yönetim ve ekonomi araştırmaları dergisi
journal of management and economics research
Cilt/Volume: 18 Sayı/Issue: 1 Mart/March 2020 ss./pp. 20-35
Ö. F. Görçün Doi: http://dx.doi.org/10.11611/yead.575054

SELECTION OF FUEL SUPPLIER FOR TRANSPORT FIRMS BY USING THE AHP

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ABSTRACT

Selection of proper fuel supplier is extremely important for companies that carry out transportation activities and it can be evaluated as a critical decision to obtain competitive advantages in the transportation market. A structural and systematic frame is suggested in this paper in order to solve the decision problems for fuel supplier selection. In order to determine the selection criteria, the board of experts was constructed and a large number of roundtable meetings that realized in the way of brainstorm were organized with them. One of the most important questions can be asked as what are the selection criteria and decision options for the fuel supplier selection process? Experts who are a decision maker in their companies tried to seek a rational answer to this question. At the end of these meetings, obtained results were re-evaluated by the members of the board and selection criteria and decision options that will use for evaluation process were determined. The decision alternatives are Brand-P, Brand-B, Brand-S, and Brand-O. The selection criteria can be sorted as: fuel price per liter, product quality, service quality, easy terms of payment, brand awareness, environmental sensitivity. Actually, selection of fuel and fuel supplier has an extremely complex characteristic and it is a multi-criteria decision-making problem. In this paper, the analytic hierarchy process theory was selected as a multi-criteria decision making problem in order to solve the decision making problem concerning with fuel and fuel supplier selection process. By using this methodology, decision makers can select the best fuel brand and fuel supplier by comparing variables such as selection criteria and decision alternatives in a mathematical model.

Key Words: *Fuel Supplier Selection, Logistics, AHP Method, Transportation.*

JEL Codes: *F21, F43.*

AHP YÖNTEMİ KULLANILARAK TAŞIMACILIK FİRMALARI İÇİN AKARYAKIT TEDARİKÇİSİ SEÇİMİ

ÖZET

Taşımacılık faaliyetleri yürüten işletmeler için uygun akaryakıt tedarikçi seçimi son derece önemlidir ve taşımacılık pazarında rekabet avantajları kazanmak için kritik bir karar olarak

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Makale Geçmişi/Article History

Başvuru Tarihi / Date of Application	: 10 Haziran / June 2019
Düzeltme Tarihi / Revision Date	: 25 Ocak / January 2020
Kabul Tarihi / Acceptance Date	: 10 Şubat / February 2020

Araştırma Makalesi/Research Article

değerlendirilebilir. Bu çalışma akaryakıt tedarikçisi seçimi ile ilgili karar alma problemlerinin çözümü için sistematik ve yapısal bir çerçeve önermektedir. Seçim kriterlerinin belirlenebilmesi için bir uzmanlar kurulu oluşturulmuş ve bunlarla beyin fırtınası şeklinde gerçekleştirilen yuvarlak masa toplantıları gerçekleştirilmiştir. En önemli sorulardan birisi olan akaryakıt seçim süreçlerinde karar noktaları ve seçim kriterleri nelerdir? Sorusu sorulmuştur. Şirketlerinde karar verici olan uzmanlar bu soruya rasyonel bir yanıt aramışlardır. Bu toplantıların sonunda elde edilen sonuçlar uzmanlar kurulu üyeleri tarafından yeniden değerlendirilmiş ve değerlendirme sürecinde kullanılacak karar alternatif ve seçim kriterleri belirlenmiştir. Karar alternatifleri Marka-P, Marka-B, Marka-S ve Marka-O dur. Seçim kriterleri; litre başına yakıt fiyatı, ürün kalitesi, hizmet kalitesi, ödeme olanakları, marka bilinirliği ve çevreye duyarlılık olarak saptanmıştır. Gerçekte akaryakıt tedarikçisi seçimi son derece karmaşık bir karaktere sahip ve çok kriterli karar alma problemidir. Bu çalışmada Analitik Hiyerarşi Prosesi yöntemi akaryakıt ve akaryakıt tedarikçisi seçimi süreçleri ile ilgili karar verme problemlerini çözmek için çok kriterli karar verme metodolojisi olarak seçilmiştir. Bu metodolojiyi kullanarak karar vericiler seçim kriterleri ve karar noktaları gibi değişkenleri karşılaştırarak en iyi akaryakıt markası ve tedarikçisini seçebilirler.

