condition 1: “Acceptable advantage” The first condition is not fulfilled.

Q (a”)- Q(a’) ≥ DQ

DQ = 1/ (3-1) = 0.5

0.57 – 0.29 ≤ 0.5

Condition 1 is not fulfilled.

Condition 2: “Acceptable stability in the decision maker”.

Condition 2 is met because S, R, and Q are stable. Company Alternative 2 was suggested to be chosen.

4. Research Findings and Discussion

Fuzzy AHP method is a method used to translate verbal expressions into numerical data. Weights of alternatives were determined with this method and alternative ranking was made for the decision-maker factory with ELECTRE and VIKOR methods from multi criteria decision models.

The ELECTRE and VIKOR methods were compared with the ANOVA analysis in Minitab and the individual reliability levels of the methods were found. The percentages of individual reliability found with ANOVA test were close to each other. As a result of the analysis, the individual reliability level of ELECTRE method was 97.50% while the individual reliability level of VIKOR method was 97.80%. Based on these results, the results of VIKOR method are more reliable, so VIKOR method should be used in the selection of the catering company. The sequence obtained by the VIKOR method is Alternative2> Alternative 3> Alternative1. Alternative 2 was suggested to be selected for catering service.

5. Results and Suggestions

Catering company selection is one of the important decision problems for companies. For companies that receive services from catering companies, these companies have an important place. The personnel employed in the enterprise consumes the dishes taken from these companies and the consumed meals directly affect the performance and morale of the employee. Therefore, businesses should be careful in choosing a catering company. Many criteria must be taken into account for this selection. MCDM methods are successfully used in such selection problems.

In this study, a catering firm selection is done for a company that manufactures trailers. Quality, price, distance and service criteria were used in the selection of the catering company. Here, fuzzy AHP method was used to determine the weight of the criteria in order to take the positive judgments of the decision makers into consideration and thus uncertainty in the decision-making process was reduced. The weights of the criteria found by Fuzzy AHP were used for listing alternative catering companies by ELECTRE and VIKOR method. According to the statistical results, it was seen that the results of VIKOR method were more reliable. For this reason, VIKOR method should be used in the selection of catering firm for this company. According to the VIKOR method, Alternative2> Alternative 3> Alternative1. It was suggested to choose alternative 2 for caterng service. For future studies, they can use different CCKV methods instead of ELECTRE and VIKOR methods, or they can use ELECTRE and VIKOR methods for other problems.

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