Anahtar Kelimeler: *Akaryakıt Tedarikçi Seçimi, Lojistik, AHP Yöntemi, Taşımacılık.*

JEL Kodları: *F21, F43.*

1. INTRODUCTION

Supplier selection is a typical multi-criteria decision problem (Liao, and Rittsche, 2007). The decision alternatives and selection criteria is considered as factors that affected the selection decisions that related to fuel supplier. After determining these factors, the members of the board of experts were defined the features of decision makers who will give answers to the pairwise comparison questions. According to them, subjects should an owner or senior executive of a logistics company who play a key role in the decision making process. Accordingly, in total 35 executives were selected as decision makers and prepared pairwise comparison questions were directed to them. At the same time, they gave score for each comparison in the perspective of the Saaty's importance scale. Geometric mean of obtained points that given by decision makers for each comparison gives the value of elements of comparison matrix.

The main aim of this study is the comparative analysis of the selection criteria and decision options concerning with the fuel supplier selection by using the AHP method in the field of the freight transportation that is one of the important parts of logistics.

Therefore, relative importance level of alternate fuel suppliers was tried to determine. In addition to that, impacts of factors that play important roles in the selection process is defined. This study can contribute to the literature concerning with fuel supplier selection and it can help to construct a systematic and structural model to solve the decision making problem concerning with fuel supplier selection.

2. LITERATURE REVIEW

The multi-criteria decision-making methodologies were developed to solve the decision-making problems that can be defined as restrictions for industries and companies. Actually, decision making is an extremely complex and time-consuming business activity and the heuristic method may not provide successful results without using the mathematical methods. There-fore, multi-criteria decision-making methods can provide extremely successful results in any field such as production, logistics, transportation, and etc.

Generally, AHP, TOPSIS PROMETHEE, ELECTRE, MOORA, and VIKOR methods are mostly preferred methodologies to solve almost all decision-making problems that faced in the logistics and transportation companies.

The positive effects of proper fuel supplier on the competitive power of a transport company are extremely clear. Initially, it can provide the opportunity to carry out the logistics operations with lower cost. In addition to that, negative effects of some factors such as environ-mental pollution, maintenance costs, and etc. Can also be reduced. When the literature is reviewed, although there are many studies which focused on the supplier selection process, there is no study directly focus on the fuel and fuel supplier selection process for logistics and transportation companies. It can be seen that a study that evaluated the proper fuel selection by using the AHP method but it focused on the selection of fuel types such as fossils, electricity and so on. Even if these studies are not directly related to the fuel supplier selection for logistics and transportation companies, Scott et al gave a successful example that concerning the supplier selection process and they argued that Integrated supplier selection and order allocation is an important decision for both designing and operating supply chains. This decision is often influenced by the concerned stakeholders, suppliers, plant operators and customers in different tiers (Scoot et al, 2015). In addition to that, the research topic of Damle and Keswani's study (Damle and Keswani, 2015) is more closeness to this paper than others, but it focused on the selection of fuel types such as diesel, gasoline, and etc. Except for them, there are too many studies related to supplier selection by using the AHP methods and other methodologies. Most of them are related to the supply chain management and they tried to determine a new frame to construct the effective and agile system for the supply chains.

Some of studies, which realized by using the AHP method in the various fields are shown in Table 1.

Table 1. Some Studies Realized by Using the AHP Method

Akhisar and Tunay (2016)	Analyzing the performances of the life insurance companies and evaluating the selection criteria affected to the performance of these companies.
Çalışkan and Eren (2016)	Comparison of the financial performances of public and foreign investment deposit banks between 2010 and 2014.
İnce, Bedir, and Eren (2016)	Site selection problem for a new health institution, which required in Tuzla town.
Karakış and Göktolga (2016)	Comparison of the economic performances of the Central Asian Republics
Karaoğlan and Şahin (2016)	Determining the relative importance of factors effected to purchasing processes.
Rezaei and Ketabi (2016)	Evaluation of the financial performances of the Iranian Banks.
Sarıçalı and Kundakcı (2016)	Evaluation of decision alternatives about hotel choices for holiday
Altunöz (2017)	Assessment of financial performances of twelve banks publicly-traded in the Istanbul Stock Market for 2007-2016.
Urmak, Çatal and Karaatlı (2017)	Evaluating the Forestry activities carried out in Turkey in the aspects of cities.
Ünal, Köse and Gürdal (2017)	Analyzing the financial performance of industrial ceramic firms publicly-traded in the BIST
Bircan, Demir and Günel (2018)	Selection of accounting software for member of accounting professions.
Görçün (2018)	Determining the proper public transport alternatives and evaluating the selection criteria for selecting the public transport systems.
Karaoğlan and Şahin (2018)	Analyzing the financial performances of twenty-four companies, which placed in the petroleum, chemicals, and Plastics Index.
Korucuk and Erdal (2018)	Determining the logistics risk criteria for companies, which conducting the cold-chain transport in Samsun city and ranking the instruments those used in risk management.
Yaykaşlı and Ecemiş (2018)	Determining the selection criteria in purchasing process for the new car.
Çanakçıoğlu (2019)	Determining the customer selection criteria for independent accountants and financial advisor.
Görçün (2019)	Determining the proper trailers, which uses in the project logistics and heavy transportation

3. RESEARCH METHODOLY

The multi-criteria decision-making methodologies were developed to solve the decision-making problems that can be defined as restrictions for industries and companies. Actually, decision making is an extremely complex and time-consuming business activity and the heuristic method may not provide successful results without using the mathematical methods. Therefore, multi-criteria decision-making methods can provide extremely successful results in any field such as production, logistics, transportation, and etc.

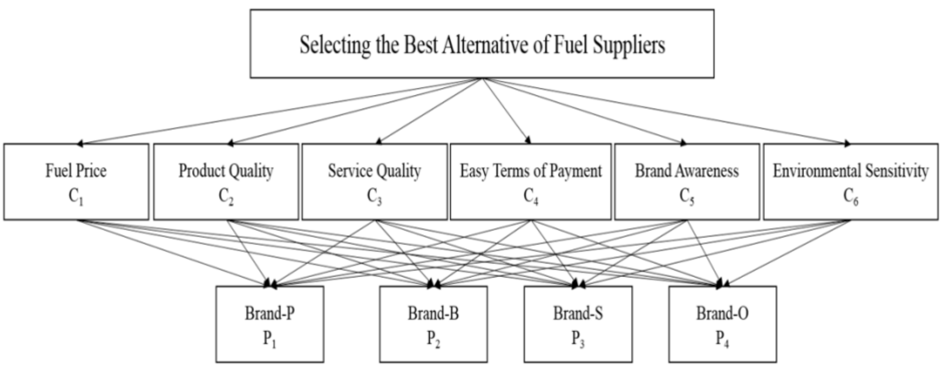
The AHP method is one of the multi-criteria decision-making methodologies. According to Saaty, it provides comprehensive structure to combine the intuitive rational and irrational values with a pairwise comparison approach (Saaty, 1986). This methodology has been used widely in the various fields such as industry and logistics, and business management. The main aim of the AHP method is to present a systematic and structural model to solve the extremely complex decision-making problems. More importantly, it also provides the opportunity to transform the verbal judgments of the decision makers to quantitative values in order to make comparison among the factors that affected to the selection process. Therefore, it is not necessary that the variables have numerical values to evaluate the factors concerning with selection. This methodology presents a meaningful and rational frame to solve the decision-making problems and it structures the decision-making problems in a systematic way. Classically, the AHP method is applied at five stages.

3.1. Defining the Main Goal of the Study

In the first step, the main goal of the study is determined. Actually, this stage can be called as the definition of the decision-making problem. In general, it can be evaluated as the selection of the best decision alternative is the main goal of any study that related to the multi-criteria decision-making process. Initially, constructing a working group that called the board of experts is a priority business and this group should be constructed by researchers. In general, the board of experts should consist five or at most seven members. While the members of the board are selected, researchers who responsible for conducting this research should have an extremely meticulous approach and all members of the board should be an expert in their fieldworks.

More importantly, if it is possible, they should play a key role decision making process in their companies or institutions. Therefore, selecting the owner or senior executives of companies as members of the working group may be one of the best solutions to construct the proper working group. In addition to that, all decision alternatives and selection criteria are determined in this phase by members of the board of experts in the roundtable meetings that realized in the way of brainstorm. The researcher who conducts this study prepare the pairwise comparison questions depending on the determined factors by the board of experts to direct to the decision makers.

Figure 1. A Hierarchical Model for AHP



3.2. Constructing the Pairwise Comparison Matrix

In the next stage, prepared questions are directed to the decision makers and giving a score for the importance level of factors in each comparison is wanted by them. The geometric mean of obtained scores calculates and the values of elements of the pairwise comparison matrix are determined. The researcher constructs the pairwise comparison matrix and the decision matrix is an nxn square matrix. When *i* is equal to *j*, the diagonal elements of this matrix take the value of 1. Each factor is compared to each other and a relative importance value of each factor is determined. In order to comparison, the importance scale that shown in Table 1 is used. The inverse of the relative value of importance of the i_{th} factor shows the value of importance of the j_{th} factor and if the importance value of the i_{th} factor is divided to 1, the importance value of the j_{th} factor is also calculated. Relative importance value can be computed by using the *equation 1*.

$$a_{ji} = \frac{1}{a_{ij}} \qquad (1)$$

The comparison matrix is constructed as shown below:

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \qquad (2)$$

Table 2. Comparative importance scale of criteria

Score	Definition	Explanation
1	Equally Preferred	factor *i* and *j* are of equal importance
3	Moderately preferred	factor *i* is weakly more important than *j*
5	Strongly Preferred	factor *i* is strongly more important than *j*
7	Very Strongly Preferred	factor *i* is very strongly more important than *j*
9	Extremely Strongly	factor *i* is extremely strongly more important than *j*

3.3. Normalization and Calculating the Weight Values of the Factors

In the third step, the values of elements of the pairwise comparison matrix which also called as the decision matrix are normalized in order to transform to the comparable values. In order to make the normalization operation, all elements of the matrix are divided to the sum of own columns and computed new values are defined as the elements of the normalized matrix. In order to compute the value of elements of the normalized matrix, *equation 3* is used as shown in below:

$$b_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \qquad (3)$$

for i, j=1,2,...,n

After the normalization operations, vector *b* is obtained for each column and the matrix *C* consists of the sum of these vectors.

$$b = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ b_3 \end{bmatrix} \qquad (4)$$

After that, the arithmetic mean of elements of rows of the normalized matrix is calculated and computed values (*w*) are determined as the weight values of the selection criteria and decision options. These operations are separately realized for both selection criteria and decision alternatives. At the end of this stage, computed weight values of the decision alternatives for each criterion gives the vector *w* by using the *equation 5.*

$$w_{ij} = \frac{\sum_{i=1}^{n} c_{ij}}{n} \qquad (5)$$

Vector *w* is constructed as shown in below and each value of the vector *w* shows the importance value of the selection criteria in percentages.

$$w = \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_n \end{bmatrix} \qquad (6)$$

In addition to that the consistency check is extremely important to be applicability of the obtained results. It can be evaluated whether the selection criteria and decision options are consistent by calculating the consistency rate (*CR*). The lambda (λ) that defined as the basic value comprises with the number of factors. For this, matrix D should be formed by multiplying the matrix A with vector w.

$$\mathrm{D} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} x \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_n \end{bmatrix} = \begin{bmatrix} d_{11} & d_{12} & \dots & d_{1n} \\ d_{21} & d_{22} & \dots & d_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ d_{n1} & d_{n2} & \dots & d_{nn} \end{bmatrix} \qquad (7)$$

The value of lambda λ can be calculated as the elements of matrix *D* are divided to the elements of vector *w* as show in below; it can be calculated by using the formula in the *equation 9.*

$$E_t = \frac{d_t}{w_t} \qquad (8)$$

$$\lambda_{max} = \frac{\sum_{i=1}^{n} E_t}{n} \qquad (9)$$

After this value are calculated, consistency indicator can be calculated this formula as shown in below. In the next stage, the value of *CI* divides to the value of random index (*RI*) that can be obtained from random index table and the consistency rate (*CR*) can be calculated. If the value *CR* is equal or smaller to 10% the consistency is acceptable. If it is greater than %10, factors should be evaluated again.

$$CI=\frac{\lambda_{max}-n}{n-1} \quad (10)$$

$$CR=\frac{CI}{RI} \quad (11)$$

Table 3. Random Index (Saaty, 1980)

n	2	3	4	5	6	7	8	9	10
RI	0,00	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,51

After the vectors related to decision options are obtained, a matrix that involved from these vectors is created. While the rows of the matrix show the decision alternatives, its columns show the selection criteria. The sum of the rows of the matrix is multiplied with values of vector w separately. After this process, values of importance level of each decision options and these values show the percentage weight of each decision option.

3.4. Calculation of the Importance Value of Each Decision Option

In this final stage, percentage distribution of the decision alternatives is determined in analogy to the previous calculations. In other words, pairwise comparisons and other computations are repeated n times and n is equal to the number of decision alternatives. After these operations, the comparison matrix g which is an nxn matrix is constructed. Column vectors s that show the percentage distribution of selection criteria considering the decision options are constructed. A column vector *s* is shown in below.

$$s = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \\ s_n \end{bmatrix} \quad (12)$$

After constructing these vectors that have a dimension of mx1, an mxn decision matrix *K* which consists of vectors *S* is also constructed. When matrix *K* is multiplied by column vector *w*, the column vector of *L* is obtained and this vector gives the percentage distribution of the importance values of the decision options. In addition to that, this distribution shows the order of importance of the decision alternatives.

$$L = \begin{bmatrix} s_{11} & s_{12} & \cdots & s_{1n} \\ s_{21} & s_{22} & \cdots & s_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ s_{n1} & s_{n2} & \cdots & s_{nn} \end{bmatrix} x \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_n \end{bmatrix} = \begin{bmatrix} l_1 \\ l_2 \\ l_3 \\ l_n \end{bmatrix} \quad (13)$$

4. DATA AND RESULTS

In the first step, a working group was constructed by the researcher who is responsible for conducting this study. Only five members were selected among a large number of executives as the member of the board of experts. While four of these members are owner of a logistics companies, only one of them is a senior executive in a logistics company and he has worked for twenty-four years in the field of logistics and transportation.

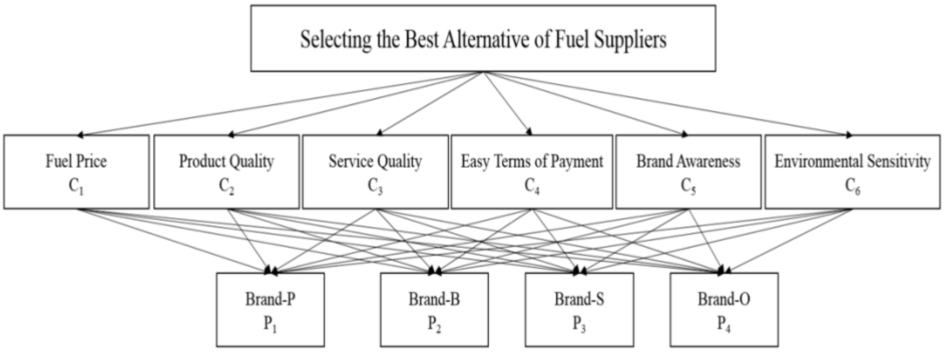
After this working group was constructed, roundtable meetings realized in the way of brainstorm were organized and the main goal is defined by the working group as the selection of the best alternative in the fuel supplier selection process. At the same time, six major selection criteria and four decision options which shown in table 1 were also determined in these meetings by the board of experts.

Table 4. Fuel Supplier Decision Options and Selection Criteria

Decision Options		Selection Criteria	
Code	**Definition**	**Code**	**Definition**
P1	Brand-P	C1	Fuel Price per Liter
P2	Brand-B	C2	Product Quality
P3	Brand-S	C3	Service Quality
P4	Brand-O	C4	Easy Terms of Payment
		C5	Brand Awareness
		C6	Environmental Sensitivity

In accordance with obtained results at the roundtable meeting that realized by the board of experts, the main goal of this study is determined as selecting the best alternative by taking into consideration all decision options that affected to the selection of fuel supplier process. Considering the determined main goal with together selection criteria and decision alternatives, a hierarchical model was constructed as shown in below.

Figure 2. Hierarchical Model for Fuel Supplier Selection



After hierarchical model was constructed by the researcher, pairwise comparison questions were prepared to determine the relative importance value of factors and were directed to the decision makers who were selected by the working group. In total 35 senior executives who work in different international transportation and logistics companies were selected in this study. At the same time, nineteen of them are both a senior executive and the owner of an international logistics company.

In the next stage prepared pairwise comparison questions consisting all decision options and selection criteria were directed to the decision makers to determine the relative importance level of all factors. Given answers to these questions by decision makers in quantitative basis were collected and the geometric mean of answers that given for each question was calculated and relative importance values of these factors were obtained.

Table 5. Pairwise Comparison Matrix

	C1	C2	C3	C4	C5	C6
C1	1,00	1,31	1,94	2,34	1,11	1,53
C2	0,77	1,00	0,78	1,99	1,35	0,96
C3	0,52	1,27	1,00	1,53	1,31	1,34
C4	0,43	0,50	0,65	1,00	1,32	1,37
C5	0,90	0,74	0,77	0,76	1,00	2,03
C6	0,65	1,05	0,74	0,73	0,49	1,00
∑	4,26	5,87	5,89	8,35	6,58	8,23

As seen in above, pairwise comparison matrix was constructed depending on the relative importance value of factors. Value of each element of pairwise comparison matrix represent the relative importance value of i_{th} selection criterion than the j_{th} criterion. If i is equal to j, always the diagonal elements of the matrix take the value of 1.

In the third stage, normalization operation is realized by using the *equation 3*. Therefore, elements of the matrix a are divided to the sum of own columns and value of elements of the vector b is calculated for each column. After that, the normalized matrix c which consists of these vectors is constructed. As seen in below, normalized matrix was constructed by using the *equation 3*.

Table 6. Normalized Matrix

	C1	C2	C3	C4	C5	C6
C1	0,2348	0,2223	0,3295	0,2806	0,1694	0,1860
C2	0,1798	0,1703	0,1333	0,2380	0,2048	0,1160
C3	0,1210	0,2170	0,1698	0,1833	0,1985	0,1634
C4	0,1003	0,0857	0,1110	0,1198	0,2002	0,1668
C5	0,2108	0,1264	0,1301	0,0910	0,1521	0,2462
C6	0,1534	0,1783	0,1263	0,0873	0,0750	0,1215
∑	1,00	1,00	1,00	1,00	1,00	1,00

The arithmetic mean of each row of the normalized matrix *C* give the relative importance value of each selection criterion. By using *equation 1*, these values were calculated and vector *w* was constructed as shown below:

$$W = \begin{bmatrix} 0,2371 \\ 0,1737 \\ 0,1755 \\ 0,1306 \\ 0,1594 \\ 0,1236 \end{bmatrix}$$

It can be seen that the relative importance values of fuel price per liter, product quality, service quality, easy terms of payment, brand awareness, and environmental sensitivity are 0.2371, 0.1737, 0.1755, 0.1306, 0.1594, and 0.1236 respectively. As a result of this, the most important selection criterion is the fuel price and its importance value is determined as %23.71. The second important selection criterion is the quality of services provided by fuel suppliers and also the third important criterion is the quality of the product (fuel). These selection criteria can be sorted as C1>C3>C2>C5>C4>C6 considering their relative importance values.

In the fourth step, in order to confirm whether the obtained results are rational and realistic, consistency check should be done. Initially, the values of elements of the decision matrix a is multiplied by the sum of the values of the vector *w* and the matrix *D* is constructed as a result of this operation. After that, these values (E_t) and λ are calculated by using the *equation 8* and *9*. When the sum of the values of the et is divided by the number of variables, it can be reached to the value of the λ. Consistency index (*CI*) and consistency rate (*CR*) are calculated by using the *equation 10* and *11*. These calculations are shown in the below,

$$\lambda = \frac{\sum_{i=1}^{n} E_i}{n} \Rightarrow \frac{6,2303+6,2481+6,2294+6,2285+6,1810+6,1857}{6} = 6,21$$

Evaluation of the selection criteria is consistent because the value of *CR* is less than 0.10. Therefore, it can be passed to the next and final stage. In the fifth stage, all of the operations that realized for evaluation the selection criteria are similarly repeated for all decision alternatives. All decision options are evaluated in the perspective of each selection criterion. The decision matrixes are constructed depending on the number of the selection criteria. Comparison Matrixes for decision alternatives are shown as seen in below:

$$CI = \frac{\lambda - n}{n-1} \Rightarrow \frac{6,21-6}{6-1} = 0,043\ ;\ CR = \frac{CI}{RI} \Rightarrow \frac{0,043}{1,24} = 0,035$$

Evaluation of the selection criteria is consistent because the value of *CR* is less than 0.10. Therefore, it can be passed to the next and final stage. In the fifth stage, all of the operations that realized for evaluation the selection criteria are similarly repeated for all decision alternatives. All decision

options are evaluated in the perspective of each selection criterion. The decision matrixes are constructed depending on the number of the selection criteria. Comparison Matrixes for decision alternatives are shown as seen in below:

Table 7. Pairwise Comparison Matrices

	Fuel Price					Product Quality			
	P1	P2	P3	P4		P1	P2	P3	P4
P1	1,00	1,72	2,17	1,86	P1	1,00	1,53	1,31	1,34
P2	0,58	1,00	1,73	1,22	P2	0,65	1,00	1,24	1,67
P3	0,46	0,58	1,00	1,46	P3	0,77	0,81	1,00	2,10
P4	0,54	0,82	0,68	1	P4	0,74	0,60	0,48	1,00
∑	**2,58**	**4,12**	**5,58**	**5,54**	∑	**3,16**	**3,94**	**4,02**	**6,11**

	Service Quality					Easy Terms of Payment			
	P1	P2	P3	P4		P1	P2	P3	P4
P1	1,00	2,01	1,72	1,42	P1	1,00	1,63	1,92	2,17
P2	0,50	1,00	1,32	1,37	P2	0,61	1,00	2,09	1,81
P3	0,58	0,76	1,00	1,44	P3	0,52	0,48	1,00	2,03
P4	0,70	0,73	0,69	1,00	P4	0,46	0,55	0,49	1,00
∑	**2,78**	**4,50**	**4,73**	**5,23**	∑	**2,59**	**3,67**	**5,50**	**7,00**

	Brand Awareness					Environmental Sensitivity			
	P1	P2	P3	P4		P1	P2	P3	P4
P1	1	1,88	1,43	1,06	P1	1	1,65	2,11	1,33
P2	0,53	1	1,13	1,52	P2	0,61	1	1,19	1,59
P3	0,70	0,89	1	1,99	P3	0,47	0,84	1	1,56
P4	0,95	0,66	0,50	1	P4	0,75	0,63	0,64	1
∑	**3,18**	**4,42**	**4,06**	**5,57**	∑	**2,83**	**4,12**	**4,94**	**5,47**

In the next stage, in order to obtain the comparable values, the normalization operations were realized for each decision matrix by using the *equation 3*. As a result of these operations, the normalized matrices were constructed as shown in below:

Table 8. Normalized Matrixes

	Fuel Price						Product Quality				
	P1	P2	P3	P4	**S1**		P1	P2	P3	P4	**S2**
P1	0,3875	0,4180	0,3883	0,3353	**0,3822**	P1	0,3161	0,3886	0,3248	0,2200	**0,3124**
P2	0,2252	0,2429	0,3101	0,2205	**0,2497**	P2	0,2067	0,2541	0,3078	0,2735	**0,2605**
P3	0,1787	0,1403	0,1791	0,2638	**0,1905**	P3	0,2421	0,2053	0,2488	0,3429	**0,2598**
P4	0,2086	0,1989	0,1225	0,1805	**0,1776**	P4	0,2351	0,1520	0,1187	0,1636	**0,1673**
∑	1,00	1,00	1,00	1,00	1,00	∑	1,00	1,00	1,00	1,00	1,00

	Service Quality						Easy Terms of Payment				
	P1	P2	P3	P4	**S3**		P1	P2	P3	P4	**S4**
P1	0,3594	0,4467	0,3640	0,2714	0,3604	P1	0,3855	0,4453	0,3492	0,3099	0,3725

P2	0,1789	0,2224	0,2781	0,2624	0,2354	P2	0,2362	0,2728	0,3794	0,2578	0,2866
P3	0,2086	0,1689	0,2112	0,2751	0,2159	P3	0,2006	0,1307	0,1817	0,2894	0,2006
P4	0,2531	0,1620	0,1467	0,1911	0,1882	P4	0,1777	0,1511	0,0897	0,1428	0,1403
∑	1,00	1,00	1,00	1,00	1,00	∑	1,00	1,00	1,00	1,00	1,00

Brand Awareness						Environmental Sensitivity					
	P1	P2	P3	P4	**S5**		P1	P2	P3	P4	**S6**
P1	0,3145	0,4250	0,3518	0,1895	0,3202	P1	0,3529	0,4007	0,4270	0,2424	0,3557
P2	0,1674	0,2262	0,2782	0,2734	0,2363	P2	0,2137	0,2426	0,2407	0,2903	0,2468
P3	0,2203	0,2003	0,2464	0,3576	0,2561	P3	0,1673	0,2040	0,2024	0,2846	0,2146
P4	0,2979	0,1485	0,1237	0,1795	0,1874	P4	0,2660	0,1527	0,1300	0,1827	0,1829
∑	1,00	1,00	1,00	1,00	1,00	∑	1,00	1,00	1,00	1,00	1,00

Obtained vectors that called as s are collected and matrix *D* is constructed and the matrix *D* is the sum of these matrices. The matrix *D* is constructed as shown in below:

Table 9. Matrix K

	S1	S2	S3	S4	S5	S6
P1	0,3822	0,3124	0,3604	0,3725	0,3202	0,3557
P2	0,2497	0,2605	0,2354	0,2866	0,2363	0,2468
P3	0,1905	0,2598	0,2159	0,2006	0,2561	0,2146
P4	0,1776	0,1673	0,1882	0,1403	0,1874	0,1829
∑	1,00	1,00	1,00	1,00	1,00	1,00

Finally, elements of the matrix K are multiplied by the vector v and at the end of the calculation, the vector *l* is obtained. The vector l gives the relative importance value of the decision alternatives. In this study, the vector l is constructed as shown in below:

$$L = \begin{bmatrix} 0{,}3822 & 0{,}3124 & 0{,}3604 & 0{,}3725 & 0{,}3202 & 0{,}3557 \\ 0{,}2497 & 0{,}2605 & 0{,}2354 & 0{,}2866 & 0{,}2363 & 0{,}2468 \\ 0{,}1905 & 0{,}2598 & 0{,}2159 & 0{,}2006 & 0{,}2561 & 0{,}2146 \\ 0{,}1776 & 0{,}1673 & 0{,}1882 & 0{,}1403 & 0{,}1874 & 0{,}1829 \end{bmatrix} x \begin{bmatrix} 0{,}2371 \\ 0{,}1737 \\ 0{,}1755 \\ 0{,}1306 \\ 0{,}1594 \\ 0{,}1236 \end{bmatrix} = \begin{bmatrix} 0{,}352 \\ 0{,}251 \\ 0{,}222 \\ 0.175 \end{bmatrix}$$

When the consistency ratio of the decision alternatives is checked, it is seen that all options are consistent. Consistency ratios of these options can be shown as 0.022, 0.022, 0.029, 0.024, 0.054, and 0.031 for all decision alternatives respectively. Consequently, consistency ratios of the decision alternatives are less than 0.10 and all of them are consistent.

5. RESULTS AND CONCLUSIONS

Proper fuel supplier selection is getting increasingly more importance in the field of logistics and transportation. In order to gain competitive advantages, an international transportation company that is the most important part of logistics needs to focus on the transportation costs and perfection of the logistics operations as critical factors of its competitive power and sustainability in the transport markets. Proper fuel supplier selection can help reduce the transport and logistics costs in addition to increasing the competitive power of a transport firm. Therefore, this study proposes an applicable and structural frame relating to fuel supplier selection process to improve its competitiveness of logistics and transportation companies. The total performance that expected from a fuel supplier is evaluated by using the AHP method and it can help to improve the capabilities and abilities of fuel suppliers. More importantly, depending on existence of the effective and cost-efficient fuel suppliers, the national, regional and international economies can be affected by virtue of the more advanced logistics and transportation activities positively. In addition to that, this study can also help to construct a systematic and structural frame in order to solve the decision making problems concerning with the fuel supplier selection.

In order to reach to the right and applicable results concerning with the fuel supplier selection, this study focuses on the real judgments of decision makers. This approach can be evaluated that is one of the strengths sides of this study. Therefore, owner or senior executives of the logistics companies were selected as members of the board of experts. More importantly, pairwise comparison questions prepared according to the judgments of the members of the board of experts were directed to the decision makers who play an important role in the decision making process in the transportation and logistics companies. As a result of this approach, validity level of this study is very high and it can also be applied to the actual fuel supplier selection processes in the field of logistics and transportation.

This study claims contribute to the literature concerning with the field of logistics and transportation. First of all, the all selection criteria and decision alternatives that affected to the fuel supplier selection process were evaluated extensively by the helps of experts. Additionally, decision makers in the logistics and transportation companies can apply results of this study in the fuel supplier selection processes.

The results of this research present that the fuel prices criterion is considered as the most important by the experts who are the owner or senior executives of a logistics company with a priority weight of 23.71% followed by the quality of service that had a priority weight of 17.55%. When all decision alternatives are evaluated, it can be seen that the best option is the Brand-P with a priority weight of 35.18% followed by the Brand-B that had a priority weight of 25.14%.

There is limited study in this field and even if it is seen as a serious problem, this situation demonstrates that the literature concerning with this field can be improved by virtue of studies that will realize in the future. Obtained findings can easily be generalized to all transportation companies in the field of logistics because of the selected firms for this research are already international companies.

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